Assessing the Interaction between Real Estate and Equity in Households Portfolio Choice

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Abstract

In this paper, we provide a new empirical analysis of the dynamic portfolio decisions of households by simultaneously considering their stock market participation and home tenure choices. There is already a huge body of literature on housing status (own/rent) decisions and many contributions documented the low stock market participation rate of US households. Although some papers evidenced that the home status (modeled as an exogenous variable) has an impact on the stock proportion in portfolio, our paper is the first one to allow both decisions (home and stock) to be simultaneous and endogenous. We estimate a dynamic bivariate logistic panel data model on Panel Study of income Dynamics data from 1999 to 2007 controlling for sample selection bias and time-invariant unobserved heterogeneity. We first evidence that our original joint setup outperforms a standard one (with two distinct equations for stock holdings and for home tenure), i.e. marginal odds ratios are significant. Using these estimates, we are able to simulate individual paths of stock and home equity positions over the life cycle according to households attributes. *Ceteris Paribus*, we show that households taking positions in one asset (home or stock) encounter a positive position in the other asset at an earlier stage in their life cycle, i.e. some households appear to be locked in a no-stock-and-renter position.

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1 Introduction

Physical real estate accounts for a large share of the wealth of households in many developed countries. In the US, according to the Survey of Consumer Finances (SCF), the owner-occupier rate in 2007 is 68.6 percent and housing represents almost 60 percent of households' total assets. Simultaneously, stocks only accounts for 17.9 percent of the value of total financial (i.e. excluding home equity) assets of all US famillies. Many academic contributions tried to provide a theoretical explanation to this so-called stock market participation puzzle (or equivalently the *equity premium puzzle*): the majority of US households do no participate in the stock market though mean and variance of returns are historically attractive compared to other financial assets like bonds, saving bonds, retirement accounts, cash value life insurances, etc. Recently, some papers have put the emphasis on the role played by real estate holdings in explaining household portfolio choices and in particular stock market participation. They rely on the fact that housing is a non standard asset – it is singular with low divisibility (large costs when adjusting the consumption of housing services) and low liquidity (fixed transaction costs and non zero time-to-sell) – whose holding might distort the optimal composition of a household's portfolio.

Standard models of portfolio choices suggest that a zero position on the stock market cannot be optimal for risk averse agents. In a dynamic empirical contribution, Vissing-Jorgensen (2002) proposed some refinements compared to the standard setup. She uses two mechanisms: heterogeneity in nonfinancial income patterns and stock market participation costs. Considering a fixed transaction costs may explain why previous non stockholders (i.e. five years before in her dynamic setup based on PSID data) have a lower probability to participate in the stock market. Sufficiently large costs may dissuade households with low financial wealth to enter the stock market. The author also explains how heterogeneity in nonfinacial income may help to reproduce the changes in equity shares in households participating in the stock market.

As pointed out by Grossman and Laroque (1990), housing is simultaneously a consumption good and an investment asset, thereby distorting its holdings in household portfolio: the value of home equity is much larger than it should be if housing was a standard financial asset. Building on this seminal contribution, Yao and Zhang (2005a) evidence that housing transaction costs might help in explaining households' stock market participation decisions[1]. They extend the setup of Cocco (2004) or Hu (2005) which shows

[1] Some *theoretical* contributions already simultaneously deal with the determinants of home tenure and equity market participation. Yao and Zhang (2005b) proposed a life-cycle framework suggesting that household liquid wealth plays a

that homeownership crowds out stocks in net worth and incorporate a home tenure owner/renter trade-off. Their results suggest that owners hold a higher equity proportion in their *liquid* financial assets (i.e. stocks and bonds) than renters. The authors attribute this fact to the buffer role against financial risks played by home equity. They also detect that households with low financial wealth mainly choose to hold riskless assets (bonds) rather than stocks or real estate because of the fixed costs associated with stock market participation and mortgage down-payment liquidity constraints associated with access to home-ownership. Moreover, the authors provide evidence that households with low home value–net worth ratios and large mortgage–net worth ratios experience large probability to become stockholders. Kullmann and Siegel (2005) also focussed on the role of home tenure in equity holdings in a empirical contribution with panel data. In line with Vissing-Jorgensen (2002), they proposed a *dynamic* panel data model, hence controlling for possible state dependence in stock market participation. Their main results are similar to those obtained by Yao and Zhang (2005a). They also investigate the relationship between exposure to real estate (i.e. background risk measured by the local volatility of the dwelling value of homeownerss) and shareholding and found a significant role for this factor.

Our article differs from previous studies by explicitly dealing with the potential *simultaneity* of home tenure and equity market participation choices. In most of the contribution to this literature, the analysis is focused on the impact of home tenure on equity holdings while the reverse is not considered. Home tenure (at least in the empirical literature) is treated as independent from the position in the stock market and even *exogenous* in some cases. In our opinion, such a hypothesis may be too strong: for example, let us consider the situation of a household currently renting its housing services with low liquid financial wealth (small amount of bonds, no stocks). Suppose this household is hit by a large positive nonfinancial income shock permitting it either to pay the transaction costs associated with equity market participation or to constitute a sufficient downpayment toward becoming owner-occupier. In this case, the joint nature of both decisions is evident: at a certain date, the household must choose between becoming a owner with no stock and becoming a stock market participant while staying in the housing rental sector. Differently said, the problem does not reduce to a choice between two categories {stockholder, non stockholder} for each kind of tenant, but to a choice between four categories {stockholder, non stockholder} $\times$ {owner, renter}. The potential importance of this simultaneity issue is

significant role in explaining home and stock ownership. As investors become olders, their decisions regarding home tenure and stockholdings are being distorted: this is the hump-shaped life-cycle home and stock ownership pattern. Moreover, the theoretical framework shows that the previous home equity position of household also affects their cross decisions on housing and stock markets over the life-cycle.

also clear when considering the possible wealth reallocation of households at each date. Though most of US households choose to invest in riskless assets to constitute their mortgage downpayment, it appears that a fraction of households participating in the equity market may choose to sell their stocks to get a mortgage loan with eligible Loan to Value ratios and then become homeowners.

To quantitatively assess the importance of joint home-stock decisions, we estimate a bivariate dynamic logit model on data from the Panel Study of Income Dynamics (PSID) from 1999 to 2007 (i.e. 5 waves at a biannual frequency)[2]. We collect information regarding the home and equity positions of 2163 US households, as well as different socio-demographic factors (gender, age, marital status, number of children), real income, real net worth (i.e. bonds, stocks and home equity), ratio of mortgage over house value and time dummies.

Our model provides some empirical refinements about the quantitative importance of joint home-stock decisions of US households and the covariates creating wedges in this simultaneous choices. We estimate an original bivariate dynamic logit model in the line of Bartolucci and Farcomeni (2008). We simultaneously estimate three equations: *(i)* two marginal conditional logit equations (the first one for equity market participation and the second one for home tenure) with state dependence terms (lagged position variables) and unobserved heterogeneity terms to control for household specific effects, *(ii)* a log odds-ratio equation conditional on some selected covariates accounting for potential *simultaneity* in home and stock market decisions.

