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

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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 and rationalizes heterogeneity in the marginal propensity to consume. In addition, the model is consistent with micro evidence that households achieve higher savings through homeownership, a fact that cannot be explained by traditional models of household savings.

Keywords: commitment; hand-to-mouth; housing; life-cycle models; temptation preferences
JEL classification: D11; D14; D91; E21

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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. Our model builds upon Kaplan and Violante (2014), who explain the presence of wealthy hand-to-mouth households and demonstrate their importance for fiscal policy. Their model relies upon the assumption that housing delivers excess returns relative to all available liquid assets. As a result, households invest primarily in housing, which limits their ability to consumption smooth over income shocks. 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

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

as stocks, how can we explain the existence of wealthy hand-to-mouth households? In our framework, households purchase housing not only for its future returns, but also for its "commitment benefit," as the illiquid nature of housing helps households commit to a self-imposed savings plan, where they gradually repay their mortgage and accumulate wealth in the form of home equity. As a result, we are able to relax the key assumption from Kaplan and Violante (2014), and still provide a 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 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 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

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

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 increases the illiquiodity of housing, thus making housing useful 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, a_t, 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, $f p_t$ 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:

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

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

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

If there exists a positive mortgage balance $m_t > 0$ at the time a house is sold, the value of the house is used to repay the mortgage and the remaining home equity goes to the household. 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.

Household i receives labor income, $y_{i,t}$, in every period before retirement, $t \leq W$, which is assumed to evolve according to the following:

$$\ln y_{i,t} = g_t + \alpha_i + z_{i,t} \tag{13}$$

where g_t is a deterministic age profile, α_i is a household-specific fixedeffect, and $z_{i,t}$ is an idiosyncratic shock to log income that is described by an AR(1) Markov process:

$$z_{i,t} = \rho z_{i,t-1} + \varepsilon_{i,t}. \tag{14}$$

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

$$y_{i,t} = \omega y_{i,W} \tag{15}$$

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.

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

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 Key Model Insights

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 simple version of the baseline model described previously in order to make our points as clearly as possible. In Table 1 we present the parameter restrictions imposed in the simplifiedmodel.

Specifically, we assume that housing does not enter the utility function, labor income is deterministic, and that the returns on 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 Demand for Illiquidity and Homeownership

In this simplified model, households with standard preferences $\lambda = 0$ have no demand for housing. Homeownership comes with sizeable transaction costs, yet delivers no benefits in either utility or returns. This is demonstrated in Figure 1, which presents the life cycle profile for one household. The left panel presents asset accumulation, which reaches a peak at age 65 when the household retires. The household saves only in liquid assets and never purchases a home. The right panel presents income and consumption over the life cycle. We see that income rises in a hump shape, before dropping drastically at the time of retirement. Despite this hump shaped income process, the household is able to perfectly smooth consumption between the early 30s and the end of life.

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 greater 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.

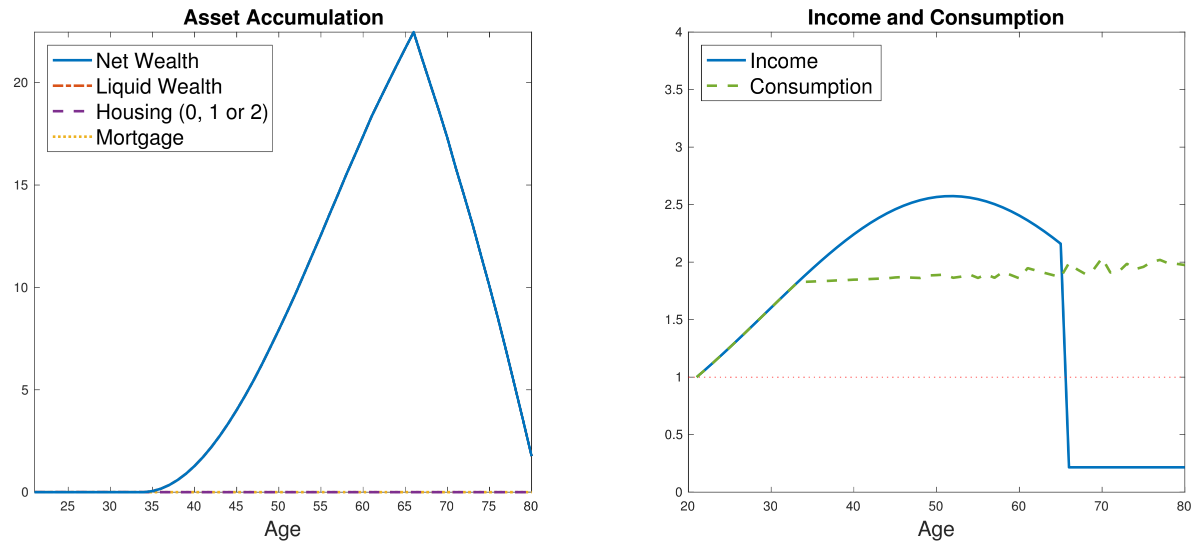

Figure 1: Lifecycle Profiles for Standard Households
$R = R^H = 1.021$, $p_1 = 4$

The reason is that accumulating wealth in liquid form is costly in the presence of temptation: 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.

