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**Housing Tenure Choice Implications
of Social Networks: A Structural Model Approach**

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Housing Tenure Choice Implications of Social Networks

By Abdul Munasib

Abstract

The influence of social networks on housing tenure choice remains conspicuously unexplored despite the fact that social networks are crucial in information dissemination. Social networks can encourage the attainment and retention of homeownership by channeling important knowledge and information regarding household finance, wealth management, home maintenance, etc. Social networks also provide greater connection to the location thereby potentially encouraging locational stability and homeownership.

The analysis of the relationship between social networks and housing tenure decisions, however, is complicated because of the issue of mobility. Because social networks in large part are tied to the physical location, this relationship cannot be studied in isolation from the mobility decision. This paper presents a dynamic model of joint mobility-housing tenure decision and social network accumulation. Parameters of the dynamic program are estimated using a simulated method of moments (SMM) procedure. The data source is the Indonesian Family Life Survey (IFLS), a large scale survey of Indonesian households, which contains rich information on community participation by households allowing the construct of a comprehensive measure of social networks.

JEL Classification: D85, J6, R, R2, R21, Z13

Keywords: Social network, housing tenure choice, homeownership.

I. Introduction

The recent literature on housing tenure choice has been focusing increasingly on the information aspects of the tenure decision [Haurin and Morrow-Jones 2007]. Research over the last two decades has established the crucial importance of social networks in information sharing and dissemination [Durlauf and Fafchamps 2004]. Social networks can influence housing tenure decisions by channeling knowledge and information regarding the housing market, household finance and wealth management, home maintenance, etc.

The usefulness of social networks in economics and non-economic lives of the individual is well-established [Durlauf and Fafchamps 2004]. People value social networks and these networks can be viewed as an investment. As a result, individuals make concerted efforts to accumulate social networks [Munasib 2005]. Since social networks in large part are tied to the physical location, preserving and accumulating social networks may be one of the reasons for a household to pursue locational stability which, in turn, may also encourage homeownership.

On the other hand, a housing tenure decision (henceforth referred to simply as ‘tenure’ decision) that comes with the relocation decision causes a large depreciation of social networks [Glaeser et al. 2002, Durlauf and Fafchamps 2004, Munasib 2005] and thereby greater transaction costs.¹ Since tenure decisions are frequently associated with a change of location, a study of the relation between tenure choice and social networks cannot be meaningful without accommodating the mobility decisions. Researchers have often emphasized the importance of modeling tenure choice and mobility decisions jointly. The agent-based dynamic models of mobility and tenure choice pose these two decisions as joint decisions [Ioannides and Kan 1996, Ozyildirim 2005]. Several empirical studies have also established that tenure choice and mobility

¹ See Munasib [2005] for a discussion of mobility and the dynamic decisions of social network accumulation.

decisions are correlated [Zorn 1988, Boehm et al. 1991, Ioannides 1987, Ioannides and Kan 1996, Kan 2000, Ozyildirim 2005].

Academic research on the relationship between social networks and tenure choice, however, is conspicuously absent.² This paper presents a dynamic model of joint mobility-tenure choice with social networks and non-housing wealth as state variables. The solution of the Bellman equation generates simulated moments that are matched with sample moments to obtain simulated method of moments estimates of the parameters of the dynamic program. These parameter estimates are used to show that people with larger social networks are more likely to be homeowners.

There are two main reasons to adopt the above mentioned structural estimation and the dynamic framework. First, interactions among the tenure-mobility decision, evolution of social networks and wealth accumulation are inherently dynamic. Consider the evolution of social networks: social networks of each period are built on the social networks of the previous period. Now, a decision to relocate at a point in time, by causing a large depreciation, will not only affect social networks of the immediate next period but also the entire profile of social networks over the remaining lifecycle. Similarly, a decision to buy a home is likely to affect not only the wealth of the immediate next period but also the remaining of the decision horizon. Households maximizing lifetime utility are likely to take these into account.

Secondly, a reduced form estimation of the effect of social network on the joint mobility-tenure decision is complicated by the fact that social network is endogenous. Since homeowners are invested in the location of their homes they are likely to have higher levels of social involvement (and possibly more social networks) compared to non-owners [DiPasquale and

² DiPasquale and Glaeser [1999] is a notable exception that addresses some of the issues related to social involvements and homeownership.

Glaeser 1999]. By the same logic, households expecting to move have a lower incentive to invest in local social networks. A reduced form estimation of the causal effect of social networks on the tenure decision will always crucially hinge on the validity of instrument(s).