We find that our original joint setup outperforms a standard one (with two distinct equations to model stock holdings and home tenure), i.e. marginal odds ratios are significant. Our results may be summarized as follows: first, contrary to some contributions in the existing literature, we do not find that homeownership crowds out stock holdings (first logit equation): in line with some previous results within *dynamic* models, previous owners are more likely to become stockholders. Moreover, the negative impact of home equity on stock market participation decisions already evidenced in the literature with older data (between 1984 and 1999) – the low liquidity of home equity – is no longer significant in our recent sample. The enlarged access to home equity withdrawal in the beginning of the 2000′s may have increased the liquidity of home equity. Second, we find a positive contribution of current stock market participation on the probability to be a future owner-occupier (second logit equation). Households with a large share

[2] We exclude preceeding waves since before 1999, the typical PSID survey frequency was 5 years which might be too long when considering transitions rates in home tenure and equity market (more than one transition could happen in five years).

of equity in financial wealth (possibly those with greater risk aversion) are more prone to convert their financial wealth into home equity than households mostly holding bonds. Hence, we evidence a two-sided dynamic relationship between home tenure and stock market participation: past home position significantly influences equity market participation and conversely. More precisely, households taking positions in one asset (home or stock) encounter a positive position in the other asset at an earlier stage in their life cycle, i.e. some households appear to be locked in a no-stock-and-renter position. Finally, we find that some factors (age, home equity, whether the household holds other real estate assets) have a significant impact on the log of odds ratio (third equation). In particular, it appears that young households have a higher probability to become simultaneously owner and stockholder than older ones, *ceteris paribus*.

We then extend our setup and add three continuous equations for the determination of the value of stocks, bonds and home equity held by each household. The whole model (three participation equations, three continuous equations) enables us to simulate individual historical paths on the two markets (home and stock) over the considered period and to quantitatively assess the role of the log odds ratio in cross decisions.

The paper is organized as follows: Section 2 presents the econometric methodology. Section 3 describes the dataset. Section 4 presents the whole set of results and the sensitivity analysis. Section 5 concludes.

2 The Econometric Model

2.1 Dynamic Logit Equations

Let $y_{k,i,t}$ denote the categorical response variables for household i at calendar year t, with $i = 1, ..., n$, $t = 2001$, 2003, 2005 or 2007 and $k = h, s$. $y_{h,i,t}$ is the home tenure and has two categories {owner-occupier, renter}. $y_{s,i,t}$ is the stock market position and has two categories {stockholder, non stockholder}. $\mathbf{y}_{i,t}$ denote the vector with elements $y_{k,i,t}$ and $\mathbf{x}_{i,t}$ is the $(1 \times K)$ vector of strictly exogenous covariates for household i at date t. This vector includes socio-economic factors such as age of head (linearly specified), number of adults in household, number of children, log of real household income (two years before), log of real networth (two years before), the log of home equity over value of home (two years

before) and dummies regarding whether the household own a business or another real estate asset than its current home. This vector also contains temporal dummies (for years 2003, 2005 and 2007) to capture the temporal dependence of home tenure and stockholding positions: as previously explained in the data section, the homeownership and stockholders rate are steadily rising over the considered period. Lagged variables $y_{k,i,t-1}$ (i.e. previous year home tenure and stock market position) are included to capture state dependence, i.e. the direct impact of past positions on current choices. The panel structure of our data sample (we follow the same households for a long period - 6 years - and may then observe multiple spells) permits the identification of an unobserved time-constant heterogeneity term ω_i.

Let $p\left(\mathbf{y}_{i,t} \mid \mathbf{x}_{i,t}, \mathbf{y}_{i,t-1}, \omega_i\right)$ denote the conditional distribution of the vector of endogenous variables $\mathbf{y}_{i,t}$ given the vector of exogenous covariates, lagged endogenous variables and unobserved random terms. Following Bartolucci and Farcomeni (2008), we adopt a *local* specification for marginal logits and for log-odds ratios. More precisely, each of the two marginal logits $\eta_{k,i,t}$ is modeled as follows

$$\eta_{k,i,t} = \log \frac{p\left(y_{k,i,t} = 1 \mid \mathbf{x}_{i,t}, \mathbf{y}_{i,t-1}, \omega_i\right)}{p\left(y_{k,i,t} = 0 \mid \mathbf{x}_{i,t}, \mathbf{y}_{i,t-1}, \omega_i\right)} \quad k = h, s \tag{1}$$

where the value taken by $y_{k,i,t}$ determines the home tenure ($k = h$) or the stock market position ($k = s$). In the former case, we arbitrarily select the category $y_{h,i,t} = 0$ to denote the renter state while $y_{k,i,t} = 1$ is for homeownership. In the latter case, $y_{s,i,t} = 0$ is for non-stockholder position and $y_{s,i,t} = 1$ for stockholders.

The marginal log odds ratio $\varphi_{i,t}$ is specified as follows

$$\varphi_{i,t} = \log \left[\frac{p\left(y_{h,i,t} = 1,\ y_{s,i,t} = 1 \mid \mathbf{x}_{it}, \mathbf{y}_{it-1}, \omega_i\right) p\left(y_{h,i,t} = 0,\ y_{s,i,t} = 0 \mid \mathbf{x}_{it}, \mathbf{y}_{it-1}, \omega_i\right)}{p\left(y_{h,i,t} = 0,\ y_{s,i,t} = 1 \mid \mathbf{x}_{it}, \mathbf{y}_{it-1}, \omega_i\right) p\left(y_{h,i,t} = 1,\ y_{s,i,t} = 0 \mid \mathbf{x}_{it}, \mathbf{y}_{it-1}, \omega_i\right)} \right] \tag{2}$$

This log odds ratio measure the gap between the pair of conditional logits. For example, a large value for $\varphi_{i,t}$ (i.e. a log odds ratio largely positive) means that the ratio of probability of being an owner-occupier ($y_{h,i,t} = 1$) compared to a tenant in the private rental sector ($y_{h,i,t} = 0$) for household i at calendar year t is higher when holding stocks ($y_{s,i,t} = 1$) rather than not ($y_{h,i,t} = 0$). Hence, the value taken by $\varphi_{i,t}$ is extremely important for the purpose of this paper: if it strongly diverges from zero, it necessarily means that *current* decisions of household on one market (the stock market for example) are related to *current* – i.e. not solely past positions – choices on the other market (home tenure). Differently said, it would mean that household's decisions regarding their home tenure and stock

market participation are simultaneously rather than sequentially taken in their life-cycle. We propose the following simple three-equations linear setup for marginal logits and log odds ratio

$$\begin{cases} \eta_{k,i,t} = \alpha_k + \mathbf{x}_{i,t}\beta_k + \mathbf{y}_{i,t-1}\gamma_k + \omega_{k,i}, \quad k = h, s \\ \varphi_{i,t} = \overline{\alpha} + \overline{\mathbf{x}}_{i,t}\overline{\beta} + \mathbf{y}_{i,t-1}\overline{\gamma} + \overline{\omega}_i, \end{cases} \tag{3}$$

α_k (resp. $\overline{\alpha}$) are the intercept terms for each marginal logit equation (resp. log odds ratio). The unobserved heterogeneity factors ω_i $(k = h, s)$ and $\overline{\omega}_i$ are elements of vector ω_i. As will be detailed in the next subsection, ω_i also includes terms from the different continuous equations that we will have to estimate to conduct the model simulation. The vector of covariates $\overline{\mathbf{x}}_{i,t}$ in the log odds equation only include a fraction of the elements of vector $\mathbf{x}_{i,t}$: we have to be parcimonious when modelling odds ratios in order to limit the number of parameters to estimate[3]. Notice that supposing that some factors affecting the marginal logits do not impact the log odds ratio is equivalent to assuming that the underlying utility function of households is separable in these factors: the contribution of this variable to the current endogenous household's decision on one market (home tenure for example) does not distort the current endogenous decision on the other market (stock market in this case). $\beta_{k,z}$ (resp. $\overline{\beta}$) is the $(K \times 1)$ vector of parameters that evaluates the impact of exogenous covariates of marginal logits (respectively log odds ratio). γ_k (resp. $\overline{\gamma}$) is the vector of parameters assessing the contribution of last year home tenure and stock market position on current marginal logits (resp. log odds ratio).