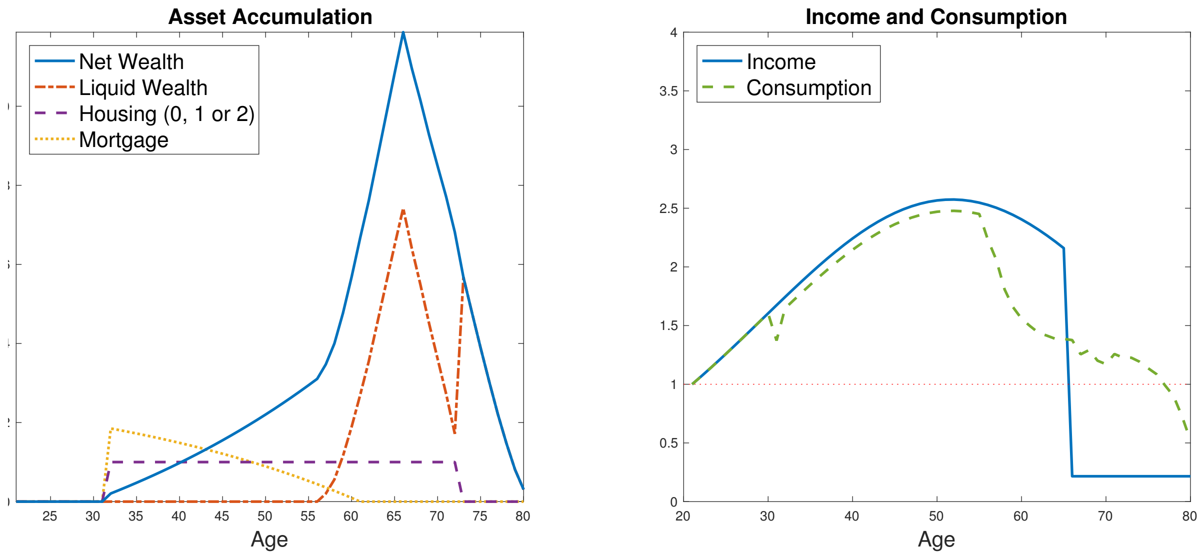

Figure 2: Lifecycle Profiles for Tempted Households
$R = R^H = 1.021$, $p_1 = 4$

Panel (b) of Figure 2 shows the implications of households' asset portfolio decisions for their consumption, relative to 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 during the early 30s. After buying the home, consumption follows labor income closely: the difference between the two is the per 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 Homeownership is a Savings Commitment Device

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 disincentivizes savings. Therefore, on aggregate households may be better off facing the welfare loss of not being able to support retirement consumption, rather than accumulating high levels of liquid wealth, which entails a high cost of temptation in each period.

Households' saving incentives change substantially 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. For this reason, housing plays a role as a savings commitment device.

