Temptation, Commitment, and Hand-to-Mouth Consumers*

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November 4, 2017

JOB MARKET PAPER

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Abstract

20% of U.S. households are "wealthy hand-to-mouth" who hold only illiquid assets. But why should they do so, since higher-yielding liquid assets are available? To rationalize this behavior, we build a life-cycle model with non-standard preferences: households are tempted to consume their liquid assets, and therefore purchase housing as a savings commitment device. As a result, households choose to be "wealthy hand-to-mouth" to obtain the "commitment benefit" from housing. The model matches the fraction of hand-to-mouth households, rationalizes the heterogeneity in the marginal propensity to consume, and is consistent with micro evidence that households achieve higher savings through homeownership, none of which traditional models can explain.

Keywords: commitment; hand-to-mouth; housing; life-cycle models; temptation preferences

JEL classification: D11; D14; D91; E21

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*We thank Tilman Graff for outstanding research assistance. We are grateful to Orazio Attanasio, Hamish Low, Costas Meghir, Peter Neary, Akos Valentinyi, Gianluca Violante and seminar participants at Oxford and Yale for helpful comments.

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1 Introduction

A large fraction of U.S. households hold almost no liquid assets, despite owning sizeable illiquid assets, primarily housing. Kaplan, Violante, and Weidner (2014) provide empirical evidence that this group of households, which they call the "wealthy hand-to-mouth", amount to roughly 20% of the U.S. population. Households' overwhelming preference for housing is puzzling for two reasons: first, households limit their ability to respond to adverse shocks by concentrating their wealth in illiquid housing; second, this desire for illiquidity arises even though housing has a lower risk-adjusted return than liquid assets like stocks.

In this paper, we give a new explanation for the preference for housing and consequently the existence of the wealthy hand-to-mouth. We develop a structural life-cycle model where households are tempted to consume their liquid assets, following Gul and Pesendorfer (2001), and therefore purchase housing as a savings commitment device. Housing acts as a commitment device due to the need to make regular mortgage payments, gradually building wealth in the form of home equity. We demonstrate that this model is able to match the empirical evidence that 20% of households are wealthy hand to mouth, despite the presence of a high return liquid asset. We then evaluate the model's ability to match macroeconomic evidence on heterogeneity in the marginal propensity to consume (MPC) across the distribution of households' resources and microeconomic evidence that homeownership leads to greater wealth accumulation. First, our model is able to match the empirical evidence that the MPC declines relatively slowly with wealth, a finding that cannot be explained by traditional heterogeneous agent models. Second, our model is consistent with the evidence that households achieve higher savings through homeownership, a finding that helps identify the role of temptation and commitment relative to alternative explanations.

An important feature of our model is that it provides an explanation of wealthy hand-to-mouth households, despite the presence of a liquid asset with higher returns than housing. Kaplan and Violante (2014), explain the desire to hold illiquid housing and the presence of wealthy hand-to-mouth consumers through assuming that housing delivers excess returns relative to all available liquid assets. As a result, households mainly invest in housing assets with higher returns, which in turn limits their ability to smooth their consumption. But, as we demonstrate in our analysis, housing delivers lower risk-adjusted returns than stocks, even when accounting for imputed rents and other benefits to homeownership, a finding that is consistent with a wide body of empirical literature.[1] Given the presence of a high-return liquid asset such as stocks, how can

[1]For instance, Flavin and Yamashita (2002) and Piazzesi, Schneider, and Tuzel (2007) both find that housing delivers lower risk adjusted returns than stocks.

we explain the existence of wealthy hand-to-mouth households? In our framework, the desire for housing stems from the desire for illiquidity to avoid temptation. Illiquid housing helps households commit to a self-imposed savings plan that obliges them to repay their mortgage and gradually build up wealth in the form of home equity. As a result of this "commitment benefit", we are able to provide a choice-theoretic micro-foundation for the empirical finding that 20% of households are wealthy hand-to-mouth.

Our model incorporates a number of realistic features of real-world housing and mortgage markets. Households both choose whether or not to own a home, and can also decide on the size of their home in each period of their lives. Home-size adjustments are subject to both a fixed financial cost and a utility cost; it is because of these transaction costs that housing serves as a commitment device. The house price process is calibrated from the data and enters the model exogenously. Housing is assumed to be a leveraged investment, reflecting the fact that households typically buy a home with a mortgage: households borrow a fraction of the value of their homes. Finally, households cannot extract a fraction of their home equity; only full extraction when the house is sold is allowed.

In our quantitative exercise, we match a number of empirical observations on U.S. households: the share of liquid assets, the fraction of households with zero net wealth ("poor hand-to-mouth"), and the fraction of households with no liquid wealth but substantial illiquid wealth (wealthy hand-to-mouth). The model also provides a micro-founded explanation for the slow decline of average MPCs by net wealth, a finding that is now widely recognized in the empirical literature, Jappelli and Pistaferri (2014) and Fagereng, Holm, and Natvik (2016), among others, but cannot be explained by traditional heterogenous agent models. In addition we document that liquid wealth is more important in explaining MPC heterogeneity across households than net wealth: we find a 40 percentage point decline in MPCs between the top and the bottom quartiles of liquid wealth.

In the empirical section of the paper, we present micro evidence that homeownership leads to higher wealth accumulation, evidence that is consistent with our model of housing as a savings commitment device. We compare the aggregate wealth accumulation of homeowners and renters using the Dutch Household Survey (DHS). Through the lens of our theory homeowners are households who commit to a future savings plan that obliges them to repay their mortgage in each future period. By contrast, renters are the ones that choose not to commit. Our strategy is to use propensity score matching (PSM) to compare the savings behavior of renters and homeowners. Using the DHS Survey, which contains a wide range of psychological questions related to planning horizons and financial literacy, we match households based on preferences, in addition to more standard measures such as demographics, wealth, income, and household composition. We find that renters who become homeowners increase their net savings by approximately 6,600 euros per year, which is over a quarter of their average net annual income, while their net savings in liquid assets do not change significantly. We demonstrate that our model is able to rationalize the empirical evidence that homeownership leads to higher savings, a finding that cannot be explained by standard housing models thus highlighting the commitment benefit of housing.

This paper contributes to two strands of literature related to the marginal propensity to consume and to housing. First, there exists a large body of literature that attempts to explain large and heterogeneous MPCs. Understanding the behaviour of MPCs is of crucial importance for many macroeconomic questions, including how fiscal stimuli, stabilization and redistributive policies should be implemented. Traditionally this heterogeneity is rationalized as a reflection of exogenous differences in tastes, a tradition which can be traced back to Kaldor (1955), who assumed that workers have a higher MPC than capital owners. In a similar vein, Mankiw (2000) considers some households to have long time horizons, while others have short ones, leading them to react differently to income shocks (spenders-savers model). Galí, López-Salido, and Vallés (2004) introduce non-Ricardian (rule-of-thumb) households into an otherwise standard New Keynesian model to show the importance of non-zero consumption response to shocks on monetary policy rules. More recently, Carroll et al. (2017) assume that MPC differences reflect differences in households' discount factors. While the previous literature models hand-to-mouth households exogenously, Kaplan and Violante (2014) have turned the attention to providing micro foundations for such heterogeneities. We build upon this literature by proposing a model of wealthy hand-to-mouth households who display large MPCs out of transitory shocks.

Second, our paper contributes to the micro literature that asks whether homeownership leads to greater wealth accumulation. Knowing how households' savings behaviour responds to their portfolio choices is important when the goal of the fiscal policy is to increase average savings. Di, Belsky, and Liu (2007) and LeBlanc and Schmidt (2017) both find that homeowners accumulate more wealth than renters. Our study is most similar to the latter, who also compare the savings behavior of homeowners to otherwise similar renters.

We innovate upon their method by using a variety of psychological measures related to savings preferences and financial sophistication, which improves identification. In addition, we use household panel data rather than cross-sectional data, which allows us to match households based on lagged net wealth, an important determinant of homeownership. We find evidence that homeownership leads to greater savings and wealth accumulation, evidence that is consistent with our explanation of the wealthy hand-to-mouth.

The rest of the paper proceeds as follows. Section 2 describes the model. Section 3 provides an insight on the role of temptation and commitment in homeownership. Section 4 describes the parametrization of the model and reports the key results on hand-to-mouth households and the marginal propensity to consume. Section 5 documents the commitment benefit of homeownership, using micro evidence on the savings behaviour of homeowners and renters. Section 6 concludes the paper.

2 The Benchmark Life-Cycle Model

In this section, we develop our life-cycle model with temptation preference building on Gul and Pesendorfer (2001). Households live for T periods as adults, of which W periods are spent as workers and $T-W$ periods as retirees. They maximise their present discounted lifetime utility, which depends on nondurable consumption and housing service flow. Households can reallocate resources between periods by saving in a fully liquid asset or in less liquid housing. There are two sizes of housing available: apartment and house. Buying an apartment or a house comes with a mortgage equal to the price of the home minus the necessary downpayment. Those households who do not own a home are renters. The only source of uncertainty in the model comes from labor income.