Overall, the simultaneous estimation of the two marginal logits $\eta_{k,i,t}$ and the only log-odds ratio $\varphi_{i,t}$ delivers a complete characterization of the joint conditional distribution of $y_{s,i,t}$ and $y_{h,i,t}$. Once the three corresponding equations have been estimated, we use the approximate iterative procedure described by Colombi and Forcina (2001) to obtain $p\left(\mathbf{y}_{i,t} \mid \mathbf{x}_{i,t}, \mathbf{y}_{i,t-1}, \omega_i\right)$ from the vector $\left\{\eta_{h,i,t}, \eta_{s,i,t}, \varphi_{i,t}\right\}$. This procedure[4] is computationally cumbersome since it requires an optimization process within our likelihood maximization procedure. This explains that we have to keep the number of parameters reasonably low.

2.2 Continuous equations

In a first step, we will limit our analysis to stock market participation and home tenure decisions. The results of the estimation of the three-equations system (3) is largely detailed in the first part of the results

[3] For example, Bartolucci and Farcomeni (2008) treat the log odds ratio as constant.
[4] We use MATLAB functions made available by Bartolucci (2007).

section. However, we will further need to complete our setup with three continuous equations for the determination of the amount of shares, home equity and bonds held by each household, since the lag of these variables enter the dynamic logit equations (vector $\mathbf{x}_{i,t}$) and are affected by current home tenure and stock market participation choices of this household. More precisely, for the simulation of the model, we need to estimate *(i)* the amount of shares $s_{i,t}$ among stockholders since the value of $s_{i,t}$ has an impact on the composition of the household real networth which is a component of $\mathbf{x}_{i,t}$ and will then impact future home tenure and stock market participation decisions, *(ii)* the value of current home equity he_{it} among homeowners (which will also affect future transitions of households) and *(iii)* the value of real non-stock liquid financial wealth $b_{i,t}$.

We then estimate a three-equations system with continuous endogenous variables. Among the explanatory variables, we include almost all those already present in vector $\mathbf{x}_{it}$ as well as additional factors usually present in this kind of model: lagged values of the log of all three endogenous variables: $s_{i,t-1}$, he_{it-1} and $b_{i,t-1}$ for previous (i.e. two years ago) stockholders, homeowners or bondholders as well as three dummies ($d_{s,i,t-1}$, $d_{h,i,t-1}$ and $d_{b,i,t-1}$) taking the value 1 for non-stockholders, renters, non-bondholders respectively and zero otherwise. The system is as follows

$$\begin{cases} \log\left(\frac{s_{i,t}}{nw_{i,t}}\right) = \overline{\alpha}_s + [\mathbf{x}_{i,t},\ \mathbf{z}_{i,t}]\,\overline{\beta}_s + \mathbf{y}_{i,t-1}\overline{\gamma}_s + \overline{\omega}_{s,i} + \varepsilon_{s,i,t} \\ \log\left(he_{i,t}\right) = \overline{\alpha}_h + [\mathbf{x}_{i,t},\ \mathbf{z}_{i,t}]\,\overline{\beta}_h + \mathbf{y}_{i,t-1}\overline{\gamma}_h + \overline{\omega}_{h,i} + \varepsilon_{h,i,t} \\ \log\left(b_{i,t}\right) = \overline{\alpha}_b + [\mathbf{x}_{i,t},\ \mathbf{z}_{i,t}]\,\overline{\beta}_b + \mathbf{y}_{i,t-1}\overline{\gamma}_b + \overline{\omega}_{b,i} + \varepsilon_{b,i,t} \end{cases} \tag{4}$$

The interpretation of parameters $\overline{\alpha}_s$, $\overline{\beta}_s$, $\overline{\alpha}_h$, $\overline{\beta}_h$, $\overline{\alpha}_b$, $\overline{\beta}_b$ is straightforward following the presentation of system (3). The vector $\mathbf{z}_{i,t}$ contains all additional covariates compared to those included in the transition equations. We also include three vectors of parameters $\overline{\gamma}_s$, $\overline{\gamma}_h$ and $\overline{\gamma}_b$ since the previous stock market position or home tenure (owner or private renter) may impact the composition of the real networth $nw_{i,t}$. $\overline{\omega}_{s,i}$, $\overline{\omega}_{h,i}$ and $\overline{\omega}_{b,i}$ are unobserved time-constant heterogeneity terms, possibly correlated with those included in system (3). The potential link between these three terms is essential since it may capture wealth reallocation effects (i.e. households converting non financial into financial assets for example). $\varepsilon_{i,t} = \{\varepsilon_{s,i,t}, \varepsilon_{h,i,t}, \varepsilon_{w,i,t}\}$ is a supposedly homoskedastic Gaussian error term vector[5], $\varepsilon_{i,t} \sim \mathcal{N}(0, \Gamma)$. Let $g_1\left(s_{it} \mid \mathbf{x}_{i,t}, \mathbf{z}_{i,t}, \mathbf{y}_{i,t-1}, \overline{\omega}_{s,i}\right)$ be the density of stock values conditional of observed and non observed factors. Let $g_2\left(he_{it} \mid \mathbf{x}_{i,t}, \mathbf{z}_{i,t}, \mathbf{y}_{i,t-1}, \overline{\omega}_{h,i}\right)$ and $g_3\left(b_{it} \mid \mathbf{x}_{i,t}, \mathbf{z}_{i,t}, \mathbf{y}_{i,t-1}, \overline{\omega}_{b,i}\right)$ denote the equivalent density

[5] Γ could also contains non-zero diagonal elements to reproduce time-dependent reallocation effects not captured by vector $\overline{\omega}_{s,i}$. However, this hypothesis has been rejected with log likelihood ratios testing procedure.

functions for home equity and bond values of household i at date t respectively.

2.3 Unobserved heterogeneity

The joint distribution of the six (two marginal logits, the log odds ratio and three continuous equations) heterogeneity terms of vector $\omega_i = \{\omega_{s,i}, \omega_{h,i}, \overline{\omega}_i, \overline{\omega}_{s,i}, \overline{\omega}_{h,i}, \overline{\omega}_{b,i}\}$ is assumed to be normal $\omega_i \sim \mathcal{N}(0, \Omega)$. Ω is supposed to be time homogenous. We have to estimate six variance terms (included in vector $\boldsymbol{\sigma}_\omega^2$) and 15 linear correlation terms[6] (vector ρ_ω).

2.4 Likelihood inference

Let $\mathcal{L}_{i,t}(\omega_i)$ be the likelihood expression for household i at date t conditional on all strictly exogenous covariates (omitted from the argument of likelihood to keep notations simple), on past stock market positions and home tenure of the household (also omitted) and on heterogeneity terms ω_i. The expression for log-likelihood is

$$\begin{aligned} \mathcal{L}_{i,t}(\omega_i) &= p(\mathbf{y}_{i,t} \mid \mathbf{x}_{i,t}, \mathbf{y}_{i,t-1}, \omega_i) \left[g_1(s_{it} \mid \mathbf{x}_{i,t}, \mathbf{z}_{i,t}, \mathbf{y}_{i,t-1}, \overline{\omega}_{s,i})\right]^{e_{s,i,t}} \\ &\quad \times \left[g_2(he_{it} \mid \mathbf{x}_{i,t}, \mathbf{z}_{i,t}, \mathbf{y}_{i,t-1}, \overline{\omega}_{h,i})\right]^{e_{h,i,t}} \left[g_3(b_{it} \mid \mathbf{x}_{i,t}, \mathbf{z}_{i,t}, \mathbf{y}_{i,t-1}, \overline{\omega}_{b,i})\right]^{e_{b,i,t}} \end{aligned} \tag{5}$$

with $e_{s,i,t} = 1$ if household i participates in the stock market at calendar year t and zero otherwise. $e_{h,i,t} = 1$ if household i is an owner-occupier at date t and zero otherwise. $e_{b,i,t} = 1$ if household i holds bonds at date t and zero otherwise. We deduce the overall expression of the joint non conditional log-likelihood

$$\mathcal{L} = \sum_{i=1}^{N} \log \left\{ \int p(\mathbf{y}_{i,1999} \mid \omega_i) \left[\prod_{t=2001}^{2007} \mathcal{L}_{i,t}(\omega_i) \right] dF(\omega_i) \right\} \tag{6}$$

where $F(.)$ is the cumulative normal distribution function of unobserved heterogeneity terms with variance-covariance matrix Ω. The term $p(\mathbf{y}_{i,1999} \mid \omega_i)$ is included because of the *initial condition problem*: the first lag of endogenous variables $\mathbf{y}_{i,1999}$ is possibly correlated with the unobserved time-constant heterogeneity factor. The complete model of transitions on housing and labor market, wages and housing costs is estimated with maximum likelihood techniques with a large number (i.e., 15) of simulated values for each component of vector ω_i.