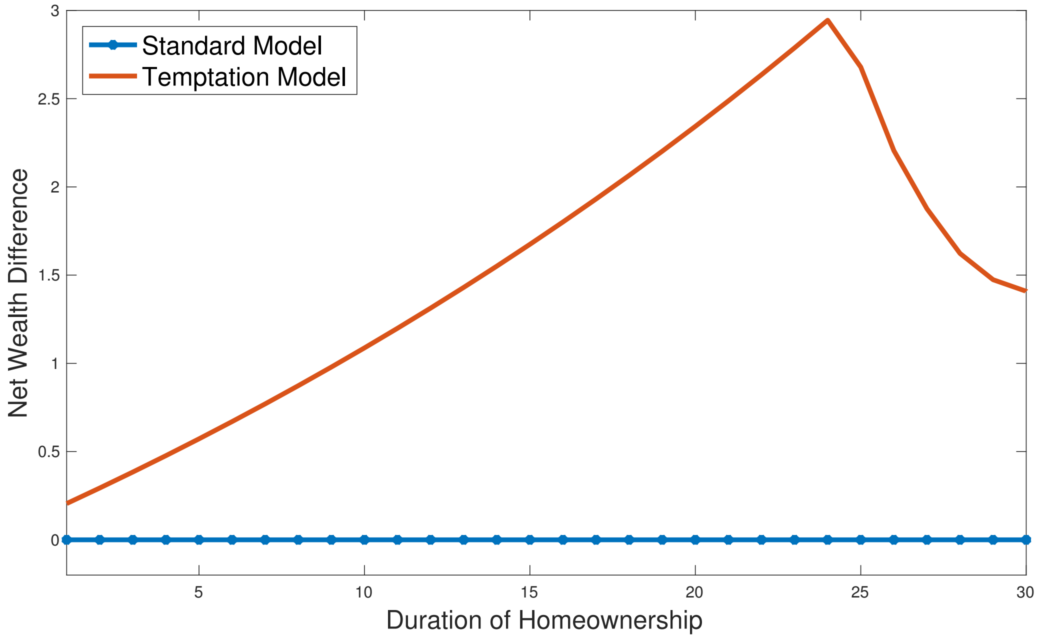

Figure 3: The Effect of Commitment on Savings

Figure 3 presents the effect of homeownership on savings. The blue dotted line shows the difference in net wealth for a tempted household that has access to housing, relative to an identical household that does not have access to housing. The line is increasing over the duration of home ownership, indicating that the presence of housing changes the savings behavior of the tempted households. After buying a home, households are required to repay the mortgage in each period, which acts as a self-imposed commitment device that forces them to accumulate home equity. When housing is not an available savings option, households save less because keeping their savings in liquid form is costly.

In contrast, the red straight line in Figure 3 shows the difference between the wealth accumulation of a standard household that has access to housing, relative to an identical household that does not have access to housing. The line is horizontal, indicating that the presence of housing does not change the savings behavior of the standard households. In this model, the type of asset choice does not impact the amount of asset accumulation.

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 drastically increase savings in order to support a basic level of consumption during their retirement. As a consequence, they try to catch up with savings, although this effect is only partial.

4 Macroeconomic Results

We now calibrate the model and study its aggregate implications. The model is calibrated so that housing does not deliver excess returns over liquid assets, thus relaxing the key assumption that generates wealthy hand-to-mouth in Kaplan and Violante (2014). We demonstrate that this model still generates a large fraction of wealthy and poor hand-to-mouth households, consistent with U.S. data.

We then examine the importance of wealthy hand-to-mouth households in explaining consumption behavior, using the model to replicate observed heterogeneity in the MPC. A wide body of empirical literature finds that the average MPC declines relatively slowly with wealth, a finding that contradicts a large class of traditional heterogeneous agent models[2] We demonstrate that our model is able to match the empirical evidence on MPC heterogeneity, using for comparison the empirical results from Fagereng, Holm, and Natvik (2016), who study the consumption response to winning the lottery. We find that the average MPC declines relatively slowly with wealth, but relatively quickly with liquid assets, consistent with the data.

4.1 Housing Returns

A key feature of our calibration is that housing does not deliver excess returns relative to liquid assets. In this section, we calculate the return of stock and housing. 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

[2]See for instance Bewley (1977), Aiyagari (1994), or Krusell and Smith (1998).

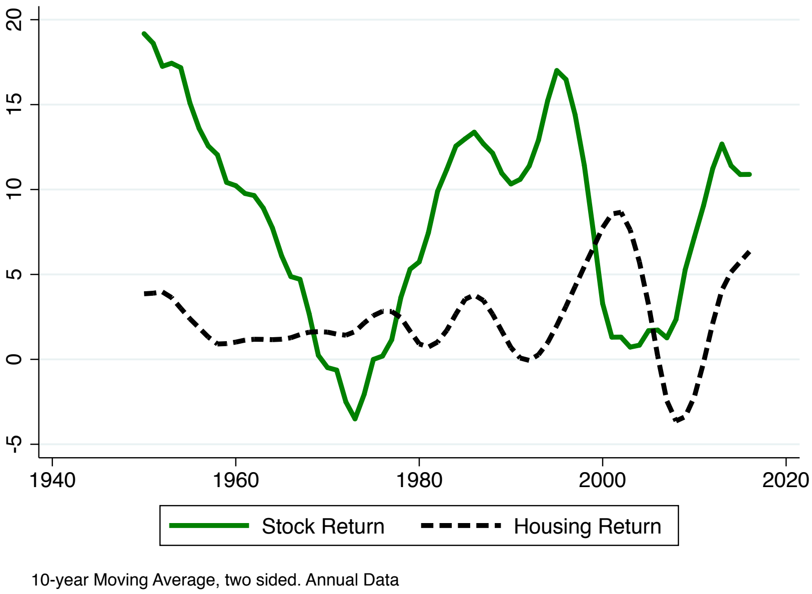

Figure 4: Real Returns

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 between 1950 and 2016 is around 8%.

Following Kaplan and Violante (2014), we set the maintenance cost at 1% and the

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

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 2.

	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 2: 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] 3 Month T-Bill times series is downloaded from the database of the Federal Reserve Bank of St. Louis (Fred).