The data source of this paper is the Indonesian Family Life Survey (IFLS), a large scale survey of Indonesian households, which contains rich information on community participation by the households. To construct a comprehensive measure of social networks I use a household's membership in various groups and organizations, its activities and participations in these organizations as well as intensities of these participations. This is an important contribution of this paper because capturing intensities of interactions is rare in the literature.

In what follows, section II discusses the issues related to social network measures, section III reviews the existing literature on the joint mobility-homeownership decision, section IV discusses the general setup of the dynamic decision process of the household, section V describes the data, section VI explains the parameterization and econometric model. Section VII presents the results and section VIII concludes.

II. Social Networks

“Number of associational memberships” – the so-called “Putnam’s Instrument” popularized by Robert Putnam [Putnam 1995, Putnam 2000] – has a special place in the *social capital* literature. It is one of the most frequently used measures of social capital.³ When membership is used to measure individual social capital it is essentially based on the ‘network view’ where social capital of an individual represents her social connectedness; this view also renders an optimization framework in a relatively straight-forward manner [Durlauf and

³ Carter and Maluccio [2003], Grootaert [2000], Narayan and Pritchett [1999], Costa and Kahn [2003], Maluccio, Haddad and May [2001], and Helliwell [1996], are some of the frequently cited studies that used this measure. Also see Durlauf and Fafchamps [2004] for a detailed survey of studies that used this proxy.

Fafchamps 2004]. An alternative view of social capital is the so-called ‘trust/co-operation’ view of social capital that defines social capital as the level of trust in the society [Paldam 2000]. This, however, is not very conducive to individual optimization [Munasib 2005, Glaeser, Laibson and Sacerdote 2002, Durlauf and Fafchamps 2004]. Because the idea of social capital is often too broad and, at time, all-encompassing, we confine ourselves to the narrower concept of *social network*, which also is conducive to individual optimization [Jackson 2005].

Number of membership alone, however, is not an adequate measure of the individual’s social network. Putnam’s Instrument is vulnerable to the following criticisms raised in Paldam [2000], Sobel [2002], and Fukuyama [2000]. Memberships in voluntary organizations with weak intensity could be difficult to keep track of. Large number of voluntary organizations exists with memberships that cost little and demand little contact or real trade-off. Such voluntary organizations may claim a large membership while they do not require any sacrifice of time or other resources. The justification for using intensity weights come from the fact that, while some voluntary organizations do not require much involvement and little or no real trade-offs, there are others that are very demanding and come to dominate the lives of its members (church affiliations, for instance). Thus, a household that is a member of several different groups may or may not have more social networks compared to a household where all members belong to just one group because mere membership may not have any significant impact on social networks unless the household actively participates in these groups. In this study, I combine three kinds of measures: the number of memberships, the amount of time spent in these organizations (an intensity measure with real trade-offs) and cash contribution to these organizations (another intensity measure with real trade-offs). The index thus created is referred to in this paper as “multilevel index of social engagement”, or simply the “social network index”, for short.

III. Literature Review

Krumm [1984] and Zorn [1988] were the earliest works that explored empirically the joint mobility-tenure decision. Zorn [1988] provides a cost-benefit analysis of the mobility decision, joint with tenure prior to and after a potential move. Since mobility and tenure are both binary decisions, this provides eight discrete alternatives for households, which he reduces to six by assuming that households cannot change tenure without moving. Zorn [1988] emphasizes the simultaneous nature of mobility and tenure choice. Since it is assumed that housing consumption cannot be adjusted without moving, this divides households' lifetimes into two terms, each of which can be identified by their housing choice. The budget constraint incorporates the fixed costs of moving as a flow cost. Any fixed costs associated with purchasing a home are assumed to be perfectly capitalized into house prices. For this reason they do not show up as separate costs in the budget constraint. Existing owners can choose to move-own, move-rent, or stay-own. Existing renters can either move-own, move-rent, or stay-rent. Li [1977] also addresses the joint mobility-tenure decision, but in a purely statistical framework. He models mobility and tenure decisions over time as a Markov process.

Ioannides and Kan [1996] develop a dynamic behavioral model of households' decision on residential mobility and housing tenure choice together with the amounts of housing and non-housing consumption. Household/individual behavior is formulated as a stochastic dynamic programming problem in which a household makes a sequence of decisions (joint choices of housing tenure mode, housing consumption and investment levels, and non-housing consumption level), which maximize remaining lifetime utility. They also make the assumption that housing consumption/investment can only be changed by moving. The possibility for adjustment through home improvement is, therefore, ignored. They estimate their model using a random effects

model where individual heterogeneity is modeled as a time-invariant random variable that varies across individuals.