[6] An alternative modelling procedure proposed by Heckman and Singer (1984) where ω is a discrete random vector with finite support is not convenient in our large sample, multivariate case.

3 Data

3.1 Data description

For the seek of our study with state dependence effects, we rely on panel datasets. As we mainly focus on the different asset classes (stocks, bonds, bank account savings, current accounts) held by U.S. households, we choose to use the Panel Survey of Income Dynamics (PSID hereafter). The Family files data are collected over the $[1999-2007]$ period. This sample period choice is first motivated by the fact that the Wealth Supplement surveys are useful to reconstitute households' financial wealth and home equity are also available for those years. Moreover, starting from 1999, the survey frequency is two years (compared to five years before 1999): such a frequency reduces the risk of *unobserved spells* (more than one transition between two interviews): this point is extremely important since we focus on *transition* rates to homeownership and stock market participation. Unobserved spells would conduct to biased transition rates. Following Vissing-Jorgensen (2002), we exclude the Poverty and the Latino Sample. As detailed in the literature, lower and upper centiles for each interest variables are deleted to control for possible outliers[7].We only keep those families whose structure has remained unchanged throughout the period of observation to limit the possible impact of socio-demographic choices on our interest variables. Moreover, our final dataset only contains informations for each of the households ever in the sample throughout the $[1999-2007]$ period (Vissing-Jorgensen, 2002 or some of the results of Kullmann and Siegel). This – quite standard – assumption is necessary in our dynamic setup since *one* missing observation for a given household at a certain date conducts to *two* missing points for the estimation because of state dependence terms.

We collect informations from the two following PSID datasets: the first group of variables comes from the Family files[8]. These variables are used to characterize the surveyed household: age of head, number of household's members, number of children, residence location code. We also retain a measure of households' income and the situation of the household on the housing market (renter or owner) and the value of the property for owner households. Finally, we retain the amount of the principal and secondary mortgages for homeowners.

The second group of variables is collected in the Wealth Supplement, which precisely describes the

[7] With this procedure, most of the *top-coded* variables (for wealth or income for example) are suppressed.

[8] We use family instead of individual files since the latter do not contain wealth informations. We nevertheless have to use the individual files to keep track of the identifying numbers of household's head.

components of wealth held by American households. We retain a definition of total wealth *including home equity*. The households' wealth is calculated by summing the following types of asset: if own part or all of a farm or business, money in checking or savings accounts, money market funds, certificates of deposit, government savings bonds or treasury bills not including assets held in employer-based pensions or IRA's, any real estate other than a main home[9], shares of stock in publicly held corporations, mutual funds or investment trusts[10], other physical assets[11], other savings or assets[12]. The *financial* wealth variable is the sum of cash, bonds and stocks and is net of the value of debt. This latter variable is defined as other debts aside from any mortgage or vehicle loans, such as credit card charges, student loans, medical or legal bills, or loans. The sum of financial wealth and home equity is total wealth.

Since we seek to explain the joint decision of housing tenure and participation in the stock market (hold shares/shares not held), the dependent variables are $OWNHOUSE_{it}$ et $OWNSTOCK_{it}$. Notice that the lag of these variables (i.e. the home tenure and stockholding position at the preceding interview, two years before) will be included among the set of explanatory variables. The covariates are the following:

$RNETWORTH_{it}$ measures the total real net wealth[13] of a given household i at period t. The variable, $RINCOME_{it}$, measures the total family income collected in a given year[14]. As this variable can contain either null or negative values (which indicates a net loss), we exclude such observations and only keep households with non-negative income.

$STOCK_{it}$ represents the value of shares held by households in the sample. This variable includes shares of stocks in publicly held corporations, mutual funds, or investment trusts, not including stocks in employer-based pensions or IRA's.

LH_EQ_{it}, is the logarithm of the home equity deflated by the Consumer Price Index. The value of home equity is built with the house price PH_{it} and the outstanding primary plus secondary mortgage value $MORTGAGE_{it}$. PH_{it} is defined as the current value of the apartment or house self-assessed by the household. The value $MORTGAGE_{it}$ taken by this variable represents the principal currently owed

[9] Such as a second home, land, rental real estate, or money owed on a land contract

[10] Not including stocks in employer-based pensions or IRA's

[11] Cars, trucks, motor home, trailers or boats.

[12] Such as bond funds, cash value in a life insurance policy, a valuable collection for investment purposes, or rights in a trust, money in private annuities or Individual Retirement Accounts (IRAs)

[13] We depart from the nominal ($WEALTH_{it}$) given in the Wealth Supplement and use the Consumer Price Index variation between the considered year and 1984, FRED (Federal Reserve Economic Data) Economic Research Division Federal Reserve Bank of St. Louis CPIAUCSL.xls; Consumer Price Index for All Urban Consumers: All Items; Index 1982-84=100; M; SA; 2010-12-15. http://research.stlouisfed.org/fred2/categories/9

[14] For each year, the total family income is the sum of these seven variables: Head and Wife/"Wife" Taxable Income, Head and Wife/"Wife" Transfer Income, Taxable Income of Other FU Members, Transfer Income of OFUMS, Head Social Security Income, Wife/"Wife" Social Security Income, OFUM Social Security Income.

from all mortgages or land contracts on the home. The ratio ($MORTGAGE_{it}/PH_{it}$), defines the share of mortgages with respect to the value of the house. It measures the degree of household home leverage.

$WBUSIN_{it}$, $WOREAL_{i_t}$ are binary variables (= 1 when the household owns part or all of a farm or business or when anyone in the family owns any real estate other than the main home, i.e. a second home, land, real estate for rental purpose). For these variables, we allow the business assets, and other types of asset holdings to influence the decision to buy a home or to enter the stock market.

$y2003$, $y2005$, $y2007$ are dummy variables that account for the business cycle impact on the decision to buy a home or to participate in the stock market. Year 2001 is the reference. The remaining explanatory variables are AGE_{it}, $NUMKIDS_{it}$, $NBADULTS_{it}$, which respectively denote the age of head, the number of kids and adults. This latter variable is obtained by subtracting the number of kids from the total number of household's members. All these variables are linearly specified.

Conditionally to the first double decision related to the participation equations, we will also need to determine the share of household's net wealth invested in different types of assets: bonds b_{it}, stocks s_{it} and home equity. The determination of these continuous variables is necessary for the simulation of the model. The vector of dependent variables is : s_{it}/nw_{it} the proportion of shares of stocks in the networth of the household, LH_EQ_{it}, the logarithm of home equity and $\log(b_{it})$ the logarithm of the bond and other risk-free assets value.

3.2 Summary Statistics

We now provide some descriptive statistics for different subsamples of households for our sample period $[1999-2007]$. We focus on key identical variables across different subgroups. These variables include the percentage of stock ownership, the fraction of homeowners, the house value-networth ratio, the households' income and networth (in 1984 dollars), the shares to networth ratio, the shares to financial assets ratio, the networth to income ratio, the number of children under 18 living in the household, the number of adults in the household, the percentage of households owning a business and the percentage of households owning other types of real estate assets.

Table 1 illustrates the year by year evolution of the variables of interest. We first observe that the average age of head slightly increases from 47.2 to 48.2 years over the $[1999-2007]$ period. The number of children per household is about 0.73 in 1999 and steadily diminishes to 0.68 in 2007. The share of

households with other real estate assets remains steady over the observation period (between 17.2 and 19.3%). Similarly, the proportion of households owning a business is relatively constant over time, in spite of a fall in 2007.