4.2 Model Calibration

We calibrate the our model in two steps. First, the standard parameters are calibrated based on the existing literature. Second, we estimate the non-standard parameters in order to minimize the distance between key moments in the data and the model. In this section, we describe the calibration of the standard parameters. In Section 4.2.1 we describe the second step, where we estimate the remaining parameters. The complete list of parameter values 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.[5] 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 remaining parameters in the utility function are calibrated in Section 4.2.1 in order to ensure that our model matches key moments related to homeownership.

[5] 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.

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

Table 3: Preference Parameters

4.2.1 Housing Parameters

The remaining parameters in the model (λ, χ, p_1, μ, θ) are calibrated such that the model matches aggregate statistics related to homeownership, asset holdings, and hand-to-mouth behavior. We select five moments that we match using these parameters.

First, we match the fraction of wealthy hand-to-mouth households (20%), the fraction of poor hand-to-mouth households (10%), and the ratio of household wealth held in liquid assets (25%). These three moments are computed for the United States using the Survey of Consumer Finances. We follow the method of defining wealthy and poor hand-to-mouth households contained in Kaplan, Violante, and Weidner (2014) and get very similar results. We believe that all of these moments will be helpful in determining the temptation parameter λ and the housing preference parameters.

Second, we match the average homeownership rate in the United States, which was 68% according to the Survey of Consumer Finances. We choose to match this moment based on the example set by Attanasio et al. (2012), who pin down the utility preference parameters in their model by matching homeownership rates in the United Kingdom.

Finally, we match the fraction of the down payment that is held in liquid assets one year before home purchase (51%). We believe that this moment will be especially useful in determining the temptation parameter, as it reflects the ability of the household to accumulate liquid wealth prior to home purchase. This moment reflects the empirical evidence that households accumulate the majority of their down payment in the year before purchasing their home. We compute this statistic using the Dutch Household Survey, which we use extensively in Section 5, although we believe that similar holds in the United States. For instance, Haurin, Hendershott, and Wachter (1997) find that households save the majority of their down payment in the year prior to home ownership, using U.S. data from the National Longitudinal Survey of Youth. In addition, Charles and Hurst (2002) find that the vast majority of mortgage applicants have liquid wealth less than 10% of their predicted house value, using U.S. data from the Panel Study of Income Dynamics (PSID).

It is important to note that there are three ways to generate wealthy hand-to-mouth households in our model. The first is to assume that housing generates substantially higher returns than liquid assets, however, we rule out this option based on the empirical evidence on risk-adjusted returns presented in Section 4.1. Second, housing preferences could result in wealthy hand-to-mouth households if the taste for housing (μ and θ) is sufficiently high such that households are willing to forgo the benefits of consumption smoothing. And third, temptation and commitment could result in wealthy hand-to-mouth households, if it is difficult for households to hold wealth in liquid assets. In reality, we believe that the truth lies somewhere in between these different explanations.

We calibrate the remaining model parameters (λ, χ, p_1, μ, θ) by minimizing the quadratic distance between the empirical moments and the simulated model moments using a simple minimization routine to search across parameter values.

Parameter		Temptation Model $\lambda \geq 0$	Standard Model $\lambda = 0$
Temptation	λ	0.12	-
Utility cost of housing adjustment	χ	0.93	0.00
Initial house price	p_1	5.79	5.00
Housing utility (non-homotheticity)	μ	0.26	0.35
Housing utility (MU of conusmption)	θ	-0.07	0.03

Table 4: Calibrated parameters from our minimization routine

Table 4 presents our calibrated parameters. In the first column, we estimate the parameters in the unrestricted temptation model, allowing the temptation parameter λ to be any positive value. In the second column, we estimate the parameters under the restriction that $\lambda = 0$, thus turning off the temptation channel in our model. It is interesting to note three differences between the unrestricted and restricted model. First, λ is positive in the unrestricted model, demonstrating that temptation helps explain the presence of hand-to-mouth households and down payment savings. Second, there exists a positive χ in the unrestricted model, whereas this parameter becomes zero in the restricted model. This likely reflects the "taste for illiquidity" in the unrestricted model with temptation, where greater transaction costs increase the desirability of housing. And finally, the taste for housing is higher in the restricted model, reflecting the need to have higher taste for housing in order to explain housing preferences in the model without temptation.[6] The moments implied by these two calibrations are presented in Table 5, which will be discussed in the next section.

4.3 Model Comparison to U.S. Data

In this section we evaluate how well our model matches targeted moments on homeownership, asset holdings, and hand-to-mouth status. Table 5 reports the empirical moments that we target in column 1, followed by the results from our temptation model ($\lambda = 0.12$) and standard model ($\lambda = 0$) in columns 2 and 3. We find that our temptation model obtains a good match of these empirical findings. Most importantly, this model is able to match the finding that roughly 20% of households are wealthy hand-to-mouth; we obtain a figure of 21% in our model. Our model is able to achieve this result, despite the fact that housing does not deliver excess returns over liquid assets.