The links between social networks and homeownership is rarely explored in the literature. DiPasquale and Glaeser [1999], a rare exception, argue that homeownership gives individuals an incentive to improve their community and because homeownership creates barriers to mobility it may encourage investment in local amenities and social capital (measured by organization memberships). Using the U.S. General Social Survey they document that homeowners invest more in social capital and that a large portion of the effect of homeownership on these investments comes from lower mobility rates for homeowners.

IV. Model: The General Structure

The household has a finite horizon T . Each period t the tenure status of the household is denoted by,

$$(1) \quad ts_t = \text{current tenure status} = \begin{cases} 0 & \text{(not owning)} \\ 1 & \text{(owning)} \end{cases}$$

Each period, the household must take a decision x_t defined as follows.

$$(2) \quad x_t = \begin{cases} 1 & \text{(not move, continue current tenure status)} \\ 2 & \text{(not move, change tenure status)} \\ 3 & \text{(move, continue current tenure status)} \\ 4 & \text{(move, change tenure status)} \end{cases}$$

The state variables, non-housing wealth and social networks – both controlled Markov processes – are, respectively,

$$(3) \quad w_{t+1} = w(w_t, ts_t, x_t, \eta^w, \mathcal{E}_w),$$

$$(4) \quad sn_{t+1} = sn(sn_t, ts_t, x_t, \eta^{sn}, \mathcal{E}_{sn}),$$

where, w denotes net non-housing wealth and sn denotes social network levels of the household. Parameters η^w and η^{sn} account for individual heterogeneity in the contexts of the evolutions of non-housing wealth and social networks, respectively. The pair $\{\varepsilon_w, \varepsilon_{sn}\}$ accounts for stochasticities in the evolution processes of these state variables.

Each period the household receives a reward,

$$(5) \quad f_t = f(ts_t, w_t, sn_t).$$

The reward is assumed to be a function of the housing tenure status. Dietz and Haurin [2003] survey the literature on benefits of owned homes and find that a large number of studies document benefits of living in an owner-occupied home. Dietz and Haurin [2003] review the literature on the benefits of home-owning and they note that there is good evidence to support claims that homeownership has a positive effect on the level of household wealth.⁴ Another positive effect is on the quality of home environment [Menaghan and Parcel 1991], where a contributing factor is a greater rate of home maintenance for properties that are owner-occupied [Galster 1983; Gatzlaff, Green, and Ling 1998]. There is also an increasing amount of evidence that the children of parents who are owner-occupiers achieve higher levels of cognition, have fewer social problems, and are more likely later in life to become homeowners [Green and White 1997; Boehm and Schlottmann 1999; Haurin, Parcel, and Haurin 2002].⁵ The likely mechanisms are the improved home environment, the greater geographic stability associated with

⁴ When real house value rises, real wealth tends to increase. The long term evidence about the prevalence and distribution of increases in real house values is quite mixed [Dietz and Haurin 2003]. Wealth also may rise through gains in home equity as the mortgage is repaid, but renters also could participate in this type of “forced savings”. Haurin and Rosenthal [2004] find that the economic gains resulting from house price appreciation are predominantly saved.

⁵ These studies include numerous economic and demographic control variables for parental and family background and the neighborhood. They also address the problem of unobserved heterogeneity that could lead to sample selection issues when comparing renters with owners.

homeownership [Aaronson 2000], and the improved level of owners' self-esteem [Rohe and Stegman 1994].

Apart from non-housing wealth also appears in the reward function is the social network because people derive satisfaction from social networks: people rely on social networks as informal insurance and derive satisfaction from socializing [Lin et al. 2001, Dasgupta 2002, Durlauf and Fafchamps 2004, Munasib 2005].

The Bellman equation of the household's problem is the following. $\forall ts_t \in \{0,1\}$,

$$w_t \in [w_{\min}, w_{\max}], \quad sn_t \in [sn_{\min}, sn_{\max}], \quad \delta \in (0,1), \quad t = 1, 2, \dots, T,$$

$$(6) \quad V_t(ts_t, w_t, sn_t) = \max_{x \in \{1, 2, 3, 4\}} \{f(ts_t, w_t, sn_t) + \delta V_{t+1}(ts_{t+1}, w_{t+1}, sn_{t+1})\}.$$

In section VI, this general model is parameterized to make it operational for estimation.