When it comes to explain the stock market participation, we observe that the share of shareholders is around 50%. Despite a slight recovery in 2005 (51.9%), the trend is clearly negative slopped between 1999 and 2007 (48.6% in 2007). We detect a similar evolution for the homeownership trend: 75.5% of the households were homeowner in 1999 against 72% in 2007. Regarding the composition of the portfolio (financial and real estate) held by the average household and its evolution over the $[1999 - 2007]$ period, we learn from Table 1 that the proportion of shares in liquid financial wealth of households, in 1999 was worth 27.2% but only 18.5% in 2007.

With these elements in hands, we are able to highlight some sharp contrasts between renters and homeowners. Table 2 shows that the percentage of households participating in the stock market is higher for homeowners than for renters. Homeowners are on average more likely to participate in the stock market. For example, in 1999, 58.5% of homeowners were shareholders against 30% in the renters' population. This proportion slightly increased for owners (59.1% in 2007), while it decreased to 21.6% in 2007 for renters. Moreover, the amount of shares relative to the financial (liquid) networth of homeowners is twice as high as of renters. This gap widens along the sample period. In their contributions, Kullmann and Siegel (2005), Yao and Zhang (2005a) and Vissing-Jorgenssen (2002) evidenced similar patterns. Another point highlights the contrast between homeowners and renters: despite a higher rate of stock market participation of the owners, their risk exposure is much lower. Indeed, the share of equity shares in net wealth is lower for owners than for renters. This is the traditional "crowding-out effect" detailed by Cocco (2004). Focusing on the role of housing consumption in explaining the cross-sectional heterogeneity of investors' portfolio decisions, he found that the housing asset crowds out stockholding in net worth. As our sample covers a more recent period than the above contributions, it seems interesting to notice the persistence of these structural differences.

4 Results

This section presents the quantitative results. It is divided into two parts. In a first subsection, we present the estimation results. At this stage, we seek to judge the goodness of fit statistics provided

by the econometric model. In a second subsection we present three counterfactual exercises based on simulations. Our goal in simulating these scenarios is to assess the additional information provided by our econometric model on the joint choice to enter the stock market and become homeowner.

4.1 Estimates

We first present the parameter estimates of a reduced version of the model, i.e. the system of transition equations (3). Results are summarized in Table 3. Continuous equations will later be added in the simulation subsection. In Table 6, the first column lists exogenous covariates, lagged endogenous variables and the estimated variances of unobserved terms. The second column gives parameters estimates corresponding to the first logit equation, i.e. the relative probability of being owner in t compared to renter conditional on past position, exogenous variables and household specific terms, $p\left(y_{h,i,t}=1 \mid \mathbf{\Theta}_t\right)/p\left(y_{h,i,t}=0 \mid \mathbf{\Theta}_t\right)$ with $\mathbf{\Theta}_t = \{\mathbf{x}_{it}, \mathbf{y}_{it-1}, \omega_i\}$. The third column gives parameter estimates corresponding to the relative conditional probability of being stockholder rather than not $p\left(y_{s,i,t}=1|\mathbf{\Theta}_t\right)/p\left(y_{s,i,t}=0 \mid \mathbf{\Theta}_t\right)$. The last column gives estimates corresponding to the log odds ratio $\varphi_{i,t}$. The symbol , **, means significant at 5% level and * at the 10% level. All the reported standard errors are heteroskedasticity-robust. Notice that the chosen final setup results from previous estimations of enlarged models with many other covariates. Some of them have been discarded with usual log likelihood ratio tests. As previously explained, we only consider households with four consecutive observations (in 2001, 2003, 2005 and 2007). The total number of such households is $2,163$ after dataset treatment, hence the total number of observations is $8,652$. Most of the explanatory variables are lagged to prevent from simultaneity issues: for example, decisions regarding whether to hold another business $WBUSIN_{it}$ or real estate asset $WOREAL_{it}$ and those concerning $y_{h,i,t}$ or $y_{s,i,t}$ might be jointly taken; we then have to lag these variables as well as all the financial or economic ones. The only contemporaneous variables are the socio-demographic ones: age of head, number of adults or number of children. We have reduced the number of estimated parameters in the log odds ratio equation: many explanatory variables have been discarded since we detect no significant impact on $\varphi_{i,t}$ when estimating enlarged setups.

We first check for the goodness-of-fit of our model with standard pseudo R^2 fit statistics (i.e. log likelihood ratios comparisons between pairs of models). We find that the presence of explanatory variables contributes to improve the likelihood of our model by 36% compared to a very simple model with only intercept terms. The log likelihood discrepancy between our benchmark model and a model with only

the two marginal logit equations (1) but no odds ratio (i.e. setting $\varphi_{i,t}$ to zero) is above 5%. Hence, this advocates for the presence of simultaneity effects through equation (2). Moreover, had we deleted cross state-dependence terms, the likelihood gap would have widen to almost 15%. This confirms the importance of dynamics terms (impact of lagged home tenure on stockholding and of lagged stock market position of home tenure decisions). Finally, we detect a significant role for the unobserved heterogeneity variance terms; but no correlation between the term in the home tenure logit equation and the term in the stock market participation logit equation.

4.1.1 No age effect on home tenure, but a positive influence on stock market participation

We found no significant effect of age of head (linearly specified) on the marginal probability ratios of becoming an owner rather than a renter, $\frac{p(y_{h,i,t}=1 \mid \mathbf{\Theta}_t)}{p(y_{h,i,t}=0 \mid \mathbf{\Theta}_t)}$. In a first glance, this result seems to stand in sharp contrast with previous estimates: the homeownership rate grows with age of head, at least before retirement. Our descriptive statistics also confirms this pattern, but recall that our setup is not focused on the *level* of stock market participation or home tenure rates, but on the *transition* rates to homeownership and stockholding. Hence, we detect no significant distortion of transition rates to ownership over the life-cycle, once controlling for other factors such as income or wealth effects. Moreover, we also tested for the role of AGE_{it}^2 since, as explained by Yao and Zhang (2005b), the home-ownership rate exhibits a hump shaped pattern over the life-cycle in the US (with a peak just before retirement). However, we detect no significant contribution for this variable.

On the contrary, age appears to positively influence the transition rate to equity market participation. Once again, quadratic terms in age have been discarded: our estimates suggest than when controlling for other factors such as income, wealth or previous position (home tenure or stock market participation), the well documented hump-shaped pattern in stock ownership is no longer valid (notice that Kullmann and Siegel, 2005, also fails to detect a significant impact of the square of age of head on stock market participation). This result (i.e., age positively influences stock ownership) is in line with previous empirical studies (for example, Yao and Zhang, 2005a, found a positive influence of age on stock market participation for homeowners): young households with low financial wealth and generally no home equity preferentially invest in riskless assets such as bonds. Consequently, their equity share in financial wealth is low. Interestingly, we find a significant negative contribution of age to the log odds ratio $\varphi_{i,t}$: conditionally on past positions on both markets, elderly households exiting to participation in

one market (i.e. either becoming owner-occupiers or stockholders) encounter a lower probability to switch to participation in the other market than younger ones. Differently said, if we compare two otherwise similar households at different stages in their life-cycle and suppose both are renter and non-stockholders, the younger one experiences a higher probability to become *simultaneously* owner and stock market participant at a two years horizon than the older one (when controlling for other socio-economic and financial factors). This fact will be clearly illustrated in the simulation subsection. Notice also that head's age will appears to be one of the few variables significantly contributing to the log of odds ratio (many other potential covariates have been discarded based on log likelihood ratio tests), but this influence is non negligible: if we had solely estimated the two marginal logits equations $\frac{p(y_{h,i,t}=1 \mid \mathbf{\Theta}_t)}{p(y_{h,i,t}=0 \mid \mathbf{\Theta}_t)}$ and $\frac{p(y_{s,i,t}=1 \mid \mathbf{\Theta}_t)}{p(y_{s,i,t}=0 \mid \mathbf{\Theta}_t)}$, the pseudo R^2 fit statistics would have been only 30% instead of 36% for the benchmark.