	Data	Temptation Model	Standard Model
Wealthy Hand-to-Mouth	20%	21%	14%
Poor Hand-to-Mouth	10%	9%	0%
Liquid over total assets	25%	29%	33%
Homeowners	68%	68%	72%
Down payment in advance	51%	64%	76%

Table 5: Model versus Data

The standard model is not able to match all of the empirical moments. Given that households with standard preferences have no desire for illiquidity, they keep a higher fraction, 33%, of their wealth in liquid form. In addition, the model cannot deliver the observed fractions for hand-to-mouth households. As a large fraction of wealth is kept in liquid form, there are no poor hand-to-mouth households in the simulated sample.

[6]Since μ is positive, an increase in μ has a direct positive effect on utility. In addition, it is worth noting that 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

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

Similarly, when $\theta > 0$ implies housing and consumption are compliments. Thus in the unrestricted model, housing and consumption are substitutes, whereas in the restricted model housing and consumption are (weak) compliments.

The standard model has particular difficulty in matching the share of down payment that is accumulated one year in advance. In the data, households accumulate just 51% of their down payment in liquid assets one year prior to their first home purchase. In the standard model, households instead accumulate 76% of their down payment one year prior to home purchase. This follows from the consumption smoothing motive, which favors a gradual accumulation of liquid assets in order to pay the down payment, rather than an abrupt drop in consumption during the year of home purchase.

One reason that the standard model has such difficulty in matching the empirical moments is because the housing utility parameter μ is being pushed in two directions. On one hand, a large μ would help the model match the observed share of wealthy hand-to-mouth households. On the other hand, a large μ results in an increase in the share of homeowners, as well as a greater motivation to accumulate wealth prior to homeownership.

4.4 The Marginal Propensity to Consume

We find that our temptation model delivers an average MPC of 0.35, well within the standard range of empirical estimates. For instance, Carroll et al. (2017) report that aggregate MPC estimates for the U.S. range between 0.2 and 0.6, based on a comprehensive summary of the existing empirical literature. In our model, households have a high MPC due to their decision to keep the vast majority of their wealth in illiquid assets, thus restricting their ability to consumption smooth over transitory income shocks. In this section, we examine this issue further by decomposing the average MPC based on measures of liquid assets, net assets, and hand-to-mouth status.

We find that our model obtains a good match of the empirical evidence on MPC heterogeneity based on household asset holdings. Our model is able to replicate two key findings, both of which are difficult to reconcile with a large class of traditional heterogeneous agent models. First, the average MPC declines relatively slowly with household wealth. And second, the average MPC is highest within households that have low liquid wealth.

Empirical evidence on MPC heterogeneity comes from Fagereng, Holm, and Natvik (2016, hereafter FHN), who study the consumption response to winning the lottery. These authors find that net wealth is unimportant in explaining MPC heterogeneity, once you control for liquid asset holdings. This study is unique in the quality of its data: the authors use administrative tax data from Norway, which contains rich information on household income and asset holdings. The authors find an average MPC of 35% in the year after winning the lottery.[7] For households with low liquid wealth, the effect

[7] This can be interpreted as the marginal propensity to consume out of a transitory and unexpected

is much higher. Households in the lowest quartile of liquid wealth have an MPC of 45 percent, whereas those in the highest quartile have an MPC of 22 percent. While the average MPC declines substantially with liquid wealth, the authors find that it declines much less with net wealth.

These results are broadly consistent with the findings of Jappelli and Pistaferri (2014), who use Italian survey data to study the consumption response to unexpected transitory income shocks. These authors find that the average MPC varies substantially based on cash-on-hand (i.e. income and liquid assets). These authors 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 they would spend. They find an average MPC of 48 percent in response to a positive shock equal to one month of income.[8] In addition, they find that the average MPC for households in the lowest quintile of cash-on-hand is about 26 percentage points higher than the MPC of those in the top quintile.

These empirical findings are especially interesting compared to traditional incomplete markets models, as developed by Huggett (1993), Aiyagari (1994), and Carroll (1997). While these models are able to match the average MPC, they have trouble replicating the observed MPC heterogeneity. In these models, households attempt to consumption smooth in the face of idiosyncratic income risk and a borrowing constraint. These households accumulate a buffer stock of capital to prevent their borrowing constraint from becoming binding. As a result, net wealth is the main determinant of household MPCs. But even these differences in net wealth are insufficient to explain MPC heterogeneity. For instance, Jappelli and Pistaferri (2014) study whether an Ayiagari model with heterogeneous households and a standard calibration is able to replicate the observed MPC distribution. They find that this requires implausibly impatient households: β has to be 0.6 or lower.