V. Data

The data comes from the second and the third waves (1997 and 2000) of the Indonesian Family Life Survey (IFLS) [Frankenberg et al., 1995, 2000; Strauss et al., 2004]. IFLS was conducted in 13 provinces representing more than 83 percent of the national population. While the IFLS has two more waves (1993 and 2004) these are only two waves that have the information about social networks.

A notable strength of this study is the comprehensiveness of the social network information. The IFLS dataset is especially rich in terms of the information it contains on community participation (PM module) and other measures of social networks. The first measure used is an index of the number of unique group memberships of a household in the various community groups. These groups range from organizations for local governance, cooperatives, and women's groups with the focus on family welfare to manning community health posts. The

motivation for using unique memberships is that once a household member participates in a group, the household has access to the group's networks. A household whose members participate in several different groups will have access to more social networks than a household where all members belong to the same group. However, mere membership may not have any significant impact on social networks unless the households actively participate in these groups. The next two indicators look at the time a household spends and the monetary contributions the household makes per group membership. The PM module of IFLS-2 asked questions about 12 different groups. Time and money contributions scores are multiplied with the number of unique group memberships to obtain a composite index of social networks. This approach is similar to Maluccio et al. [2001].⁶

Tables 1 presents the descriptive statistics of the variables of interest. Table 2 shows the variation in these variables across different joint mobility-tenure decisions; we see that non-movers have higher levels of social networks. Table 3 presents the means of age, non-housing wealth and social networks across homeowners and non-owners; we see that homeowners have higher levels of social networks. The age range in 1997, for which usable data is available is [30, 65]. Between the two that gives us a horizon of 39 years.

VI. Parameterization and Estimation Strategy

VI.1. Parameterization

[a] Time horizon: $T = 39$.

[b] State variable: ts = tenure status. State transition function is,

⁶ For example, suppose a household had 1 unique group membership. Also the household was ranked amongst the median households in terms of attendance and in the topmost quintile in terms of cash contributions. Its index of social network will be $SN = 1 \times [3/3] \times [5/3] = 0.56$. On the other hand, if the household was a member of one group, but did not attend any meetings or make monetary contributions, its score is $SN = 1 \times [1/3] \times [1/3] = 0.11$. In case of more than one group memberships, we use average cash and time contributions.

$$(7) \quad ts_{t+1} = \begin{cases} 0, & \text{if } (ts_t = 0, x_t = 1,3) \text{ or } (ts_t = 1, x_t = 2,4) \\ 1, & \text{if } (ts_t = 1, x_t = 1,3) \text{ or } (ts_t = 0, x_t = 2,4) \end{cases}$$

[c] State variable: w = non-housing wealth, where $w \in [w_{\min}, w_{\max}] = W$. State transition functions is,

$$(8) \quad w_{t+1} = \begin{cases} \beta^w \cdot \eta^w + \xi_1 \cdot w_t + \xi_{11} \cdot (w_t)^2 + \varepsilon_w, & \text{if } x_t = 1,3 \\ \beta^w \cdot \eta^w + \xi_2 \cdot w_t + \xi_{22} \cdot (w_t)^2 + \varepsilon_w, & \text{if } ts_t = 1, x_t = 2,4 \\ \beta^w \cdot \eta^w + \xi_3 \cdot w_t + \xi_{33} \cdot (w_t)^2 + \varepsilon_w, & \text{if } ts_t = 0, x_t = 2,4 \end{cases}$$

where, $\varepsilon_w \sim N(0, \sigma_w^2)$, and η^w is a value that comes from a distribution of non-housing wealth to capture heterogeneity. This approximates the types of people (individual heterogeneity) in the sample in the context of wealth accumulation (more on this in subsection VI.3.).

[d] State variable: sn = social network index, where $sn \in [sn_{\min}, sn_{\max}] = SN$. State transition function is,

$$(9) \quad sn_{t+1} = \begin{cases} \beta^{sn} \cdot \eta^{sn} + \gamma_1 \cdot sn_t + \gamma_{11} \cdot (sn_t)^2 + \varepsilon_{sn}, & \text{if } x_t = 1,2 \\ \beta^{sn} \cdot \eta^{sn} + \gamma_2 \cdot sn_t + \gamma_{22} \cdot (sn_t)^2 + \varepsilon_{sn}, & \text{if } x_t = 3,4 \end{cases}$$

where $\varepsilon_{sn} \sim N(0, \sigma_{sn}^2)$, and η^{sn} is a value that comes from a distribution of social network heterogeneity. This approximates types of households (individual heterogeneity) in the sample in the context of evolution of social networks (again, details on this are discussed in subsection VI.3.).