4.1.2 The role of other socio-economic factors

The number of adults has a positive impact on the ownership transition rate (married heads more frequently exit to owner-occupier state than single). Oppositely, this variable negatively influences the probability of participation to the stock market.

Surprisingly, the number of kids living in the household does not play any significant role on stock market participation (this result confirms Yao and Zhang, 2005a or Kullmann and Siegel 2005 estimates), but nor does it on the transition rate to homeownership. This result could be linked to the possible correlation between this variable and the age of head. As was to be expected, the lagged real income $RINCOME_{it-1}$ and the lagged real net worth $RNETWORTH_{it-1}$ positively influence the conditional probabilities to become homeowner and stockholder. Concerning the equity market participation, this result is in line with Yao and Zhang (2005a) or Kullmann and Siegel (2005). These results respectively confirm the role of (nonfinancial) income exemplified by Vissing-Jorgensen (2002) in explaining part of the cross-sectional heterogeneity in asset holdings and the presence of participation costs (liquidity constraints) on the stock market. Households with low financial wealth and home equity cannot pay these entry costs and keep a large share of their wealth in the form of riskless assets. A similar reasoning may be applied to the transition rate to homeownership: households with a low financial wealth are not able to constitute the necessary downpayment for a mortgage loan.

4.1.3 The effect of home equity

The log of lagged real home equity LH_EQ_{it-1} has no significant impact on marginal logits though the signs of parameter estimates are in line with the literature: positive for transition rate to homeownership (previous owner-occupiers with large home equity are more likely to remain owner than those with small home equity), negative for transition rate to stock market participation: Yao and Zhang 2005a, 2005b and Kullmann and Siegel, 2005, found a significant negative contribution of the home value-networth ratio $PH_{it}/RNETWORTH_{it}$ and a positive of the mortgage-networth ratio $MORTGAGE_{it}/RNETWORTH_{it}$ to equity market participation. Hence, their results suggest an overall negative impact of home equity on stock market participation: this is due to the low availability of liquid wealth to pay stock market participation costs for households with a large (rather illiquid) value of home equity. In our case, we do not separately consider the contribution of PH_{it} and $MORTGAGE_{it}$ due to a lack of significance, we only consider home equity as a single covariate. The non significance of the log of home equity on stock market participation in our sample may reflect the larger use of home equity withdrawal in the considered period $[1999-2007]$ compared to the sample period of the existing literature (typically the 80's and 90's): home liquidation costs and refinancing charges have decreased and home equity became more liquid recently.

Notice that even though the total real networth does not appear to distort cross-decisions of households on both market (no effect of $RNETWORTH_{it-1}$ on $\varphi_{i,t}$), the *composition* of this networth has a significant impact on the log odds ratio $\varphi_{i,t}$. For given amount of wealth (i.e. controlling for $RNETWORTH_{it-1}$), the larger the home equity LH_EQ_{it}, the higher the joint probability to be (more precisely to remain) homeowner and stockholder conditionally on previous states. This suggests that owner with a large home equity over net worth ratio are more frequently simultaneously owner and stockholders at a two years horizon than renters or owners with low home equity. This result is close to what has been evidenced by Yao and Zhang (2005a): home equity acts as a buffer against financial risk. A fraction of households with low home equity may have to sell their house to participate in the equity market (*participation costs hypothesis*). They hence have a lower probability to become simultaneously owner and stockholder than households with a large home equity. All in all, our results show that the role of the low liquidity of home equity in our sample period has been reduced compared to previous studies with older sample periods.

Our results also confirm the significance of the cross-dynamics of home tenure and stock market

participation. First, lagged position on the equity market impacts (at the 10% level) current home tenure choices. Previous stockholders more frequently exit to ownership. Hence, the composition of financial wealth (i.e. the ratio of shares to financial wealth) influences the transition rate to homeownership. Households may use some of their risky assets to constitute the down-payment for a mortgage loan: *ceteris paribus*, households with low risk aversion (higher share of equity) may be more prone to convert some of their liquid asset into home equity. Moreover, we also find that previous home tenure has an impact on the transition rate to equity market participation. Households currently owning their primary residence have a higher future probability to participate in the stock market than renters. This result somewhat contradicts the well-known crowding out effect of ownership on equity holdings (Yao and Zhang, 2005a), but the latter was obtained in a non dynamic setup (i.e. no state dependence effects). On the contrary, our findings are similar to those of Kullmann and Siegel (2005) evidenced in a dynamic panel setup. Overall, households having a positive position in one asset (either being homeowner or stockholder) encounter a higher probability to hold the other asset in the next two years. Differently said, some households appear to be locked in a no-stock-and-renter position.

We do not detect any significant contribution of $WBUSIN_{it-1}$ or $WOREAL_{it-1}$. Yao and Zhang (2005a) found that these two variables negatively influence the transition rate to equity market participation of owners, but these results were obtained with a different sample period. Finally, we do not detect any cycle effects in transition rates (dummies $y2003$, $y2005$, $y2007$ are rejected – $y2001$ is the reference).

4.2 Sensitivity analysis

Since our chosen sample period [1999-2007] is different from the one generally considered in the literature, we have to conduct a sensitivity analysis to disentangle facts resulting from our modelling from those resulting from our specific sample period. As previously explained, the [1999-2007] period present some advantages for our analysis: the survey frequency is only two years and it is characterized by a rather steady growth of home prices. However, stock prices have encountered very large movements in the beginning of the 2000's and we cannot be sure that the presence of time dummies $y2003$, $y2005$, $y2007$ in our setup is enough to control for these dynamic effects. Some structural time-dependence in parameters might still be present.

Consequently, we reproduce our estimation exercise on the [1984-1999] sample period to check for the structural stability of our main results. We collect four PSID waves corresponding to years

1984, 1989, 1994 and 1999. Treatments of the dataset are perfectly similar to those presented in the data description subsection. Once again, we only consider households with four consecutive observations and with no change in structure throughout the period. Compared to Table 6, our set of covariates is slightly different: we do not directly estimate the impact of LH_EQ_{it}, the logarithm of home equity, but rather differentiate the contribution of the home value (for owner-occupiers) PH_{it} and of the outstanding mortgage $MORTGAGE_{it}$ as done by Yao and Zhang (2005a). We check for the impact of these two terms on the two marginal logits, but also on the simultaneous log-odds ratio. Notice that we also tested for the influence of squared terms such as $(RINCOME_{it})^2$, $(RNETWORTH_{it})^2$, $(PH_{it})^2$ or $(MORTGAGE_{it})^2$ but fail to detect any significant contribution. Finally, notice that we do not consider all covariates introduced by Kullmann and Siegel (2003) such as gender, health condition or educational attainment of head to keep the estimation process computationally tractable. However most of the socio-demographic variables are time-constant and are then potentially captured by our unobserved heterogeneity terms, though not directly identified.

Results of this supplementary analysis are available upon request. The main results are similar to our benchmark. We nevertheless detect a significant gap (in absolute value) between the contribution of previous home value PH_{it} and mortgage $MORTGAGE_{it}$ of the transition rate to stock market participation. This is in line with Yao and Zhang (2005a) and confirms that the role of these varaibles has changed over time. Moreover, dummies $WBUSIN_{it}$ and $WOREAL_{i_t}$ now have a significant impact in the stock market participation equation. We still do not detect any time effect through $y1994$ or $y1999$ time dummies ($y1989$ is the reference).