2.1 Model Structure

Temptation Preferences

Households with standard preferences have no demand for commitment devices because they are ex-post fully committed to their ex-ante choices. In order to generate demand for commitment, households have to exhibit some sort of present-biased behavior. In this section, we introduce the temptation preferences of Gul and Pesendorfer (2001) that represent preferences for immediate gratification. Households with temptation preferences, similarly to those with standard preferences, want to maximize the sum of their expected, discounted lifetime utility, which can be written as:

$$\max \mathbb{E}_t \sum_{t=0}^{T} \beta^t U_t. \tag{1}$$

In contrast to standard preferences, the instantaneous utility function representing temptation preferences depend not only on the chosen consumption bundle, but also on the most desirable consumption bundle in the feasible choice set:

$$U(c_t, h_t, \tilde{c}_t, \tilde{h}_t) = u(c_t, h_t) - \lambda\Big[u(\tilde{c}_t, \tilde{h}_t) - u(c_t, h_t)\Big] \tag{2}$$

where u is a concave function, which is increasing both in c_t and h_t and is specified later. c_t and h_t are the chosen level of nondurable consumption and housing status, while $\tilde{c}_t$ and $\tilde{h}_t$ are the most desirable nondurable consumption and housing status. Households may be tempted to maximise their current period utility instead of maximising their discounted lifetime utility. In particular, they may wish to spend all of their available liquid resources on nondurable consumption and housing, since that is the most tempting alternative of all. Therefore the most tempting alternative, ($\tilde{c}_t$, $\tilde{h}_t$) maximises their immediate utility:

$$\big[\tilde{c}_t, \tilde{h}_t\big] = \arg \max_{c_t, h_t \in \mathscr{A}_t} u(c_t, h_t), \tag{3}$$

where $\mathscr{A}_t$ represents the liquid budget set of the households, to be defined later. The term in square brackets in equation (2) represents the temptation motive of the households. It is the utility cost of not choosing the most tempting consumption alternative: the difference between the temptation values of the most tempting and of the chosen consumption bundles. When exposed to temptation, households can decide to exercise self-control or to succumb to temptation. If they exercise self-control they have to pay the utility cost of temptation resistance. If, on the other hand, households succumb to temptation the cost of self-control becomes zero and the utility function simplifies to its standard form.

Turning to the choice of functional form for the utility function, u, we follow Attanasio et al. (2012) and let home ownership affect the utility function flexibly.

$$u(c_t, h_t) = \Big\{ \tfrac{c_t^{1-\gamma}}{1-\gamma} \exp(\theta\phi(h_t)) + \mu\phi(h_t) - \chi I_{h_t \neq h_{t-1}} \tag{4}$$

and

$$\phi = \begin{cases} 0, & \text{if } h_t = 0 \\ 0 \le \phi \le 1, & \text{if } h_t = 1 \\ 1, & \text{if } h_t = 2 \end{cases} \tag{5}$$

where γ is the risk aversion parameter, and θ and μ are housing preference parameters. Home ownership affects immediate utility both directly and via the marginal utility of consumption. The direct effect represented by $\mu\phi(h_t)$ makes the utility function non-homothetic in consumption and housing. Moreover, the effects of housing on utility depend on the type of housing, h, which can take three values in each period: 0 if the household is a renter, 1 if it is an apartment owner, while 2 when it is a house owner. Parameter ϕ determines the relative utility from owning an apartment versus owning a house. It takes a value of zero if the household rents, implying the exponential term becomes 1 and the additive term becomes zero in equation (4). Consequently renters only derive utility from nondurable consumption and not from housing. We assume that whenever a household adjusts its housing (whenever $I_{h_t \neq h_{t-1}}$ equals one in equation (4)), it has to pay a utility cost, χ. The utility cost plays an important role in our model, as it drives the usefulness of housing as a commitment device. This cost is different from the financial cost of a move, which we also introduce later.

Assets. Households who wish to save can invest in two types of assets: a fully liquid financial asset, a_t, and a less liquid housing asset, h_t. The financial asset yields a certain return, r, in each period, therefore the gross return on assets is $R = 1 + r$. Households can buy a house at a given price, p_t or an apartment at price ηp_t, where η is smaller than 1. House prices grow at a constant rate, R^H, over time, representing a fixed gross return on the housing asset:

$$p_t = p_{t-1} R^H. \qquad \forall t \tag{6}$$

Buying or selling a home always incurs a fixed cost, which is proportional to the price of the home, fp_t for houses and $f\eta p_t$ for apartments. Also, buying a home automatically comes with a mortgage equal to a fraction $1 - \psi$ of the home price, where ψ is the downpayment requirement. The only exception is when households downsize in housing, i.e. sell their house and buy an apartment instead: we assume that these households do not take out new mortgages. Households pay a fixed interest rate, r^M on their mortgage, which is higher than the rate of return on the liquid asset.

When households do not own a home, they are renters. Without loss of generality, we assume that the cost of renting is zero. This can be thought of as a normalization: decisions are not affected by the levels of the costs and benefits attached to different housing choices, but by the relative sizes of these costs and benefits.

Mortgages. The most widely used contract in the U.S. is the 30-year fixed-rate mortgage. Therefore we assume that mortgages are 30-year contracts with fixed repayments, rp, in every period. Therefore the law of motion for mortgages is:

$$m_{t+1} \quad = R^M m_t - rp \tag{7}$$

The initial mortgage for households who buy a house at time t is

$$m_1 = p_t(1 - \psi) \tag{8}$$

and for those who buy an apartment is

$$m_1 = \eta p_t(1-\psi). \tag{9}$$

In addition, we assume that a household who downsizes from a house to an apartment cannot take out a mortgage when buying its apartment. As households are restricted to pay back their mortgages within 30 years, the following terminal condition is satisfied:

$$m_{31} = 0 \tag{10}$$

It implies the following fixed mortgage repayment for house owners:

$$rp = \frac{R_M^{30} p_t(1-\psi)}{\sum_{j=1}^{29} R_M^j}, \tag{11}$$

while fraction η of this repayment for apartment owners:

$$\eta rp = \frac{R_M^{30} \eta p_t(1-\psi)}{\sum_{j=1}^{29} R_M^j}, \tag{12}$$

Note that mortgage repayments only depend on the home price at the time the mortgage is taken out. This implies that once the mortgage is taken out, the repayment does not vary over time.

Income. Households receive labor income, y_t, in every period before retirement, $t \leq W$, which is assumed to evolve according to the following:

$$\ln y_t = g_t + \alpha + z_t \tag{13}$$

where g_t is a deterministic age profile, α is a household-specific fixedeffect, and z_t is an idiosyncratic shock to log income that is described by an AR(1) Markov process:

$$z_t = \rho z_{t-1} + \varepsilon_t. \tag{14}$$

Income after retirement, $t > W$, is a constant fraction, ω, of the last working period's labor income.

$$y_t = \omega y_W \tag{15}$$

Liquid Budget Set. In order to close the model we need to define the liquid budget set, $\mathscr{A}_t$, which is the constraint households face when they only optimize for the current period. Tempted households take into account their liquid budget set whenever they evaluate their most tempting alternatives.

$$
\mathscr{A}_t = \begin{cases} x_t \in R^+ : x_t \leq a_t + y_t, & \text{if } h_{t-1} = 0 \\ \\ x_t \in R^+ : x_t \leq a_t + y_t + \eta\big[p(1-f) - R^M m_t\big]\mathbb{I}_{h_t \neq h_{t-1}}, & \text{if } h_{t-1} = 1 \\ \\ x_t \in R^+ : x_t \leq a_t + y_t + \big[p(1-f) - R^M m_t\big]\mathbb{I}_{h_t \neq h_{t-1}}, & \text{if } h_{t-1} = 2 \end{cases} \tag{16}
$$

where $\mathbb{I}_{h_t \neq h_{t-1}}$ is an index which takes a value of one whenever households adjust their housing assets between periods $t-1$ and t.

Recursive Formulation. Having all the details of the theoretical model specified, we can define the vector of state variables, $\Omega_t = (a_t, h_{t-1}, m_t, z_t, \alpha)$ and formulate the households' value function in period t in recursive form as follows:

$$
V_t(\Omega_t) = \max_{\{c_t, h_t, a_{t+1}\}} u(c_t, h_t) - \lambda\big[u(\tilde{c}_t, \tilde{h}_t) - u(c_t, h_t)\big] + \beta \mathbb{E}_t V_{t+1}(\Omega_{t+1}), \tag{17}
$$

subject to the functional form for the utility function, as defined in equations (4)-(5), the liquid budget set defined by equation (16) and the following constraints:

$$
a_{t+1} = R \begin{cases} a_t + y_t - c_t - p(\psi + f)\left(\eta \mathbb{I}_{h_t=1} + \mathbb{I}_{h_t=2}\right) \\ \text{if } h_{t-1} = 0 \\ \\ a_t + y_t - c_t + \eta\big(p(1-f) - R^M m_t\big)\mathbb{I}_{h_t \neq 1} - \eta r p_t \mathbb{I}_{h_t=1} - p(f+\psi)\mathbb{I}_{h_t=2} \\ \text{if } h_{t-1} = 1 \\ \\ a_t + y_t - c_t + \big(p(1-f) - R^M m_t\big)\mathbb{I}_{h_t \neq 2} - r p_t \mathbb{I}_{h_t=2} - \eta p(1-f)\mathbb{I}_{h_t=1} \\ \text{if } h_{t-1} = 2 \end{cases}
$$

$$
c_t > 0, \quad h_t \in \{0, 1, 2\}, \quad a_{t+1} \geq 0,
$$

$$
y_t = \begin{cases} \exp(g_t + \alpha + z_t), & \text{if } t \leq W \\ \\ \omega y_W, & \text{if } t > W \end{cases}
$$

$$
z_t = \rho z_{t-1} + \varepsilon_t.
$$

In the Appendix we show the computations we use in order to solve the problem defined by this recursive formulation.

3 Quantitative Insights From Our Model

In this section, our aim is to show two implications of our model, which differ from those of the standard model. In order to do so, we focus on a benchmark version of the model described before in order to make our points as clearly as possible. In Table 1 we give the key parameters, which are used in the model.

We assume that housing does not enter the utility function, labor income is deterministic and that the returns on the liquid and housing assets are the same. All the other benchmark parameter values are taken from the existing literature and justified later in Section 4. A full list of all parameters is given in Appendix A.1.

Parameter		**Value**
θ	Housing preference (MU of consumption)	0
μ	Housing preference (non-homotheticity)	0
z	Idiosyncratic shock to log income	0
R	Return on liquid asset	2.10
R^H	Return on housing	2.10

Table 1: Parameters in the Simplified Model

3.1 The Commitment Value Implies a Demand for Housing

Given the parameters in Table 1, households with standard preferences have no demand for housing. Even though the returns on housing and the liquid asset are the same, buying a home comes both with sizeable utility and financial transaction costs. We demonstrate our simulation results for standard households in Figure 1, which shows that households are able to smooth consumption by keeping all their savings in liquid asset form.