[e] Reward function:

$$(10) \quad f(ts_t, w_t, sn_t, x_t) = \mu \cdot ts_t + \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta},$$

where, μ represents the effects of owner-occupation (an estimate $\mu > 0$ would indicate benefits of homeownership) compared to non-ownership. The parameters $\{\eta, \theta\}$ are associated with the utilities derived from non-housing wealth and social networks, respectively.

[f] Bellman Equation:

(11) $\forall w_t \in W, \forall sn_t \in SN$, discount factor $\delta \in (0,1)$, and $t = 1, 2, \dots, T$,

$$V_t(w_t, sn_t, 0) = \max \left\{ \begin{aligned} & \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_1 \cdot w_t + \xi_{11} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_1 \cdot sn_t + \gamma_{11} \cdot (sn_t)^2 + \varepsilon_{sn}, 0), \\ & \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_3 \cdot w_t + \xi_{33} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_1 \cdot sn_t + \gamma_{11} \cdot (sn_t)^2 + \varepsilon_{sn}, 1), \\ & \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_1 \cdot w_t + \xi_{11} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_2 \cdot sn_t + \gamma_{22} \cdot (sn_t)^2 + \varepsilon_{sn}, 0), \\ & \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_3 \cdot w_t + \xi_{33} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_2 \cdot sn_t + \gamma_{22} \cdot (sn_t)^2 + \varepsilon_{sn}, 1) \end{aligned} \right.$$

$$V_t(w_t, sn_t, 1) = \max \left\{ \begin{aligned} & \mu \cdot ts_t + \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_1 \cdot w_t + \xi_{11} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_1 \cdot sn_t + \gamma_{11} \cdot (sn_t)^2 + \varepsilon_{sn}, 1), \\ & \mu \cdot ts_t + \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_2 \cdot w_t + \xi_{22} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_1 \cdot sn_t + \gamma_{11} \cdot (sn_t)^2 + \varepsilon_{sn}, 0), \\ & \mu \cdot ts_t + \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_1 \cdot w_t + \xi_{11} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_2 \cdot sn_t + \gamma_{22} \cdot (sn_t)^2 + \varepsilon_{sn}, 1), \\ & \mu \cdot ts_t + \frac{(w_t)^{1-\eta}}{1-\eta} + \frac{(sn_t)^{1-\theta}}{1-\theta} + \delta V_{t+1}(\beta^w \cdot \eta^w + \xi_2 \cdot w_t + \xi_{22} \cdot (w_t)^2 + \varepsilon_w, \beta^{sn} \cdot \eta^{sn} + \gamma_2 \cdot sn_t + \gamma_{22} \cdot (sn_t)^2 + \varepsilon_{sn}, 0) \end{aligned} \right.$$

VI.2. Estimation Strategy

The Bellman equation can be solved for the optimal policy as a function of the state variables. This policy function and the state transition functions can be used to calculate various moments of the action and the state variables simulated over the T horizon. On the data side,

similar moments can also be constructed, which are the data moments. Setting $\delta = 0.95$, the Simulated Method of Moments (SMM) estimate of the set of parameters Θ is,

$$(12) \quad \hat{\Theta}_{SMM} = \arg \min (\psi^D - \psi^S(\Theta))' W (\psi^D - \psi^S(\Theta))$$

where,

$$\Theta = \{\mu, \eta, \theta, \beta^w, \xi_1, \xi_2, \xi_3, \xi_{11}, \xi_{22}, \xi_{33}, \beta^{sn}, \gamma_1, \gamma_2, \gamma_{11}, \gamma_{22}\},$$

ψ^D = moments calculated from the data,

$\psi^S(\Theta)$ = moments obtained from the simulated data, and

W = the weighting matrix.