Interestingly, our two main results are preserved : *(i)* the cross-dynamic terms are still significant, $OWNHOUSE_{it-1}$ positively impacts the transition rate to stock market participation (in line with Kullmann and Siegel, 2003) and $OWNSTOCK_{it-1}$ positively impacts the transition rate to homeownership. This confirms that stock market and homeownership decisions should be jointly modeled: over the life-cycle, some households taking a positive position on one market encounter will participate in the other market sooner than those who did not; *(ii)* we still detect simultaneous effects: as evidenced in the benchmark model, age distorts the decision to become simultaneously owner and shareholder. Moreover, $MORTGAGE_{it-1}$ and PH_{it-1} also influence this joint decision. The larger the home value, the higher the probability to simultaneously participate in the stock market and remain homeowner. The outstanding mortgage intuitively has the opposite role. Notice finally that log likelihood ratios tests suggest that

this specification (with both $MORTGAGE_{it-1}$ and PH_{it-1}) is to be preferred to the benchmark (with only LH_EQ_{it-1}) for the [1984-1999] period.

4.3 Simulation

4.3.1 Methodology

We now use the estimated model to simulate some counterfactual exercises. We select all household's head for a specific year (i.e., the starting year 1999) and simulate their housing tenure, stock market participation and total networth (shares, bonds and home equity) until year 2007. We can then estimate the evolution of the homeownership and stock market participation rates at different horizons over time. Moreover, with such a setup, we can compare time paths on housing and stock markets of two households with similar profile (for example the same socio-demographic characteristics), except in one dimension (for example the family income or the home tenure or stock market participation). We will be able to assess the contribution of this sole factor on future home and stock transition decisions.

The simulation of the role of a household's characteristics involves several technical steps. First, we select the concerned factor: for example, suppose we want to compare future choices of an owner-occupier household h_1 and a household living in the rental sector h_2, *ceteris paribus*. We then select the average socio-demographic profile from our 1999 sample of households and impute it to h_1 and h_2 (i.e. average age, number of children, networth and income). We suppose both households do not participate in stock markets in 1999 and that h_1 is a homeowner with average home equity) and h_2 lives in the rental sector (no home equity, but a similar amount of bonds since we assume the same networth for both households).

We simulate home tenure and stock market participation of the two households from 2001 to 2007. We simulate values for shares, home equity and bonds using system (4) each time the households participate in these markets. All other components of vector $\mathbf{x}_{i,t}$ and $\mathbf{z}_{i,t}$ are kept constant over time (no change in socio-demographic profile) except the log of real income which is assumed to exogenously follow the time pattern of its observed counterpart in the sample.

Overall, for each household, we simulate 2.000 paths on both markets between 2001 and 2007. For each path, we draw a new vector of unobserved factors $\widehat{\omega}_i$ with our estimates $\widehat{\Omega}$ of the variance-covariance matrix. The estimates of transition probabilities $\widehat{p}(\mathbf{y}_{i,t} \mid \mathbf{x}_{i,t}, \mathbf{y}_{i,t-1}, \widehat{\omega}_i)$ is evaluated with Colombi and Forcina (2001) optimization procedure. In the case of stock market participation, homeownership or bond

holdings, a new value for shares, home equity or bonds is randomly drawn using variances estimates $\widehat{\Gamma}$. We finally compare the transition rates of both households at different time horizons.

4.3.2 Counterfactual results

The implementation of counterfactual simulations is done with the complete model, i.e. systems (3) and (4). Indeed the simulation of bond, stocks and home equity are necessary to simulate the dynamics of the log of real networth which enters the set of exogenous covariates in the transition equations. Our aim is to measure the effect of a single characteristic. When computing transition probabilities in a given sample, such probabilities are influenced by a variety of factors related to the heterogeneity of agents in that sample. The contribution of these different factors to determine measured probability is combined and hard to disentangle using only model estimates. However, when simulating our model, it becomes possible to isolate the contribution of a given factor to determine its role on transition probabilities and compare historical paths on both markets.

We propose three counterfactual exercises that aim to investigate the contribution of age, initial position on the housing market and the initial position on the stock market to transition rates. We define an artificial household that shares the average 1999 sample characteristics. Its profile is as follows: the adult of reference of this household is 49 years old, it is composed of two adults and one child. The average income equals $36,316$ US dollars per year and its networth stands at $32,533$ US dollars. This *benchmark* household is renter and does not participate in the stock market in 1999.

By age We define three other artificial individuals that differ from the previously presented one *only by age*. The first one is 69 years old, the second one is 39 years old and the youngest, is 29. The objective of this exercise is to assess quantitatively the impact of age on the choices of home tenure and stock holdings of agents at different temporal horizons (i.e., 2001 means two years' horizon and 2007 eight years' horizon) when controlling for all other factors (in particular all are renters and non-stockholders with similar income and wealth). Table 4 summarizes the results for each type of head's age at different time horizons.

At a two-year horizon, we find that the elderly have a higher probability to participate in the financial market (this is linked to the positive impact of age of head on the marginal logit for stock market participation) than young households. Elderly households have no significantly different probability

of becoming homeowner than young ones, *but a lower probability of being simultaneously owner and shareholder*. This result is linked to the impact of age on the log odds ratio $\varphi_{i,t}$ and confirms that the simultaneous choice criteria of home tenure and equity market participation are dependent on head's age. This might illustrate differences in risk aversion according to age. The paradox is raised if one compares the degree of liquidity of both assets (financial and real estate). If old agents are more risk adverse (particularly if we consider negative comovements between stock returns and consumption), they also have a higher preference for liquidity. Indeed, though risky, shares remain more liquid than real estate assets: for a given level of wealth, young households might be less sensitive to the low liquidity of housing compared to households close to retirement: for an elderly household renting its dwelling, transition to homeownership may entail the contraction of a mortgage and the imminent prospect nearing retirement – and the loss of income it entails – is a incentive to avoid borrowing, therefore fosters the demand for shares, but lowers the simultaneous demand for shares and housing.

When time horizons get longer, for example at a eight-year horizon, the older household progressively has a higher probability of being simultaneously owner and shareholder. We interpret this result as a sign of the impact of the age of head on the relative probability to become stockholder (second column of Table 3): *once participating in the stock market*, the older household has a higher probability to become homeowner through the positive impact of $OWNSTOCK_{it-1}$ on $\eta_{h,i,t}$. This explains why the quite paradoxical result in the short run is reversed in the long run.

By home tenure As part of this exercise, we reproduce the work usually done in the literature of the analysis of the impact of *home tenure choice* on portfolio choices. More precisely, we seek to relate the home tenure choices situation on the property market (owner/renter) to the portfolio's structure of the household. Table 5 describes the transition rates to homeownership, stock market participation and both of them of two households differing only by their mode of home tenure (otherwise income, wealth and socio-demographic factors are similar, except that we suppose the home-equity-to-networth ratio of the owner-occupier is equal to its observed 1999 average while the one of the renter is obviously null). We assume both households do not participate in the stock market in 1999.

Ceteris paribus, we find that being an owner induces a higher probability of participation in the equity market. On this point, our results are consistent with estimates from Kullmann and Siegel (2005): the lagged dependent variable regarding home tenure has a positive impact on the probability to become

a stockholder (though this effect is mitigated by the role of the home equity: owners with low home equity are more likely to become stockholders than those with a higher home equity).

By stock ownership In this third experiment, we compare two households sharing most of the characteristics of the benchmark one. The first one shares all the characteristics of the reference household, but holds stocks while the second does not. Both are renters. We seek to answer the following question: to what extent is the time (in years) needed to achieve home ownership (the transition between the state of renter and the state of owner) dependent on the shareholding status. Table 6 summarizes the obtained figures.

Our results clearly show that the household initially holding shares in 1999 has a higher probability to become homeowner than the household with no shares. This is robust whatever the considered horizons (2 years, 4 years, 6 years and 8 years). This confirms the results detailed in Table 3 (second column). If we compare two households with similar wealth and home tenure, but assume that the first one holds most of its *financial* wealth in the form of low risk assets and the second one mainly hold shares, then the latter will be more prone to convert its risky wealth into (risky and rather illiquid) home equity. This may reflect unobserved heterogeneity in risk aversion among these two types of households.