Our simulation results for tempted households are shown in Figure 2. Households with temptation preferences purchase homes despite having to pay the sizeable transaction costs. This is a rational choice of households with temptation preferences since they not only buy housing for its future return, but more importantly for its illiquidity, its commitment value. Keeping their savings in the illiquid housing asset decreases their cost of temptation and at the same time allows them to accumulate wealth for retirement. As a result, the effect of lower housing return on the demand for housing is offset by the effect of the illiquidity of housing.

Panel (a) of Figure 2 shows that tempted households begin to accumulate liquid assets quite late in their life, at around age 60.

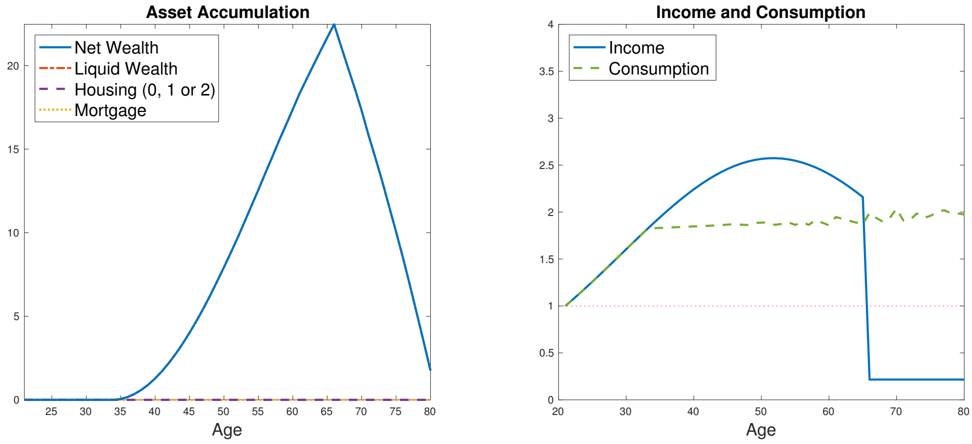

Figure 1: Lifecycle Profiles for Standard Households
$R = R^H = 1.021$, $p_1 = 4$

The reason is that accumulating wealth in liquid form in the presence of temptation is costly: households have to exercise self-control since otherwise they optimize for the current period only and spend their liquid assets immediately. By contrast, tempted households buy homes relatively early in their life, at around age 38. As a result of the temptation and commitment motives in our model, households spend a significant part of their lives as wealthy hand-to-mouth: they hold no liquid wealth while owning a sizeable illiquid, housing asset.

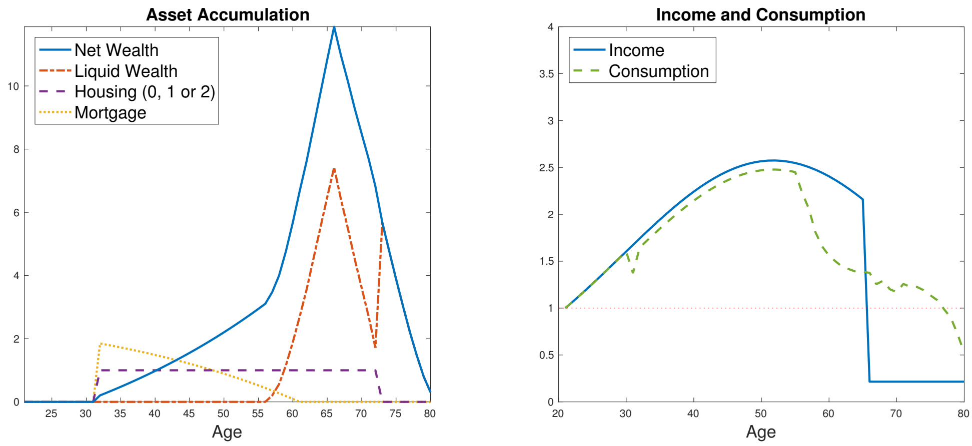

Figure 2: Lifecycle Profiles for Tempted Households
$R = R^H = 1.021$, $p_1 = 4$

Panel (b) of Figure 2 shows the implications of households' asset portfolio decisions for their consumption together with their labor income. Since tempted households do not accumulate liquid wealth at the beginning of their lives their consumption coincides with their labor income up to the point when they invest in housing. This implies that the downpayment requirement for mortgages has an immediate effect on their consumption when they buy their homes. This is why consumption drops significantly for one period at the age of 38. After buying the home, consumption follows labor income closely: the difference between the two is the period mortgage repayment. After age 60, when households start accumulating liquid wealth, consumption drops steadily. This is the consequence of temptation: households do not accumulate enough wealth for retirement when their labor income is high. As a result, facing decreasing labor income after age 55, households' consumption cannot be smoothed.

3.2 The Availability of Commitment Implies More Savings

The other important implication of our model with temptation preferences is that the savings behavior of households changes with the availability of the commitment device. Let us first consider the case when the liquid asset is the only available option for savings. On the one hand, rational, tempted households want to accumulate wealth for their retirement. On the other hand, accumulation of liquid wealth is costly, which disincentivize savings. Therefore, on aggregate households may be better off facing the welfare loss of not being able to support retirement consumption than accumulating high levels of liquid wealth, which entails a high cost of temptation in each period.

Households' incentives to save change a lot if they are allowed to invest in illiquid housing. This is because adjusting housing comes with sizeable utility and financial transaction costs. Therefore, keeping savings in the form of housing asset makes households less likely to be tempted to spend their accumulated wealth. As a result, the availability of housing helps households save more. That is the channel through which housing plays a role as a commitment device.

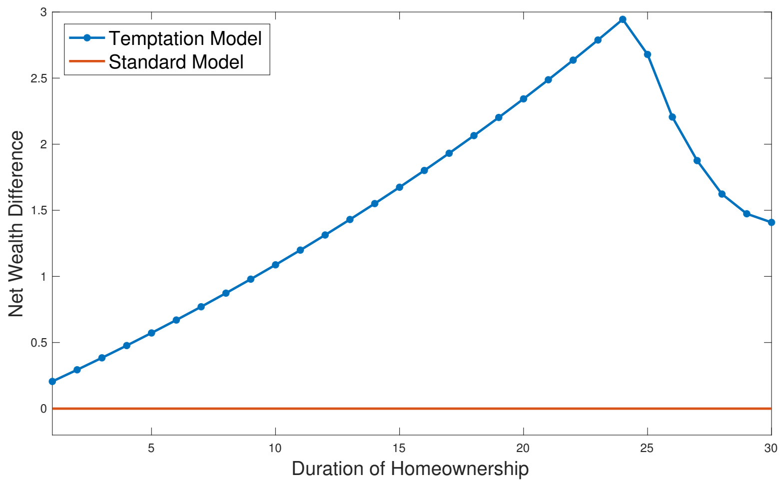

Figure 3: The Effect of Commitment on Savings

In Figure 3 we plot simulated wealth differences for standard and tempted households with and without access to a housing asset by the duration of home ownership. The red straight line shows the difference between the wealth accumulation of a standard household if it has access to a housing asset and if it has no access to a housing asset. The line is horizontal, indicating that the presence of housing does not change the savings behavior of standard households.

The blue dotted line shows the difference between the wealth accumulation of a tempted household if it has access to a housing asset and if it has no access to a housing asset. The line is increasing over the duration of home ownership, indicating that the presence of housing changes the savings behavior of tempted households. After buying a home, households need to pay the mortgage cost in each period, which can be interpreted as self-imposed forced savings that accumulates throughout the period of home ownership. When housing is not an available savings option, households save less because keeping their savings in liquid form is costly.

Note that after about twenty-five years of home ownership the wealth difference starts to decrease. As households without access to housing asset get closer to retirement they realize that they do not have sufficient amount of wealth for supporting their consumption over their retirement. As a consequence, they try to catch up with savings.

4 The Calibrated Model

In this section, we give details of the calibration of our full model. By contrast to the previous section, where we evaluate a simplified version of our model, here we assume that housing enters the utility function and that labor income is stochastic as described in Section 2.1. After calibrating the model, we aim to match three statistics in the data: (1) the average share of assets in liquid form, (2) the fraction of households that are poor hand to mouth, who have neither liquid nor illiquid savings, (3) the fraction of households that are wealthy hand to mouth, who have illiquid but no liquid savings. We also show that our model is able to capture the observed heterogeneity of the MPCs by liquid wealth, as a consequence of the presence of wealthy hand-to-mouth households. Hereafter we denote hand-to-mouth households by HtM.

4.1 Calibration of Parameters

4.1.1 External parameters

In most of the cases we rely on parameters which are taken from elsewhere in the literature. The list of all the parameters can be found in Table A.1 in Appendix A.1.

Income and initial wealth. We assume zero initial housing and liquid endowments. The initial distribution of income (α) is calibrated to match data on initial earnings dispersion of 20-25 year olds from SCF in 2013. We model retirement as the last 15 years of households' life when their income is not subject to any risk. More precisely, their income after retirement is given by a replacement rate, ω, of 60 percent of their last working period income.

Housing. Following Attanasio et al. (2012) we set the ratio of the price of an apartment to the price of a house, η, at 0.6.[2] We also impose a 5 % fixed cost of moving, f representing the cost of the real estate agent, lawyers, surveyors, removal companies when moving between homes.

Mortgage market. The cost of servicing the mortgage is fixed at 3%. Therefore the gross mortgage rate, R^M, is 1.03, which is about one percentage point higher than the risk free rate. We assume that each household borrows 90% of the value of its home, hence we set the downpayment requirement ψ to be 10%.