Let the data matrix be denoted by,

$$(13) \quad D = \{age_{1997}^i, x_{1997}^i, x_{1997}^i, ts_{1997}^i, ts_{2000}^i, w_{1997}^i, w_{2000}^i, sn_{1997}^i, sn_{2000}^i\}.$$

Thus, there are two observations of each of the state variables for each individual on a 3-period interval. A combination of vectors⁷ from D helps create $p(=34)$ moments, ψ^D . Using the solution of the dynamic program, the optimal policy $x = x(ts, w, sn; \Theta)$, Monte Carlo simulation generates time-paths $\{x_t^S(\Theta), ts_t^S(\Theta), w_t^S(\Theta), sn_t^S(\Theta) | t = 1, \dots, T\}$. The simulated data matrix constructed from these time-paths is,

$$(14) \quad S = \{age_t^S, x_t^S(\Theta), ts_t^S(\Theta), ts_{t+3}^S(\Theta), w_t^S(\Theta), w_{t+3}^S(\Theta), sn_t^S(\Theta), sn_{t+3}^S(\Theta) | t = 1, \dots, T-3\},$$

which is the simulation counterpart of D . The same p moments, ψ^S , are created from S .

Estimated parameter $\hat{\Theta}$ minimizes the weighted distance between ψ^D and ψ^S . The weighting

⁷ For example, from the matrix $Y = \{y_1, y_2\}$ a set of moments can be created from the combination of vectors $\{y_1, y_1^2, y_1 y_2, y_2^2\}$.

matrix $W = \hat{\Lambda}_T^{-1}$, where $\hat{\Lambda}_T$ is the estimated variance-covariance matrix of the combination of vectors from matrix D that were used to create p data moments ψ^D .

In this minimum distance estimation procedure the criterion function,

$$(15) \quad (\psi^D - \psi^S(\Theta))' W (\psi^D - \psi^S(\Theta)) \xrightarrow{D} \chi^2(p - q),$$

where, p is the number of moment conditions and q is the number of parameters [Ruud 2000].

This is used to assess whether the minimized distance between the sample data and the simulated data is satisfactory.

V.3. Individual Heterogeneity

The sample data is contaminated by individual heterogeneity across individuals. To account for this, (η^w, η^{sn}) were introduced in the model. Different values of η^w and η^{sn} are picked from kernel density estimates of non-housing wealth and social networks, respectively. For each pair (η^w, η^{sn}) , the Bellman is solved. Each pair represents a type of household. I used two, three and four value picks for each of η^w and η^{sn} , giving us four, nine and sixteen pairs, respectively. For example, when two values are picked (high type and low type) there are four pairs: high-wealth-high-social-network type, high-wealth-low-social-network type, low-wealth-high-social-network type and low-wealth-low-social-network type. Similarly for three values (nine types of households) and four values (sixteen types of households).

V.4. Stochasticity

I use the following estimates of (σ_w, σ_{sn}) in the stochastic dynamic program (11). First, non-housing wealth (w_{2000}) is regressed on age_{1997} , x_{1997} , ts_{1997} and, w_{1997} ; then the residual is calculated. The standard deviation of this residual is used as an estimate of σ_w . The estimate

used for σ_{sn} is the standard deviation of the residual from a regression of social network (sn_{2000}) on age_{1997} , x_{1997} , and sn_{1997} . Residuals of these estimates are reported in Table 4.

V.5. Iterations

The objective of the estimation strategy is to find the Θ that brings the model closest to the data by minimizing the weighted distance between their respective moments. The iterations of this estimation process are as follows.

1. Pick a Θ .
2. Pick (four/nine/sixteen) pairs of (η^w, η^{sn}) .
3. For each pair of (η^w, η^{sn}) and the Θ , the Bellman (equation (11)) is solved using the collocation method [Miranda and Fackler 2002].⁸
4. Simulate moments off the optimal action and corresponding state variables. Calculate moments ψ^S .
5. Match with ψ^D and calculate the weighted distance.
6. Pick another Θ and repeat steps 2 to 5.

After a large number of iterations, the Θ that produces the minimum distance is the $\hat{\Theta}_{SMM}$.

VII. Results

The criterion function in equation (15), evaluated at the estimated parameter values, is distributed χ^2 . Table 5 presents the χ^2 test results which show that the distance between the simulated and the data time paths are minimized, for all the three kinds of heterogeneity experiments, at a statistically acceptable level.

⁸ This dynamic program has an action that is discrete and three state variables one of which is also discrete. Naturally, no Euler equation can be derived.

As a comparison, figure 1 presents the kernel density estimates of actual and simulated state variables: non-housing wealth, social networks, and tenure status. They show considerable conformity. Table 6 presents all the parameter estimates and their standard errors.