5 Conclusion

In this paper, we model the potential simultaneity of home tenure and equity market participation choices. At a given date, we allow a household to choose between four categories choices {stockholder, non stockholder}$\times$ {owner, renter}. To quantitatively assess the importance of joint home-stock decisions, we propose an original bivariate dynamic logit model in the line of Bartolucci and Farcomeni (2008). This setup, with two distinct equations to model stock holdings and home tenure, clearly outperforms the standard setup with no simultaneity effects. We also find a robust two-sided dynamic relationship between home tenure and stock market participation: past home position significantly influences equity market participation and conversely. Households taking positions in one asset encounter a positive position in the other asset at an earlier stage in their life cycle.

In line with some previous contributions, owners at the previous period, are more likely to become stockholders. Moreover, we find a positive contribution of current stock market participation on the

probability to be a future owner-occupier: households with a large share of equity in financial wealth (possibly those with greater risk aversion) are more prone to convert their financial wealth into home equity than households mostly holding bonds. Finally, we find that some factors have a significant impact. In particular, young households have a higher probability to become simultaneously owner and stockholder than older ones. All in all, our results provide evidence of the presence of two effects generally ignored in the literature: a *causality* effect (past stockholding positions influence current home tenure decisions) and *simultaneity* effects.

The model needs some further extensions. In particular, at this stage we mostly focus on the participation equations. We do not put much focus on the continuous equations dealing with the relative shares of stocks, bonds and home equity except for the sake of model simulation. This could be an interesting topic for further research.

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Table 1. Summary statistics, all Households, 1999-2007

	1999	2001	2003	2005	2007
OWNSTOCK	0.5157	0.5030	0.4979	0.5109	0.4865
OWNHOUSE	0.7559	0.7361	0.7390	0.7646	0.7204
RINCOME ($100K)	0.37380	0.36631	0.34505	0.37509	0.36206
RNETWORTH ($100K)	1.10160	1.11542	1.13394	1.38138	1.46221
S_SB	0.2724	0.2764	0.2505	0.2646	0.1853
NW_INC	3.3494	3.7830	3.9644	4.2378	4.8660
PH_NW	1.4024	1.7585	1.7221	1.7300	1.1890
AGEHD	47.26	47.73	47.75	48.24	48.20
NUMKID	0.7377	0.7162	0.6782	0.6564	0.6819
WBUSIN	0.1571	0.1527	0.1452	0.1446	0.1366
WOREAL	0.1935	0.1767	0.1748	0.1862	0.1727

Table 2. Summary statistics by Home tenure

	1999		2001		2003		2005		2007	
	Renter	Owner	Renter	Owner	Renter	Owner	Renter	Owner	Renter	Owner
OWNSTOCK	0.3008	0.5850	0.2717	0.5860	0.2689	0.5787	0.2756	0.5833	0.2169	0.5911
RINCOME ($100K)	0.25571	0.41193	0.23424	0.41364	0.20825	0.39334	0.24731	0.41443	0.21294	0.41992
RNETWORTH ($100K)	0.26177	1.37274	0.25667	1.42315	0.22260	1.45566	0.29332	1.71635	0.27947	1.92111
S_SB	0.1693	0.3011	0.1666	0.3089	0.1512	0.2791	0.1510	0.2947	0.0893	0.2158
NW_INC	1.0554	4.090	1.096	4.745	1.220	4.933	1.146	5.189	1.503	6.170
AGEHD	39.10	49.89	40.40	50.36	40.04	50.47	40.22	50.71	40.24	51.29
NUMKID	0.643	0.768	0.658	0.736	0.643	0.690	0.585	0.678	0.665	0.688
WBUSIN	0.073	0.184	0.058	0.186	0.061	0.174	0.072	0.166	0.066	0.163
WOREAL	0.070	0.233	0.057	0.219	0.066	0.213	0.068	0.222	0.066	0.214

Table 3. Estimation Results, period [1999 – 2007]

	$\frac{P(owner)}{P(renter)}$	$\frac{P(shares)}{P(no\ shares)}$	$P\,(joint)$
Intercept	-7.1756^{**}	-10.3559^{**}	1.9643^{**}
	(0.8781)	(0.5581)	(0.4412)
AGE_{it}	-0.0007	0.0068^{**}	-0.0394^{**}
	(0.0041)	(0.0027)	(0.0099)
$NBADULTS_{it}$	0.6333^{**}	-0.1268^{**}	–
	(0.0834)	(0.0457)	(–)
$NUMKIDS_{it}$	-0.0129	0.0028	–
	(0.0557)	(0.0325)	(–)
$RINCOME_{it-1}$	0.3054^{**}	0.2782^{**}	–
	(0.0921)	(0.0233)	(–)
$RNETWORTH_{it-1}$	0.1961^{**}	0.5925^{**}	–
	(0.0376)	(0.0555)	(–)
LH_EQ_{it-1}	0.0230	-0.0125	0.0189^{**}
	(0.0373)	(0.0187)	(0.0028)
$OWNHOUSE_{it-1}$	4.0793^{**}	0.5818^{**}	–
	(0.3956)	(0.2014)	(–)
$OWNSTOCK_{it-1}$	0.2061^{*}	2.2393^{**}	–
	(0.1187)	(0.0694)	(–)
$WBUSIN_{it-1}$	-0.0012	-0.0090	–
	(0.1619)	(0.0823)	(–)
$WOREAL_{it-1}$	0.0049	0.0024	-0.0158
	(0.1489)	(0.0744)	(0.3738)
$y2003$	-0.0162	0.0162	–
	(0.1386)	(0.0821)	(–)
$y2005$	0.0041	0.0254	–
	(0.1422)	(0.0819)	(–)
$y2007$	-0.0336	0.0045	–
	(0.1446)	(0.0830)	(–)
$\widehat{\boldsymbol{\sigma}}_{\omega}^{2}$	0.0787^{**}	0.0541^{**}	–

Table 4: Transition rates to homeownership, to stockownership, and both, by age

	2001			2003			2005			2007		
	owner	shd	both	owner	shd	both	owner	shd	both	owner	shd	both
29	0.3321	0.2160	0.1033	0.5601	0.3821	0.2630	0.7038	0.4876	0.3910	0.7923	0.5504	0.4738
39	0.3317	0.2270	0.0926	0.5603	0.4021	0.2599	0.7059	0.5097	0.3937	0.7941	0.5749	0.4834
49	0.3305	0.2379	0.0801	0.5565	0.4233	0.2542	0.7054	0.5345	0.3970	0.7951	0.6025	0.4959
59	0.3292	0.2504	0.0683	0.5611	0.4421	0.2497	0.7069	0.5553	0.3999	0.7985	0.6259	0.5064

Table 5: Transition rates to homeownership, to stockownership, and both, by previous home tenure

	2001			2003			2005			2007		
	owner	shd	both	owner	shd	both	owner	shd	both	owner	shd	both
renter	0.3233	0.2384	0.0770	0.5538	0.4237	0.2506	0.6992	0.5368	0.3976	0.7924	0.6059	0.4991
owner	0.9723	0.3349	0.3264	0.9592	0.5382	0.5198	0.9510	0.6370	0.6103	0.9503	0.6903	0.6604

Table 6: Transition rates to homeownership to stockownership, and both by previous shareholding status

	2001			2003			2005			2007		
	owner	shd	both	owner	shd	both	owner	shd	both	owner	shd	both
no stocks	0.3240	0.2379	0.0785	0.5525	0.4230	0.2517	0.6963	0.5348	0.3957	0.7909	0.6061	0.4987
stockholder	0.3774	0.7474	0.2840	0.6103	0.6842	0.4339	0.7465	0.6743	0.5235	0.8251	0.6805	0.5789