Utility function. We set the discount rate, β, to be 0.98. The curvature parameter, γ, is calibrated to match findings in Blundell, Browning, and Meghir (1994) and in Attanasio and Weber (1995). It corresponds to an inverse elasticity of intertemporal substitution of approximately 1.5. The relative utility of an apartment compared to a house, ϕ, is set at 0.5. The temptation parameter, λ, is one of the most important parameters in our model, which measures households preferences for the tempting alternative. We use the estimate of 0.35 for λ from Kovacs (2017), who estimates the Euler equation under temptation preferences and identifies the temptation parameter using variation in the liquid asset to consumption ratio.

Parameter		**Value**
β	Discount factor	0.98
γ	Curvature parameter	1.50
ϕ	Relative utility of an apartment	0.50
λ	Temptation parameter	0.35

Table 2: Preference Parameters

[2]They calculate this parameter by dividing all houses and apartments in the data into two categories by the number of rooms using the British Household Panel Survey (BHPS). The ratio η is the ratio of the average price of a home with less than 5 rooms (incl. kitchens and bathrooms) to the price of a home with more than five rooms.

4.1.2 Return Calculations

Calculating the returns on liquid assets is relatively straightforward, while calculating the housing return needs more careful consideration. We start with the consumption-based pricing equation, which expresses asset returns in terms of prices and dividends:

$$r_{t+1} = \frac{p_{t+1} + d_{t+1} - p_t}{p_t} \tag{18}$$

where r_{t+1} is the net return on the asset between periods t and $t+1$, p_t is the price of the asset in period t, while d_{t+1} is the dividend in period $t+1$. We use this pricing formula to calculate the return on housing. Households who invest in housing in period t enjoy housing service flows between periods t and $t+1$, but also pay the costs related to home ownership over the same period. More explicitly, we can write the return on housing similarly to equation (18) as

$$r^{\mathrm{h}}_{t+1} = \frac{p_{t+1} + s_{t+1} - c^{\mathrm{m}}_{t+1} - c^{\mathrm{i}}_{t+1} - p_t}{p_t} \tag{19}$$

with p_t is the price of the house in period t, while s_{t+1} and and c_{t+1} are the housing service flow and the costs that arise between periods t and $t+1$. Maintenance cost is denoted by c^{m}, and the cost of home insurance by c^{i}. Note that we implicitly assume that depreciation is roughly equal to the maintenance cost.

In what follows we measure aggregate house prices by the Case-Shiller house price index, while we use data from the Bureau of Economic Analysis (BEA) in order to calculate the average housing service flow. We follow the approach of Kaplan and Violante (2014) to calibrate the size of different ownership-related costs. Housing service flow and related costs are all proportional to the value of the house. Given that these costs are relatively constant over time in terms of the value of the house, in the rest of the paper we use constant fractions of changing house value in order to calculate these variables. Under these conditions equation (19) can be rewritten as

$$r^{\mathrm{h}}_{t+1} = \frac{p^{\mathrm{h}}_{t+1} + (s - c^{\mathrm{m}} - c^{\mathrm{i}} - 1)p^{\mathrm{h}}_t}{p^{\mathrm{h}}_t} \tag{20}$$

where s, c^m and c^i are the housing service flows and different costs relative to the value of the house.

We use the housing gross value added at current dollars from the BEA to approximate the housing service flow and use residential fixed assets at current dollars to approximate the housing stock.[3] The average of gross housing value added over residential fixed assets

[3]Gross value added can be found in Table 7.4.5, "Housing Sector Output, Gross Value Added and

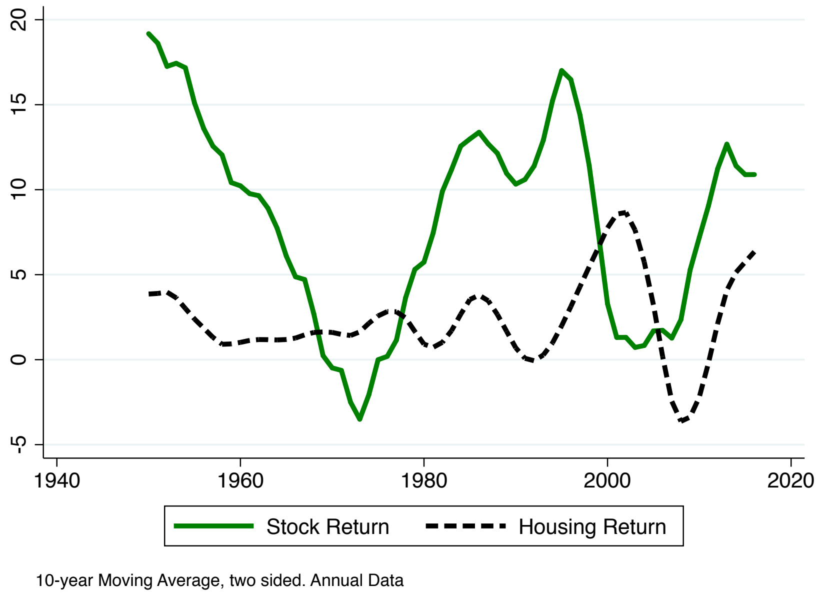

Figure 4: Real Returns

between 1950 and 2016 is around 8%. Following Kaplan and Violante (2014), we set the maintenance cost at 1% and the insurance cost at 0.35% of the value of housing. In Figure 4 we plot the calculated return on housing together with the 3 Month Treasury Bill Rate and the returns on the S&P 500 between 1950 and 2016.[4] The most important thing to notice is that stock returns are in general much higher than the return on housing or on the 3 Months T-Bill. There was only a short period of time in the seventies and a couple of years in the early twenties when stocks underperformed housing.

A part of these return differences can obviously be interpreted as reflecting differences in the riskiness of these assets. To allow for this, we calculate the risk-adjusted returns. Following Kaplan and Violante (2014) in order to calculate the risk-adjusted returns on the three assets, we subtract the variance of the return from the expected return of the asset.

$$r^i_{adj} = E(r^i) - var(r^i) \tag{21}$$

where superscript i refers to the type of the asset, i.e. 3 Months T-Bill, S&P500 and housing. Since we are using the variance as a measure of riskiness, we cannot generate a similar graph of risk-adjusted returns as in Figure 4. Instead, we have the average, risk-adjusted real returns over the period between 1950 and 2016, which is 0.69% for the T-bill, 5.40% for the stocks, while 2.10% for the housing asset as seen in Table 3.

Net Value Added" in National Income and Product Accounts (NIPA) of the BEA. Residential fixed assets can be found in Table 1.1, "Current-Cost Net Stock of Fixed Assets and Consumer Durable Goods" of the Fixed Asset Tables of the BEA.

[4] 3 Month T-Bill times series is downloaded from the database of the Federal Reserve Bank of St. Louis (Fred).

	Mean	St.Dev.	Risk-adj. Mean	Sharpe Ratio
T-Bill	0.74	2.12	0.69	-
Stock (S&P)	8.24	16.82	5.40	0.45
Housing (Case-Shiller)	2.34	5.06	2.10	0.30

Table 3: Real Asset Returns

We also report the Sharpe ratios for stocks and housing. The Sharpe ratio measures the expected value of the excess of the asset return over the T-bill return per unit of the standard deviation of the excess return. Therefore, the higher the value of the Sharpe ratio for a given risky asset, the more attractive is the asset, the more of its riskiness is compensated by its excess return. The Sharpe ratios confirm that housing yields a lower risk-adjusted return than stocks.

4.1.3 Calibrated Parameters

The remaining parameters in the utility function (θ, μ, κ) are calibrated such that the model matches the fraction of homeowners in the population. The average home ownership rate is approximately 70% in the U.S., while this rate reaches 50% by age 30. By matching these data moments we are able to determine parameters θ, μ and χ.

	Data	**Model**
Age 25-30	50%	48%
Age 20-80	68%	62%

Table 4: Ownership Rate

The calibration results are presented in Table 5. A negative θ implies Edgeworth substitutability of consumption and home ownership as the cross derivative of utility with respect to consumption and home ownership is negative in this case.

$$\frac{\partial u(C_t, H_t)/\partial C_t}{\partial H_t} = \theta\phi'(H_t)C_t^{-\gamma}\exp(\theta\phi(H_t)) < 0$$

Since μ is positive, an increase in housing has a direct positive effect on utility in addition to its cross-effect via the marginal utility of consumption.

Parameter		Value
θ	Housing preference (MU of conusmption)	-0.30
μ	Housing preference (non-homotheticity)	0.15
χ	Utility cost of housing adjustment	0.50

Table 5: Calibrated Parameters

4.2 Portfolio Choices and Implications

In this section we evaluate how well our model matches targeted observations on U.S. households. Based on the Survey of Consumer Finances (SCF), we aim to match three facts related to households' portfolio choices. The first fact is that on average about twenty-five percent of households' wealth is kept in liquid form. The second and third facts are percentages of U.S. population that are hand-to-mouth. Based on the calculations of Kaplan, Violante, and Weidner (2014) ten percent of U.S. households are poor hand-to-mouth, while roughly twenty percent of U.S. households are wealthy HtM.[5]

	U.S. Data	Temptation Model	Standard Model
Liquid Over Total Assets	25%	21%	52%
Poor HtM	10%	11%	0%
Wealthy HtM	20%	23%	7%

Table 6: Model versus Data

Note: U.S. Data comes from the Survey of Consumer Finances (SCF).

In Table 6 we report these aggregate measures observed on U.S. data together with their counterparts from our model. For comparison, we also include the results from a standard model calibration in which we target the same three variables. Our model is able to fit the observed portfolio choices well. It is worth highlighting the aspect of our temptation model, which helps us matching these patterns. Tempted households

[5]We also calculate the fraction of hand-to-mouth households and get very similar results to Kaplan, Violante, and Weidner (2014).

try to avoid keeping their savings in liquid form because that entails costly temptation. Consequently, they have a relatively low ratio of liquid wealth over total wealth. This feature of the model, in turn, gives high importance to liquid wealth as opposed to wealth itself and helps to rationalize the existence of poor and wealthy hand-to-mouth households in the population.