To exhibit the impact of social networks on homeownership, following comparative dynamics are carried: using the estimated parameters, the policy and state variables are generated. Table 7 presents the mean values of these variables for the following cases:

- (a) The average household (the benchmark case): average values of (η^w, η^{sn})
- (b) High wealth household: high value of η^w and mean value of η^{sn}
- (c) Low wealth household: low value of η^w and mean value of η^{sn}
- (d) High social network household: mean value of η^w and high value of η^{sn}
- (e) Low social network household: mean value of η^w and low value of η^{sn}
- (f) High wealth and high social network household: high value of η^w and high value of η^{sn}
- (g) Low wealth and low social network household: low value of η^w and low value of η^{sn}

Under the heterogeneity level 16, 78 percent of their 39 years lifecycle the average household lives in its owned home (the benchmark case). High social network households live in owned homes for 82 percent of this lifecycle, low wealth households 74 percent of this lifecycle, an 8 percent spread. Between high wealth and low wealth households this spread is 13 percent, 85 percent versus 72 percent. Similar trends are shown in case of nine and four pairs of heterogeneity levels. A comparison between high wealth high social network households with the low wealth low social network households shows a spread of 21 percent, 86 percent versus 65 percent. Similar trends are exhibited in the other two heterogeneity experiments (i.e., 9 and 4 pairs).

VIII. Conclusions

This is the first study of the impact of social networks on housing tenure choice. It builds a dynamic model and estimates its structural parameters. It analyzes the joint mobility-tenure choice mechanism of the household while taking into account social network accumulation. In the estimation of the parameters it accommodates for individual heterogeneity in the data.

The policy emphasis of homeownership promotion is partly a reflection of the fact that recent research provides evidence of numerous economic and social benefits accruing to homeowners [Dietz and Haurin 2003]. Given the consistent findings of the importance of social networks in both economic and non-economic aspects of the individual's life [Durlauf and Fafchamps 2004], the study of the impact of social networks on the determination of homeownership is likely to have substantial appeal in public policy discussions.

Especially in the United States, where homeownership is a major policy issue, this could be of particular interest. One of the major discussions surrounding the current subprime/foreclosure crisis in the US is whether people made poor and uninformed choices regarding home-buying due to a lack of understanding of the home-buying process, the mortgage market, and the sustainability of homeownership. Since social networks make available to a decision maker the accumulated knowledge and experience within the network, it deserves a closer look. Social networks may be exploited in order to attain more efficient and sustainable tenure decisions. Information diffusion and spread of knowledge may in fact be more effective if it is shared through social interactions compared to traditional avenues of learning [Munshi and Myaux 2002]. In fact, studies on agricultural technology adoption show that such weaker and more moderate social forces can be even more effective than highly visible, more demanding external controls [Lynne et al. 1995].

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Tables

Table 1: Descriptive Statistics

Variable	Label	Obs	Mean	Std.	Min	Max
age_{1997}	Age in 1997	1765	46.46	9.51	30.00	65.00
sn_{1997}	Social network index in 1997	1765	1.97	2.28	0.00	18.77
sn_{2000}	Social network index in 2000	1765	1.87	2.22	0.00	14.67
w_{1997}	Non-housing wealth 1997 (1,000,000 Rupiah)	1765	37.64	90.61	0.00	1046.60
w_{2000}	Non-housing wealth 2000 (1,000,000 Rupiah)	1765	34.72	76.58	0.00	914.70
x	Mobility-tenure joint decision between 1997 and 2000	1765	1.27	0.65	1.00	4.00
ts_{1997}	Homeownership in 1997	1765	0.75	0.44	0.00	1.00
ts_{2000}	Homeownership in 2000	1765	0.79	0.41	0.00	1.00

Table 2: Variation Across Different Mobility-Tenure Joint Decision

		Not move + continue current tenure	Not move + change current tenure	Move + continue current tenure	Move + change current tenure
	Number of observations	1455	188	82	40
age_{1997}	Age in 1997	47.08	44.02	43.34	41.90
sn_{1997}	Social network index in 1997	2.00	2.02	1.29	1.83
sn_{2000}	Social network index in 2000	1.94	1.75	1.05	1.87
w_{1997}	Non-housing wealth 1997	37.62	35.11	47.12	30.88
w_{2000}	Non-housing wealth 2000	35.40	26.55	42.06	33.45
ts_{1997}	Homeownership in 1997	0.83	0.32	0.43	0.35
ts_{2000}	Homeownership in 2000	0.83	0.68	0.43	0.65