To evaluate the performance of our model relative to the empirical evidence, we use our model to replicate the Norwegian lottery experiment. In our model, we simulate 1,000 households each with a different series of income shocks and heterogeneity in their initial earnings. We then take an identical set of 1,000 households and give them an unexpected and transitory income shock equal to 37 percent of their current annual income, the size of the average lottery winning in the sample used by FHN.[9] We then

income shock, as Norwegians gamble on a regular basis. About 70 percent of Norwegians above age 18 gambled in 2012. The authors perform additional robustness checks to confirm that their results are not being driven by selection into lottery playing.

[8]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.

[9]FHN report an average lottery size of 8.65 and an average income after tax of 23.66, therefore in their sample, the average lottery over net income is around 37 percent.

compute the consumption response for each household as the difference between their consumption when they received the shock and when they did not. We repeat this procedure for each time period within the life cycle, then average over individuals, in order to measure the consumption response that does not depend on the age at which you win the lottery. In order to compare our results with FHN, we split our simulated households into four quartiles based on their liquid wealth holdings in the year prior to winning the lottery. This allows us to observe the time path of consumption after winning the lottery for households within each quartile.

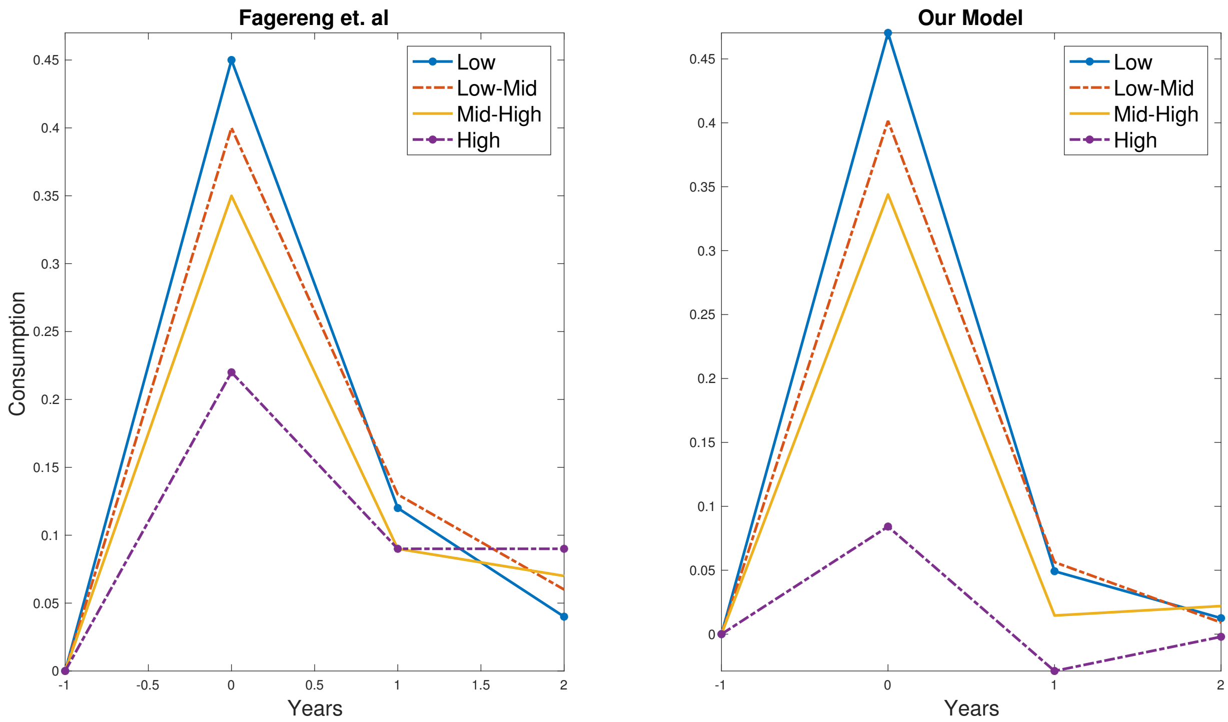

Figure 5: MPC by Liquid Wealth in the Data and the Model

Figure 5 shows the consumption response to winning the lottery, with the empirical results presented in the left panel and our model results presented in the right panel. In both panels, the household wins the lottery in year zero, therefore the largest consumption response is in this year. There is no consumption response in year -1, as the lottery winning is entirely unexpected. In the empirical evidence from FHN, we see that households in the lowest quartile of liquid wealth (the blue line) have an average MPC of 45 percent in the year that they win the lottery, higher than any of the other quartiles. In contrast, the households in the highest quartile (the purple line) have an average MPC of 22 percent. In our model, we obtain a very similar result, with an average MPC of just over 47 percent for households in the lowest quartile of liquid wealth. The consumption declines with liquid wealth holdings. The only significant difference is that households in the high liquid wealth quartile react less to income shocks in our model than observed in the data. In our model, the average MPC for households in the highest quartile of liquid wealth is 8 percent. This difference is probably driven by the fact that FHN are unable to differentiate between durable and nondurable consumption.