A re-calibarted standard model cannot match U.S. facts. Given that households with standard preferences have no desire for illiquidity, they keep a much higher fraction, 52%, of their wealth in liquid form. The model cannot deliver the observed fractions for hand-to-mouth households either. As large fraction of wealth is kept in liquid form, there are no poor hand-to-mouth households in the simulated sample, while the fraction of wealthy HtM households is very low, 7%.

Households' portfolio allocations have clear implications for their consumption behavior. Keeping a high fraction of savings in illiquid wealth in our model implies that household consumption is not isolated even from a one-period, transitory income shock. Carroll et al. (2017) give a comprehensive summary of the existing empirical literature on estimating the marginal propensity to consume. Most of the aggregate MPC estimates range between 0.2 and 0.6, which is not in line with the predictions of a standard life-cycle model. In a life-cycle framework consumption response to a transitory income shock is negligible, given that households smooth these shocks over their life. By contrast, and without targeting it, our model delivers an average MPC of about 0.35.

4.3 MPC Heterogeneity

In this section, we give a more detailed analysis of how our model matches the empirical findings on MPC heterogeneity. We use two recent papers for comparison: one is a survey-based study by Jappelli and Pistaferri (2014), and the other is an administrative data-based analysis by Fagereng, Holm, and Natvik (2016). As we summarize below, the two papers find very similar results both for the level of the average MPC and for the heterogeneity of MPCs by wealth.

Jappelli and Pistaferri (2014) use Italian survey data to study the consumption response to unexpected transitory income shocks. They exploit the survey question from the 2010 Italian Survey of Household Income and Wealth, which asks households how much of an unexpected transitory income change (equal to their average monthly income) they would spend. The average marginal propensity to consume over their sample of around 8,000 households is 0.48.[6] They also find a huge variation in MPCs by the cash-on-hand level of households. The MPCs of the top quintile of households

[6]Note that it is impossible to differentiate between durable and nondurable consumption responses here given that the survey question refers to the marginal propensity to spend, not to consume.

by cash-on-hand is about 26 percentage points lower than that of the bottom quintile of households.

Fagereng, Holm, and Natvik (2016, hereafter FHN) use Norwegian administrative data on lottery winnings to study the consumption response to unexpected transitory income shocks. They exploit the fact that a large fraction of Norwegians gamble on a regular basis and that lottery winnings above USD 1,100 have to be reported to the Norwegian Tax Authority.[7] The average marginal propensity to consume in their sample of around 18,500 households is 35 percent. The difference between the MPCs of the top and the bottom quartile of households by liquid wealth varies between 14 and 55 percentage points depending on the size of the shock. Consumption is more responsive for households with low liquid wealth. FHN also show that the correlation between MPCs and liquid wealth is higher than that between MPCs and net wealth.

Standard life-cycle models have difficulties to generate the observed size and heterogeneity of the MPCs in response to unanticipated, transitory income shocks. Introducing prudence and liquidity constraints increases MPCs somewhat, but it does not help to generate the observed large differences in consumption responses; there is insufficient concavity in the consumption function. Jappelli and Pistaferri (2014) demonstrate that an Ayiagari model with heterogeneous households, borrowing constraints and standard calibration produces a very modest 5 percentage point decline in the MPC across the wealth distribution. They also show that reproducing the observed empirical MPC heterogeneity needs implausibly impatient households: β has to be 0.6 or lower.

Contemporary models do a better job in matching the levels and heterogeneities of the marginal propensity to consume. Kaplan and Violante (2014) use a two-asset model with large excess return on housing assets compared to the liquid asset in order to generate both poor and wealthy HtM households. This framework implies that households differ a lot in their consumption responses to income shocks and a substantial fraction of households has high propensities to consume out of transitory income shocks. Most recently Carroll et al. (2017) take another route and use a standard life-cycle model with household-level heterogeneity in the discount factor to generate households with little wealth but a strong precautionary motive. Households with the combination of low wealth level and strong precautionary motive have large MPCs, which implies, together with cross-sectional wealth differences, significant MPC heterogeneity as well.

In what follows, we replicate the findings in FHN using our simulated model. In doing so and to make our exercise comparable to theirs, we set the transitory, unanticipated income shocks to be 37 percent of households' average annual income, which is the average lottery size of the sample in FHN.[8] Our model delivers an average MPC

[7] About 70 percent of Norwegians above age of 18 gambled in 2012.

[8] FHN report an average lottery size of 8.65 and an average income after tax of 23.66, therefore in

	Marginal Propensity to Consume
Non-HtM	0.21
Poor HtM	0.45
Wealthy HtM	0.68

Table 7: MPC Heterogeneity by Household Types

of 0.35. More importantly, we find a large amount of heterogeneity in households' consumption responses to the one-off transitory income shock, ranging from 0.21 to 0.68 across different types of households as shown in Table 7.

Not surprisingly, unconstrained (non-HtM) households are the least responsive to income shocks with average MPC of 0.21. In our model the large variation in MPCs across the wealth distribution is associated with the existence of wealthy HtM households. These households have larger MPCs than poor HtM households since they have high levels of wealth stored in illiquid housing and consequently, they have higher desired target consumption. The average MPCs for wealthy and poor HtM households are 0.68 and 0.45, respectively.

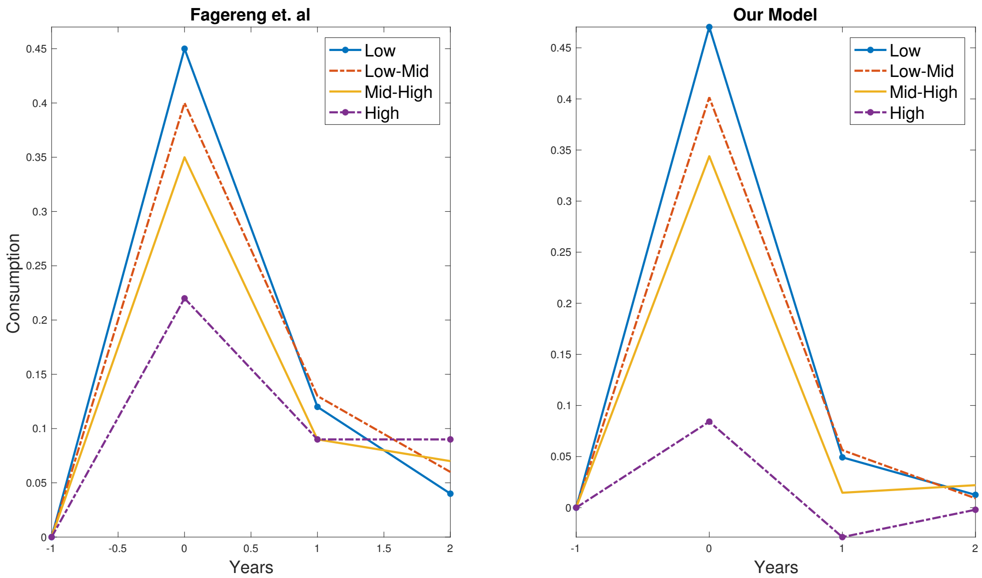

Figure 5: MPC by Liquid Wealth in the Data and the Model

Taking a look at the heterogeneity of MPCs by different wealth components of households, FHN find that the level of liquid wealth held by households is the most important determinant of the MPCs. This finding is in conflict with the predictions of traditional

their sample, the average lottery over net income is around 37 percent.

life-cycle models, where the main determinant of MPCs is net wealth. In the standard framework, MPC declines with the level of net wealth as households with higher levels of wealth have already accumulated enough savings for precautionary reasons.

Following a similar strategy, we split our simulated households into four groups by liquid wealth quartile in order to compare the model outcome to its empirical counterpart in FHN. We denote the categories as low, low-mid, high-mid, and high liquid wealth households. We then take a look at the average short-run consumption responses of these groups. The impact effects, as seen in Figure 5, are similar to the ones in the Norwegian example.

Both the average level of MPC and the heterogeneity of MPC by liquid wealth are in line with findings in FHN. The only significant difference is that households in the high liquid wealth quartile react less to income shocks in our model than what is observed in FHN, in our case the average MPC is 0.08, while in FHN this value is 0.22.

	Corr(MPC_t , X_{t-1})	
X	FHN	Our Model
Net wealth	-0.094	-0.057
Liquid assets	-0.137	-0.110

Table 8: MPC Heterogeneity: Correlations

Note: Each estimate is constructed by regressing $MPC_{i,t}$ on $X_{i,t-1}$ and age in a given percentile of the population by X.

In Table 8 we present correlations of the liquid and net wealth with the MPCs both from FHN and from our model. Correlations in both cases are constructed by first dividing households into percentiles of different wealth categories and then regressing MPCs within each percentile on households' age and different wealth components. Note that we simulate our model only by using the average shock size in FHN, while they have all their observations in their correlation sample. For this reason, differences between the correlations in our model and in FHN have to be interpreted carefully.

Our model induces a strong negative correlation between liquid assets and MPCs. This is due to the presence of wealthy HtM households, who exhibit high MPCs. The reason for their high MPCs is that they have high levels of wealth (kept in illiquid housing), therefore high targeted consumption levels, but no liquid wealth. The correlation between MPC and net wealth is much lower than that between the MPC and liquid wealth. It suggests that net wealth itself is not the important determinant of MPC. In a two-asset temptation model, net wealth does not determine MPC directly, as wealth kept in housing assets cannot be used easily to insulate consumption from income shocks. These results from our model are in line with the empirical correlations reported by FHN.

5 The Benefit from Commitment: Micro Evidence

The key idea of our theory is that housing is used as a commitment device for savings. In this section, we present micro evidence that supports this assumption. If housing is used as a commitment device for savings we should observe that homeowners and renters have very different savings behavior. This is because compared to renters homeowners are committed to a high savings track. The basic problem of identification in our case is that in order to determine the effect of housing as a commitment device on savings, we would need to observe the wealth of the households while they are homeowners and renters at the same time. But this is impossible. To overcome this problem, first, we create two groups in our dataset: those households who started as renters but became home owners (transitional renters) and those households who were renters throughout (all-time renters). Then we apply propensity score matching (PSM), to estimate by how much more or less on average the change in wealth would be for a transitional renter if it was an all-time renter. This estimated difference measures the effect of housing as a commitment device.