Table 3: Difference across Homeowners and Non-owners

	Non-homeowners (1997)	Homeowners (1997)	Non-homeowners (2000)	Homeowners (2000)
Number of observations	450	1315	372	1393
Age	43.32	47.53	46.38	50.28
Social network index	1.54	2.11	1.44	1.99
Non-housing wealth	34.27	38.79	27.93	36.53

Table 4: Residuals of Regressions to Estimate (σ_w, σ_{sn})

Variable	Mean	Std.	Min	Max
Residual of the regression of w_{2000} on $\{age_{1997}, x_{1997}, ts_{1997}, w_{1997}\}$	0.00	66.97	-353.97	848.04
Residual of the regression of sn_{2000} on $\{age_{1997}, x_{1997}, sn_{1997}\}$.	0.00	1.95	-6.98	9.85

Note: (a) N = 1765. (b) From these regressions the following estimates are obtained: $\{\sigma_w = 66.97, \sigma_{sn} = 1.95\}$.

Table 5: χ^2 Tests

		Heterogeneity		
		16 pairs	9 pairs	4 pairs
χ^2 statistic		1.80	2.14	1.87
	1%	36.19	36.19	36.19
Critical values	5%	30.14	30.14	30.14
	10%	27.20	27.20	27.20

Table 6: Parameter Estimates and Standard Errors (Standard Errors in Parenthesis)

Heterogeneity	μ	η	θ
16 pairs	21.07133 (0.0058808)	0.62568 (0.0002546)	0.78730 (0.0001377)
9 pairs	21.03444 (0.0007575)	0.62297 (0.0000616)	0.78354 (0.0000449)
4 pairs	21.06888 (0.0009122)	0.62593 (0.0000299)	0.78707 (0.0000237)

Heterogeneity	β^w	ξ_1	ξ_2	ξ_3	ξ_{11}	ξ_{22}	ξ_{33}
16 pairs	0.13090 (0.0001351)	0.04099 (0.0002927)	0.28948 (0.0002188)	0.67230 (0.0003289)	0.00011 (0.0001999)	0.00013 (0.0002711)	0.00010 (0.0001479)
9 pairs	0.13077 (0.0000705)	0.04019 (0.0000780)	0.28423 (0.0000227)	0.67137 (0.0000311)	-0.00047 (0.0000370)	-0.00048 (0.0000600)	0.00003 (0.0000216)
4 pairs	0.13154 (0.0000427)	0.04038 (0.0000496)	0.28847 (0.0000199)	0.67275 (0.0000570)	-0.00104 (0.0000382)	-0.00109 (0.0000779)	-0.00004 (0.0000568)

Heterogeneity	β^{sn}	γ_1	γ_2	γ_{11}	γ_{22}
16 pairs	0.24040 (0.0003907)	0.74650 (0.0001949)	0.54090 (0.0003560)	0.00010 (0.0003068)	0.00007 (0.0002071)
9 pairs	0.24069 (0.0000472)	0.74371 (0.0000421)	0.54103 (0.0000504)	-0.00054 (0.0000514)	-0.00057 (0.0000516)
4 pairs	0.24138 (0.0000325)	0.74741 (0.0000207)	0.54206 (0.0000762)	-0.00118 (0.0000289)	-0.00120 (0.0000466)

Table 7: Lifetime Averages

Heterogeneity	Variables	Benchmark: average wealth and social network	High social network	Low social network	High wealth	Low wealth	High wealth + high social network	Low wealth + low social network
16 pairs	Mobility-tenure decision	1.22	1.18	1.25	1.15	1.27	1.14	1.35
	Wealth	21.21	27.26	24.80	89.97	1.27	111.95	3.59
	Social network	1.70	3.10	0.32	1.78	1.12	6.15	0.27
	Homeownership	0.78	0.82	0.74	0.85	0.72	0.86	0.65
9 pairs	Mobility-tenure decision	1.24	1.24	1.35	1.19	1.31	1.20	1.25
	Wealth	25.63	25.94	21.92	66.66	2.92	65.52	3.49
	Social network	1.06	1.92	0.50	1.49	0.72	2.24	0.35
	Homeownership	0.75	0.76	0.64	0.81	0.68	0.80	0.74
4 pairs	Mobility-tenure decision	1.25	1.21	1.27	1.24	1.27	1.20	1.31
	Wealth	19.48	20.48	18.57	31.47	7.99	32.92	7.62
	Social network	1.20	2.14	0.32	1.41	1.18	2.25	0.34
	Homeownership	0.75	0.79	0.72	0.76	0.72	0.80	0.69

Figure 1: Kernel Density Estimates of Actual and Simulated State Variables