Next, we look at the correlation between wealth and MPC, using two different measures of wealth to determine whether liquid wealth or net wealth is more closely correlated with MPCs. We follow the methodology of FHN, who divide households into percentiles based on wealth, then control for age and income within each percentile by performing an OLS regression. Note that we simulate our model using the average shock size in FHN, while they have a richer distribution of shocks in their data. For this reason, differences between the correlations in our model and in FHN have to be interpreted carefully.

Table 6 presents the correlation between net wealth and MPC (in the first row) and the correlation between liquid wealth and MPC (in the second row). In the empirical evidence from FHN, we see that both measures are negatively correlated with MPC, but the size of this correlation is larger for liquid assets. We obtain a similar result in our model, where both correlations are negative, but the correlation with liquid assets is approximately 5 percentage points lower. These results indicate the importance of wealthy hand-to-mouth households, as these households have high levels of wealth but large MPCs.

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

Table 6: 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.

To better understand these results, we decompose the MPC between wealthy and poor hand-to-mouth households. We perform this decomposition in our model, although unfortunately the empirical counterparts were not measured in FHN. These results are presented in Table 7. Not surprisingly, unconstrained (non hand-to-mouth) households are the least responsive to income shocks with an average MPC of 21 percent. It is important to note that the positive MPC for non hand-to-mouth households reflects the mechanical effect of temptation, where a shock to income results in increased consumption today due to increased $\tilde{c}$.

In addition, Table 7 shows that the large variation in MPCs in our model is associated with the existence of wealthy hand-to-mouth households, who have an average MPC of 68 percent, approximately three times larger than the non hand-to-mouth households. This high MPC can be decomposed into two channels: first, the mechanical effect of temptation, and second, the hand-to-mouth behavior implied by holding no liquid assets. The temptation channel is able to explain approximately one third of the high MPC, whereas the hand-to-mouth channel explains the other two thirds. In contrast, the poor hand-to-mouth have an average MPC of 45 percent, in between that of the wealthy and non hand-to-mouth households.

	MPC in our Model
Non-HtM	0.21
Poor HtM	0.45
Wealthy HtM	0.68

Table 7: MPC Heterogeneity by Household Type

5 The Benefit from Commitment: Micro Evidence

A key implication 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).[10] It has been collected by the CentERdata Institute at Tilburg University since 1993 and 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.[11]

In Table 8 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.[12] 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 which about 80 percent is kept in illiquid form. In order to compare savings behavior of

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

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

[12] 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.

	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 8: Households' Wealth Composition in 2016

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

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.[13]

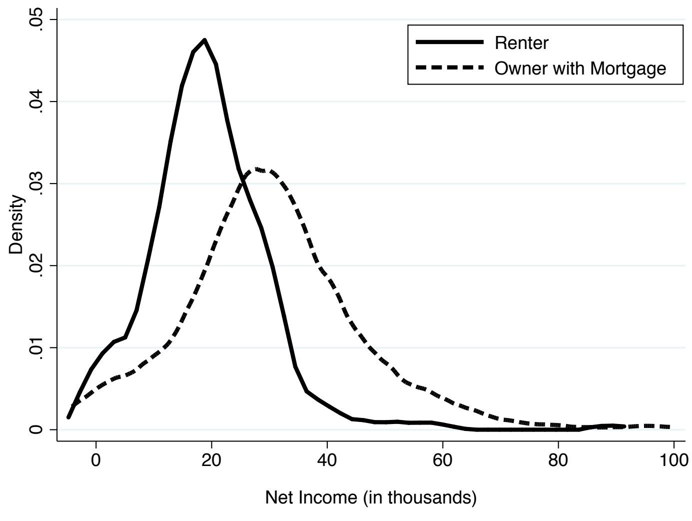

Figure 6: Households' Net Income in 2016

In Figure 7 we show the wealth accumulations separately for the two groups. For

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

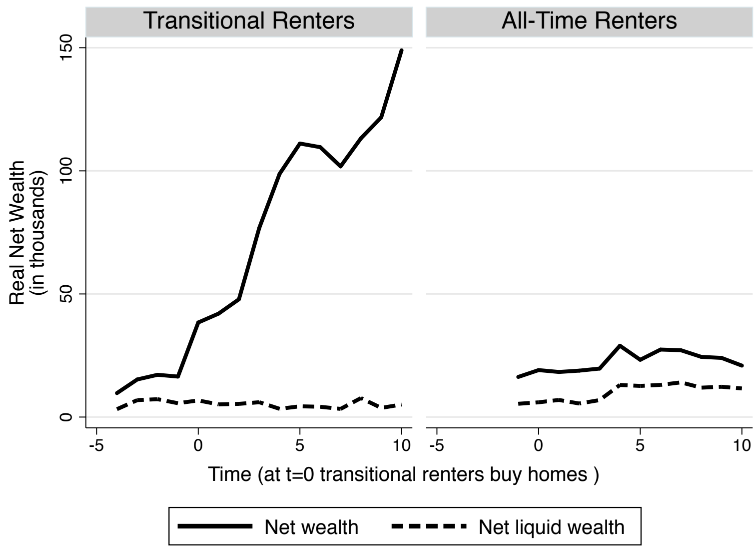

Figure 7: Unconditional Means for Wealth

transitional renters, year zero represents the period when they become homeowners.[14] 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.[15] 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 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.