There are not many papers addressing the possible savings difference between renters and owners. One exception is Di, Belsky, and Liu (2007), who show evidence that home ownership is correlated with higher levels of wealth accumulation than renting. They show that the wealth difference between home owners and renters increases with the duration of home ownership. The other is LeBlanc and Schmidt (2017), who estimate that home ownership raises savings by approximately 5,000 euros per year using German data. They interpret this savings difference as some kind of forced savings for homeowners via mortgage repayments. Our approach is most similar to the latter. We innovate upon their method in two important dimensions. First, we control for a variety of psychological measures related to savings preferences and financial sophistication. Second, we use household panel data, which allows us to match households based on lagged net wealth, an important determinant of homeownership.

5.1 Data and Descriptive Statistics

In order to examine savings differences between owners and renters we use a panel of about 2000 households in the Netherlands, the so-called DNB Household Survey (DHS).[9] It has been collected by the CentERdata Institute at Tilburg University since 1993 and

[9]Formerly it was known as the CentER Savings Survey.

	Mean (€)	Median(€)	≥ 0
Total Gross Income (age 22-59)	$34,953$	$32,745$	-
Total Net Income (age 22-59)	$26,920$	$25,380$	-
Net Wealth	$155,023$	$122,787$	0.95
Net Liquid Wealth	$26,342$	$11,442$	0.86
Checking/Saving Acc.	$22,984$	$11,000$	0.94
Mutual Funds	$3,742$	0	0.12
Stock/Bond	$1,969$	0	0.28
Net Illiquid Wealth	$128,681$	$99,120$	0.88
Net Housing Wealth	$109,257$	$75,000$	0.65
Vehicle	$8,374$	$4,688$	0.78
Insurance Policies	$4,633$	0	0.17

Table 9: Households' Wealth Composition in 2016

Note: We exclude households, which are in the top 5% in the net wealth distribution.

is specially designed for gathering information about the psychological and the economic determinants of households' financial behavior. The dataset includes responses to six questionnaires about general household information; work-related information; information on accommodation and mortgages; health and income information; information on assets and liabilities and psychological information. In the descriptive statistics, we focus on the year 2016 in particular, but we use the panel dimension of the survey in the estimation.

Measures of Wealth. The dataset from the 'Assets and Liabilities Questionnaire' contains very detailed information on assets, liabilities and mortgages, which gives us a unique opportunity to investigate savings behavior of renters and owners. We can aggregate 27 asset components, 8 debt components, and 3 mortgage components in order to have a precise estimate of households wealth status.[10] In Table 9 we report summary statistics for some wealth components of Dutch households. Their average gross annual income is around 35,000 euros, while average net annual income is around 27,000 euros. In Figure 6 we show the income distribution separately for renters and homeowners in 2016.[11] It is clear that homeowners on average have higher income than renters. The median household income for homeowners is about €$30,000$, while the median household income for renters is about €$20,000$.

Dutch households' net wealth is about four-five times their annual gross income, of

[10]In Appendix A.2 we give the definitions for different wealth categories.

[11]We use homeowners with mortgages for comparison since households who are able to buy homes without mortgages are normally much more well-off than the average household in the population.

which about 80 percent is kept in illiquid form. In order to compare savings behavior of homeowners and renters, we focus on two measures of their savings: their liquid wealth and their net wealth. (see Appendix A.2 for details). We use the panel dimension of the DHS Survey and form two groups of households between 1995 and 2016. The first group includes households who are renters over the whole observational period, the all-time renters. The second group includes those households who start as renters and become homeowners at some point over the observational period, the transitional renters.[12]

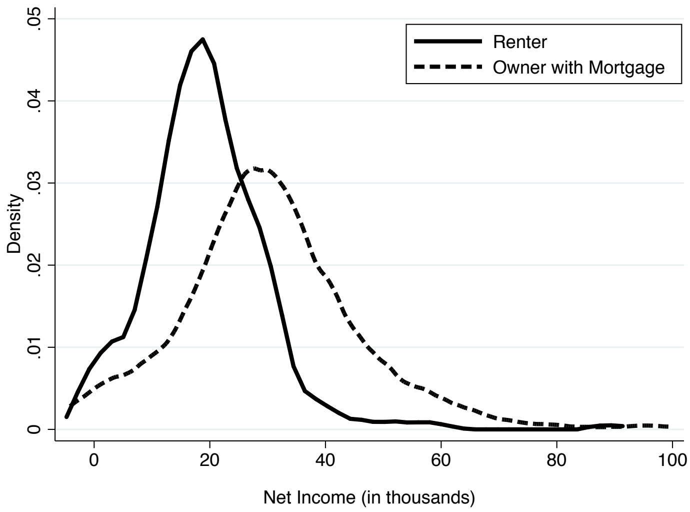

Figure 6: Households' Net Income in 2016

In Figure 7 we show the wealth accumulations separately for the two groups. For transitional renters, year zero represents the period when they become homeowners.[13] For all-time renters timing is arbitrary: we set time to be minus one when households are first observed in the sample.

The level of net liquid wealth over the observational period is stable both for transitional and for all-time renters, and it is on average higher for the former group.[14] A more striking observation from Figure 7 is the sizeable difference of net wealth accumulation between the two groups. All-time renters basically have flat net wealth profiles. Transitional renters also exhibit relatively flat profiles before they become homeowners, while this changes dramatically once they become homeowners. Their wealth level increases steadily after time zero.

This observation is in line with our theory that housing is a commitment device for savings, hence it helps to accumulate wealth. Nonetheless, we cannot give a causal

[12]We restrict our sample to those transitional renters, who are observed at least for four years before and after they become homeowners.

[13]Consequently, negative time in Figure 7 refers to the number of years before homeownership, while positive time to the number of years after homeownership.

[14]Given that this group has higher average income, their higher average wealth level in not surprising.

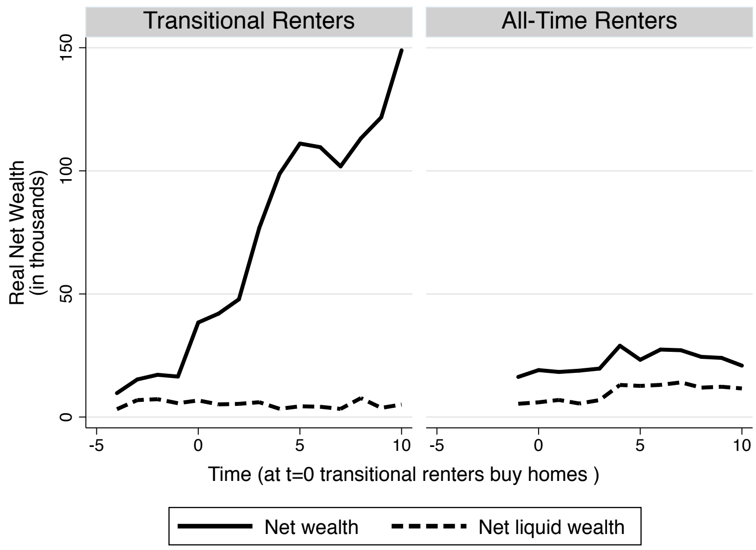

Figure 7: Unconditional Means for Wealth

interpretation to these results. Households in the two groups might be intrinsically different from each other, leading their savings behavior to be significantly different. In order to identify the effect of housing on savings, we would need to observe the wealth of households while they are homeowners and renters at the same time. As this is impossible, we go further with the analysis by controlling for all the household characteristics that are likely to affect both the choices of home ownership and the savings behavior. In doing so, we make extensive use of another questionnaire in the DHS dataset, the psychological one.

Covariates. The DHS psychological questionnaire asks households about their savings behavior from the behavioral point of view. For example, households are asked about their risk attitudes, optimal planning period, attitudes towards loans and their tastes for savings and home ownership. The availability of this survey information helps us proxy for the otherwise unobserved heterogeneity between homeowners and renters that might play an important role in the process of selecting into home ownership.

In Figure 8 we present the 2016 distributions of the survey answers to some of the most important psychological questions we control for when comparing the two groups of households. These are questions related to discount factors, risk aversions, and temptation. Variables in the first column of Figure 8 can be related to households' discount factor: these are the questions on how concerned they are about the present, whether they work on things which only pay off later in their life and a more direct question about their planning horizon. The first subfigure in the second column of Figure 8 shows the distribution of the answers to the question on financial risk-taking behavior. The last two subfigures in the second column present survey answers to questions related to temptation: questions which ask whether households' decision is based on convenience and whether managing household income is easy.

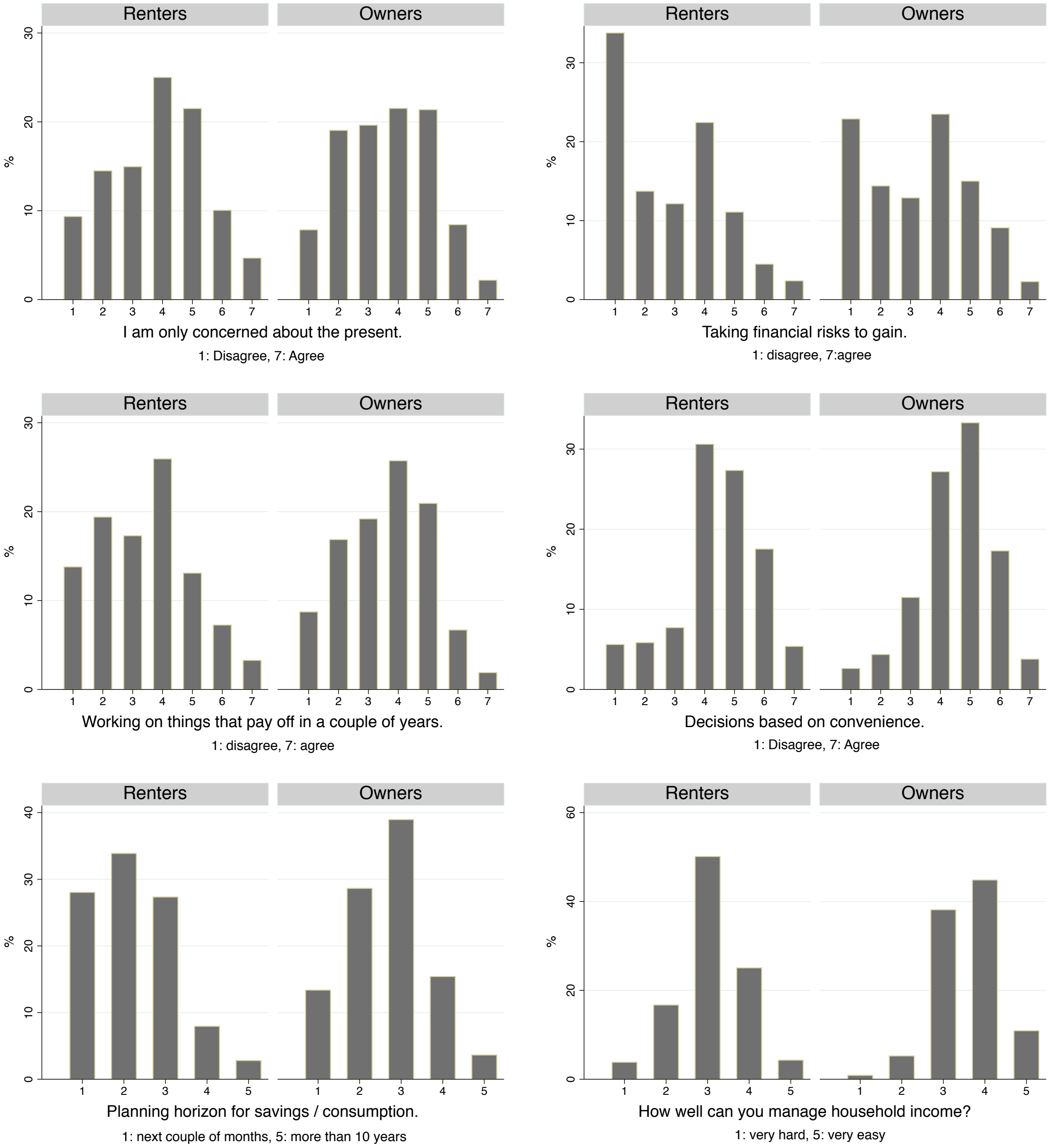

Figure 8: Psyhological Measures for Renters and Owners

The general conclusion from Figure 8 is that renters and homeowners are not significantly different along these psychological dimensions. Consequently, it is not likely that they choose ownership status driven by differences in their preferences. The psychological dimensions in which renters and owners differ the most are displayed in the bottom two subfigures in Figure 8: renters seem to have slightly shorter planning horizon, while they find managing income a bit harder on average. Note though, that the answers to these two questions are strongly affected by the income status of the households. Since renters have lower income on average, as shown in Figure 6, it is not surprising that they have difficulties with planning over longer horizons and with managing income.

Having described all the important variables we use for our analysis, in the next section we give an outline of the empirical method we apply.

5.2 Identification Strategy: A Quasi-Experimental Approach

In order to identify the effect of housing on savings we use propensity score matching. It is a quasi-randomization technique, which has lot in common with the experimental techniques, and the approach is very similar to those in the experimental literature.

We focus our attention on two time periods, (t_1 and t_2), and we use the sample of households described in Section 5.1 that includes transitional and all-time renters. The first period, t_1, is defined as the very first observation for each household as they enter the survey. In t_1 both transitional and all-time renters are renters. The second period, t_2, in turn is defined as the very last observation for each household before they leave the survey. Therefore in period t_2 transitional renters are already homeowners, while all-time renters naturally stay renters. Given that DHS is not a balanced panel the time difference between t_1 and t_2 varies between households. On average this time difference is 6 years in our sample.

We then measure wealth, W, of both groups of households in each period and calculate changes in their wealth, ΔW between t_1 and t_2. Having changes is wealth levels calculated for each group, one might think that we could use the difference-in-differences estimator to gauge the impact of home ownership on wealth accumulation:

$$\Delta W_1 - \Delta W_0 \tag{22}$$

where Δ refers to the change between periods t_1 and t_2, while W_0 is the wealth of all-time renters and W_1 is the wealth for transitional renters. Unfortunately, the results of such an estimation could not be interpreted as a causal relationship between home ownership and wealth accumulation since the two groups in the comparison may include intrinsically different households. That is, the home ownership decision itself is endogeneous. Therefore, looking at unconditional means of wealth changes is misleading.

Let us denote by ΔW_{i1} the change in accumulated wealth of a transitional renter. Subscript i is the index of the household, while subscript 1 states that the observed change in wealth, ΔW, corresponds to a renter who becomes a homeowner in t_2. In the same way, we denote by ΔW_{i0} the change in accumulated wealth of an all-time renter. Similarly to an experimental setting, we can define the treatment effect (TE) of becoming a homeowner for a single household as

$$TE_i = \Delta W_{i1} - \Delta W_{i0}. \tag{23}$$

We assign households who are transitional renters to the treatment group, while all-time renters are assigned to be in the control group.We are interested is the average treatment effect of treated households (ATT) in the population: how much more or less on average the change in wealth would be for a transitional renter if it was an all-time renter. It is equivalent to write:

$$ATT = E(\Delta W_{i1} \mid T_i = 1) - E(\Delta W_{i0} \mid T_i = 1) \tag{24}$$

where T_i is an index for treatment that takes a value of 1 if household i is in the treatment group (becomes homeowner), while a value of 0 if the household is in the control group (stays renter). $E(\Delta W_{i0} \mid T_i = 1)$, the second term on the right-hand side of equation (24), is not observable. It measures the change in wealth for a transitional renter if it was an all-time renter. If treated and control households systematically differ, i.e. when selection into home ownership is not random, proxying this term with the observable change of wealth of all-time renters, $E(\Delta W_{i0} \mid T_i = 0)$, could lead to systematic biases. In order to get around this problem, we do quasi-randomization following Rubin (1977) and Rosenbaum and Rubin (1983). That amounts to assume that, conditioning on a set of covariates, X_i, which simultaneously affects home ownership and wealth accumulation decisions, makes wealth accumulation independent from home ownership status.[15] This condition is called the Conditional Independence Assumption (CIA):

$$\Delta W_{i0} \perp\!\!\!\perp T_i \mid X_i \tag{25}$$

As it is shown in Heckman, Ichimura, and Todd (1998), it is enough to use a weaker assumption (the conditional mean independence) in order to estimate the ATT, which directly follows from CIA:

$$E(\Delta W_{i0} \mid X_i, T_i = 1) = E(\Delta W_{i0} \mid X_i, T_i = 0) = E(\Delta W_{i0} \mid X_i) \tag{26}$$

As the transition into home ownership does not predict changes in wealth after controlling for observables, taking two households with the same observable characteristics, one transitional renter and one all-time renter, is like comparing the two households in a randomized experiment. The drawback of this approach is that matching transitional

[15] X_i has to contain all the information about the wealth accumulation that was available to the household at the point of deciding on homeowenrship.

renters with all-time renters when the number of covariates is high is sometimes impossible. In order to increase the likelihood of finding exact matches, we follow the suggestion by Rosenbaum and Rubin (1983). Instead of using the covariates separately, we calculate a so-called propensity score for the matching procedure: which is the conditional probability of becoming a homeowner given the set of covariates:

$$p(X_i) \equiv Pr(T_i = 1 \mid X_i) \tag{27}$$

Using this single score makes it easier to find for each transitional renter a similar all-time renter in the sample.[16] Equation (26), the conditional mean independence assumption, can also be rewritten in terms of the propensity score, $p(X_i)$, as

$$E(\Delta W_{i0} \mid p(X_i), T_i = 1) = E(\Delta W_{i0} \mid p(X_i), T_i = 0) = E(\Delta W_{i0} \mid p(X_i)) \tag{28}$$

In order to implement this strategy in practice, we need good households level data on wealth, W, and on household characteristics, X, that might affect home ownership status and wealth accumulation simultaneously. This is why using the Dutch Households Survey Data is particularly well-suited for our purpose: it has very precise accounting of the different wealth components of households, while it also has numerous measures for households' preferences, tastes, and attitudes towards savings.

In order to estimate the propensity score, which is the probability of becoming a homeowner, we use a probit model. Then we need to find for each transitional renter a comparison group of similar all-time renters in the sample, as indicated by their propensity scores. This selection is based on a pre-defined distance criteria between propensity scores for treated and control households. We apply kernel matching, which defines a neighborhood for each treated household and calculates the counterfactual change in wealth for them using all control households within that neighborhood. In order to summarize the information from each control households in the neighborhood weights are associated to each of these controls. These weights are proportional to the proximity of the propensity scores for the treated and the control households.[17]

5.3 Results

Turning to our result, in Table 10 we report the before and after match means of the most important variables in the propensity score both for transitional and all-time renters in

[16]Note that matching only works if observables do not predict transition to home ownership exactly. This assumption ensures that transitional renters have a counterpart in the group of all-time renters: $p(X_i) < 1$

[17]See more on kernel-based matching techniques in Heckman, Ichimura, and Todd (1997) and Heckman, Ichimura, and Todd (1998) for example.

the sample.[18] Before the matching, we see significant differences between the two groups. All-time renters tend to be older and have lower net wealth than transitional renters for example.