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

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

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.

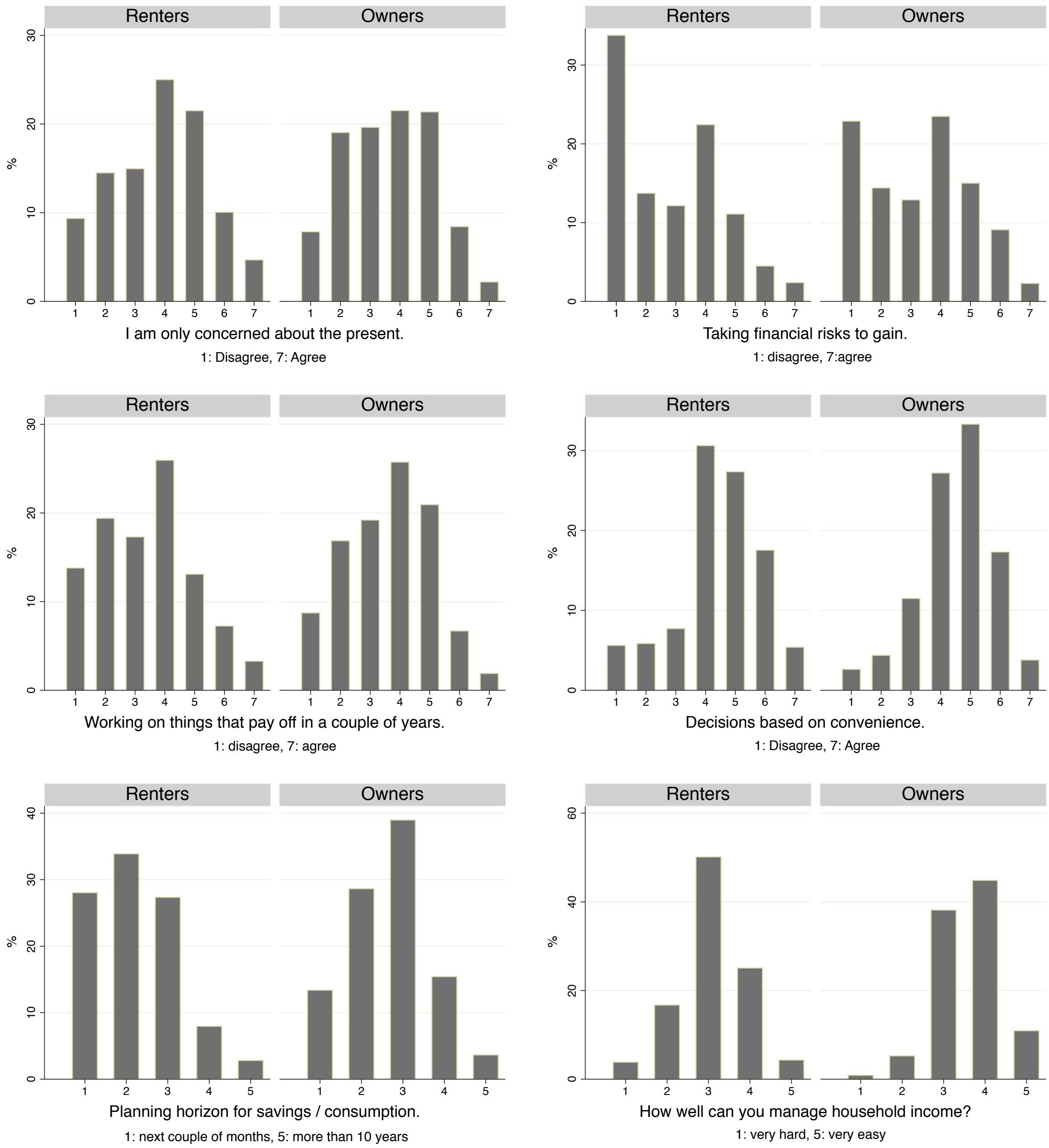

Figure 8: Psyhological Measures for Renters and Owners

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.[16] 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 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

[16] 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.

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.[17] 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.[18]

5.3 Results

Turning to our result, in Table 9 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 the sample.[19] 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.

[17]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: $p(X_i) < 1$

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

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

	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 9: 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.

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 10: Treatment Effects

Our main results are summarized in Table 10. 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
ϕ	relative utility from apartment to house	0.5
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 interest rate	4.0
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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