	Before		After	
	Transitional Renter	All-time Renter	Transitional Renter	All-time Renter
Age	34.16	43.28	35.00	35.44
Log of respondent's wealth	8.03	7.02	8.02	8.15
Education of acquaintances				
Vocational	0.018	0.096	0.021	0.035
Lower secondary	0.053	0.132	0.064	0.064
Secondary/Pre-univ.	0.098	0.189	0.106	0.138
Senior vocational training	0.170	0.240	0.191	0.165
Colleges/First year univ.	0.411	0.211	0.383	0.403
University	0.250	0.121	0.234	0.193
Hard to manage income	0.116	0.289	0.138	0.147
Dislike take financial risks	0.625	0.536	0.628	0.651
Interest in long term projects	0.286	0.189	0.266	0.287
Sacrifice present for future	0.393	0.229	0.372	0.396
Propensity score	0.574	0.174	0.507	0.500

Table 10: Before and After Match Means

In turn, the after-match means confirm that our matching strategy is effective in creating a good control group: most of the covariates are now well balanced between the treatment and the control groups. As a result, our after-match sample includes households who do not differ significantly on observable characteristics, other than their homeownership status.

[18]Table A.2 in the appendix lists all the variables in the propensity score.

Variable	Sample	Transitional Renter	All-Time Renter	Difference	T-stat
Δ Net Liquid Wealth	Unmatched	-503	$1,208$	$-1,711$	-0.41
	ATT	-501	$1,493$	$-1,994$	-0.27
Δ Net Wealth	Unmatched	$45,320$	$-1,449$	$46,770$	5.78
	ATT	$42,188$	$2,217$	$39,971$	2.89

Table 11: Treatment Effects

Our main results are summarized in Table 11. The net liquid wealth change for transitional and all-time renters shows that households' savings behavior is not affected by homeownership. Liquid wealth changes for the two groups do not differ significantly. This is not the case if we compare net wealth changes instead of liquid wealth changes: the change in net wealth for transitional renters is about 40,000 euro more on average than that for all-time renters.

Given that transitional renters are observed on average for six years after they become homeowners, this wealth difference for transitional renters results in approximately 6,600 euro of additional savings per year, which is over a quarter of their average annual net income. This finding is in line with the evidence from LeBlanc and Schmidt (2017), who estimates that home ownership raises savings by approximately 5,000 euro per year.

We interpret our results as providing strong supporting evidence for our theory. If they have the opportunity, tempted households invest in housing assets, with which they commit to a high savings track. Having a house, which most of the time has to be financed by some sort of mortgage, makes a household pay a fixed amount in each month for a long period of time. This additional mortgage payment serves in affect as self-imposed forced savings.

6 Conclusion

In this paper, we build a life-cycle model which implies a demand for commitment devices for savings. Our model is able to provide theoretical foundations for several empirical observations, which are hard to reconcile with standard life-cycle models.

First, a large fraction of US households owns a housing asset but no liquid asset. Standard models have difficulty to explain the existence of these wealthy hand-to-mouth households. We show that the commitment value of housing generates the observed fraction of wealthy hand-to-mouth households in the population even if the return on housing is lower than on the liquid asset. The pioneering work of Kaplan and Violante (2014) showed that the fraction of wealthy hand-to-mouth households in the population can be explained by a life-cycle model with a low-return liquid asset and a high-return illiquid asset. However, their model is unable to do so if a liquid asset with a higher return than housing is available. Since such high-yielding liquid assets are available in practice, our work is an essential step towards understanding the existence of wealthy hand-to-mouth households.

Second, the large empirical heterogeneity in MPCs by wealth is hard to explain in standard models such as Bewley (1977), Aiyagari (1994) or Krusell and Smith (1998). As shown in Jappelli and Pistaferri (2014) one needs an implausibly low discount factor to generate the observed MPC heterogeneity in these models. By contrast, our model implies a strong negative correlation between liquid assets and MPCs. This is due to the presence of wealthy hand-to-mouth households, who have high levels of wealth, and therefore high targeted consumption, but no liquid wealth as their savings are locked into illiquid housing assets.

Third, our theory that housing is used as a commitment device for savings has a clear implication: savings should increase significantly after households become homeowners. We find empirical evidence that strongly confirms this prediction. We show that the liquid savings of renters do not change significantly after they become homeowners, while their total net savings increase by over a quarter of their average net income per year. This implies that homeowners total savings exceed those of comparable renters by the amount homeowners keep in illiquid housing assets. This additional savings of homeowners reflects the commitment benefit of housing.

A Appendix

A.1 Model Parameters

Parameter		Value
T	number of years as adult	60
W	number of years as worker	45
β	discount factor	0.98
γ	risk aversion parameter	1.50
λ	temptation parameter	0.35
θ	housing utility parameter	-0.30
μ	housing utility parameter	0.15
ϕ	relative utility from apartment to house	0.5
χ	utility cost of housing adjustment	0.5
p1	initial house price	5
η	relative price of apartment to house	0.60
f	fixed cost of moving	0.05
ψ	down-payment requirement	0.10
r	stock return	2.1
r^H	housing return	2.1
r^M	mortgage rate	3.0
ρ	income persistence	0.65
σ_z	std. dev. income shock	0.15
ω	replacement rate	0.60
A_0	starting liquid wealth	0
H_0	starting housing wealth	0

Table A.1: Static Annual Parameters

A.2 DHS Financial Data

Total Gross Income: Gross salary, early retirement benefit, pension, disability benefits, unemployment benefits, profits (only positive), alimony and rateable value of accommodation

Total Net Income: (+) Total Gross Income, scholarship, parental support, study loan, inheritance, rent allowance, interest, dividend and real estate income (letting of rooms) (-) income tax

Net Wealth: Net Non-Housing Wealth plus Net Housing Wealth

Net Non-Housing Wealth: (+) Checking accounts, employer-sponsored savings plans, savings and deposit accounts, deposit books, savings certificates, insurance policies, growth funds, mutual funds, bonds, stocks and shares, put- and call-options, cars, motorbikes, boats, trailers, money left out to family (-) private loans, lines of credit, finance debts, loans from family and friends, study loans and credit card debts, other debts

Net Housing Wealth: (+) value of first house, value of second house (-) mortgage on the first house, mortgage on the second house

A.3 DHS Psychological Data

1. I am only concerned about the present.

   Question: "*I am only concerned about the present, because I trust that things will work themselves out in the future.*"

   Answer: scale from 1 (extremely uncharacteristic) to 7 (extremely characteristic)

2. Decisions based on convenience.

   Question: "*Whether something is convenient for me or not, to a large extent determines the decisions that I take or the actions that I undertake.*"

   Answer: scale from 1 (extremely uncharacteristic) to 7 (extremely characteristic)

3. Working on things that pay off in a couple of years.

   Question: "*I often work on things that will only pay off in a couple of years.*"

   Answer: scale from 1 (extremely uncharacteristic) to 7 (extremely characteristic)

4. Taking financial risk to gain.:

   Question: "*If I want to improve my financial position, I should take financial risks.*"

   Answer: scale from 1 (totally disagree) to 7 (totally agree)

5. Planning horizon for savings / consumption.

   Question:"*People use different periods when they decide about what part of the income to spend, and what part to save. Which of the periods mentioned below is in your household most important with regard to planning expenditures and savings?*"

   Answer: 1 (next couple of months), 2 (the next year), 3 (the next couple of years), 4 (next 5-10 years), 5 (more than 5 years)

6. How well can you manage households income?

   Question:“*How well can you manage on the total income of your household?*”

   Answer: 1 (it is very hard), 2 (it is hard), 3(it is neither hard nor easy), 4 (it is easy), 5 (it is very easy)

A.4 Matching Results

	Before		After	
	Owner	Renter	Owner	Renter
HH income				
€10-14k	0.071	0.182	0.085	0.076
€14-22k	0.161	0.236	0.170	0.137
€22-40k	0.384	0.286	0.362	0.397
€40-75k	0.286	0.121	0.277	0.282
€75k or more	0.027	0.018	0.021	0.035
Log of respondent's wealth	8.03	7.02	8.02	8.15
Age	34.16	43.28	35.00	35.44
Age^2	1240	2005	1306	1353
Number of kids	0.446	0.389	0.425	0.441
Future number of kids	0.821	0.382	0.660	0.513
Living with kids	0.241	0.250	0.245	0.250
Future living with kids	0.411	0.225	0.340	0.260
Future married	0.375	0.286	0.351	0.310
Living with partner	0.482	0.475	0.500	0.472
Future living with partner	0.705	0.493	0.670	0.603
Degree of urbanization				
High	0.259	0.286	0.287	0.287
Moderate	0.152	0.161	0.117	0.191
Low	0.143	0.125	0.128	0.148
Very low	0.107	0.150	0.128	0.107
Education of acquaintances				
Vocational	0.018	0.096	0.021	0.035
Lower secondary	0.053	0.132	0.064	0.064
Secondary/Pre-univ.	0.098	0.189	0.106	0.138
Senior vocational training	0.170	0.240	0.191	0.165
Colleges/First year univ.	0.411	0.211	0.383	0.403
University	0.250	0.121	0.234	0.193
Year dummies				
2002	0.259	0.225	0.255	0.284
2004	0.143	0.150	0.149	0.100
2006	0.107	0.107	0.106	0.123
2008	0.018	0.025	0.021	0.014

2010	0.036	0.079	0.043	0.017
2012	0.027	0.118	0.032	0.035
2014	0.098	0.082	0.096	0.108
Hard to manage income	0.116	0.289	0.138	0.147
Makes sense to save now	0.321	0.336	0.319	0.349
Dislike take financial risks	0.625	0.536	0.628	0.651
Short planning period	0.607	0.657	0.649	0.695
Planning period for savings				
The next year	0.259	0.186	0.266	0.251
The next couple of years	0.321	0.250	0.277	0.258
The next 5 to 10 years	0.063	0.061	0.064	0.038
More than 10 years	0.009	0.032	0.011	0.085
Decision made by convenience	0.473	0.461	0.479	0.531
Very concerned with future	0.464	0.393	0.457	0.505
Only concerned with present	0.170	0.196	0.138	0.180
Interest in long term projects	0.286	0.189	0.266	0.287
Sacrifice present for future	0.393	0.229	0.372	0.396
Propensity score	0.574	0.174	0.507	0.500

Table A.2: Before and After Match Means for Treated and Control Groups

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