Houses, Apartments and Condos:

The Governance of Multifamily Housing

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This version: October 11, 2015

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Abstract

The usual explanation of high rentership in multifamily buildings — a coordination problem among unit owners — is inconsistent with an increasing rate of condominium ownership in larger buildings. In order to examine the structure-ownership correlation more carefully than has been done previously, we model the value of alternate forms of joint ownership and show that economies of scale in building management can serve to mitigate the cost of governance problems associated with these arrangements. Under the assumption of declining absolute risk aversion, the model predicts that wealthier condominium investors outbid the less wealthy for investments in larger buildings. Empirical evidence from the American Housing Survey is consistent with this prediction. Because housing is durable, our study suggests that the costs of governance and the nature of the housing stock are important for understanding patterns of homeownership.

Keywords: Homeownership, Homeowners' Associations, Governance

1. Introduction

Single family houses are typically owned by the households who occupy them. While most occupants of multifamily structures are renters, patterns of multifamily building ownership are relatively under-studied. As depicted in Figure 1 (which we discuss in greater detail below), the fraction of duplex units held as condominiums in the 2011 American Housing Survey (AHS) is especially low at 9 percent. Presumably, the remaining duplex units are owned by landlords who rent the units, although landlords may also choose to owner-occupy a unit. The rate of condo ownership nearly doubles in buildings of around twelve units, however, and continues to increase in even larger buildings. In Figure 2, we illustrate that this pattern is replicated both within cities and across regions in the U.S. A related fact suggesting that small multifamily buildings are somehow problematic for condominium ownership is that the relative share of the U.S. housing stock in two to four family buildings has declined continuously since 1973 (Eggers and Thackeray 2007).

The usual explanation of high rentership in multifamily buildings – a coordination problem among unit owners – is inconsistent with the greater prevalence of condominium ownership in larger buildings. In order to examine the structure-tenure correlation more carefully than has been done previously, we ask a fundamental question: what is the relationship between building size and its ownership and governance? This is somewhat different than the traditional examination of homeownership (for example, Coulson and Dalton 2010, Hilber 2004, Carrillo and Yezer 2009) which asks: what characteristics of *households* make them more likely to become owner-occupiers?

In particular, we investigate two forms of building ownership. The first we refer to as "direct" ownership in which investors are the residual decision-makers with respect to their investment in a building. Condominium ownership represents a type of direct ownership in which investors own their own unit and have a voice in building-level capital budgeting decisions through a homeowners' association or similar governance mechanism. Sole owners are another special case of direct ownership in which there is a single investor in a building. Alternatively, indirect ownership schemes are defined as forms of joint ownership in which co-investors delegate decision-making to a single general partner (although investors typically retain certain rights to sanction or terminate the general partner).

Literature on the role of housing structures in housing markets is sparse. Glaeser (2011b), Glaeser (2011a) and Glaeser and Shapiro (2003) somewhat informally argue that maintenance and upkeep are building-specific (as opposed to unit-specific) issues and so the problems of decentralized ownership of buildings makes condominiums and cooperatives difficult to manage. These difficulties make it more efficient to put those decisions in the hands of a single owner (a landlord) and make multifamily units rentals. However, this casual theorizing fails to explain the observed rise in the rate of condominium ownership among larger multifamily buildings. The literature on public goods suggests that management difficulties increase in the number of participants Cornes and Sandler (1996) .

Linneman (1985) discusses a trade-off between the costs of monitoring a landlord on one hand, and the value of having a landlord solve the free-riding problem, on the other. These trade-offs, in addition to economies of scale for landlords, are assumed to influence the relative productivity of landlord versus owner management in ways that are un-modeled in his investigation of tenure. Williams (1993) proposes a model of multifamily structure ownership which trades off the rental externality described in Henderson and Ioannides (1983) against economies of scale provided by landlords. This model again fails to explain the non-linear relationship between homeownership and building size, a fact that the author acknowledges.

In the model that follows, we separately incorporate economies of scale in management, the agency costs of employing a general partner, and the free-rider problem among co-investors who retain direct ownership. The goal is to identify building sizes over which sole owners, other direct investors and indirect investors may dominate. The model more precisely identifies the trade-offs between alternate forms of joint ownership than has been achieved in the literature to date.

The results show that sole owners will tend to outbid joint investors for single family houses if the costs of effort are comparable among investors and general partners. Comparison of investor bids as a function of building size for alternate forms of joint ownership depends on the relative costs of direct investor and general partner (GP) effort, the importance of third-party managers and the opportunity costs of GPs and managers. The implication is that we may observe both direct and indirect forms of ownership depending on the parameters of the model and on housing demand in particular locations. Most relevant for our purposes, under the assumption of declining absolute risk aversion, the model predicts that wealthier investors outbid the less wealthy for direct ownership investments in larger buildings.

We empirically examine this latter prediction using a sample of condominiums from the 2011 American Housing Survey (AHS). We do so by estimating the bids of condominium owners with respect to marginal quality, as measured by interior floor space. The bids are modelled as functions of both demographic and unit characteristics, particularly the number of co-investors (as measured by the number of units) in the building. In order to do this we first account for the selection of buildings into condominium status, as opposed to sole ownership or indirect ownership, and then for the selection into owner-occupied condos in order to overcome observability problems discussed below. We then use two-step procedures for recovering the bid functions that were first proposed by Epple (1987) and Bartik (1987). Identification is possible due to the observed variation in the hedonic price function across U.S. regions. By splitting the sample into high and low wealth sub-samples, we find that low wealth investors are sensitive to building size and their bid gradient with respect to unit count is negative and quite steep. They, therefore, are the winning bidders for joint ownership of smaller buildings, and are then outbid as condominium buildings become larger.

A main conclusion of the paper is that economies of scale in the management of buildings serve to mitigate the cost of governance problems associated with joint ownership arrangements. Because housing is durable, the costs of governance and the nature of the housing stock are important for understanding the patterns of ownership, and therefore of homeownership, observed in U.S. housing markets.

The paper proceeds as follows. In the next section we present some of the stylized facts and quandaries to which we have alluded. Then we present the model and analyze it. The succeeding section estimates the bid functions from the data. This involves several econometric issues, which are addressed, and we present empirical evidence consistent with model predictions. We then conclude.

2. Homeownership and Structures

By way of context, about three-fourths of year-round housing in the U.S. is in single family structures. The vertical bars in Figure 1 show that most of the multifamily housing in the U.S. is quite small as well. Over 64 percent of the multifamily residences surveyed in the 2011 AHS were in buildings of 12 or fewer residences. Confounding simple explanations of the homeownership-structure correlation, condo ownership steeply increases in small buildings (with 12 or fewer residences see the right panel of Figure 1). Interestingly, the rate of condominium ownership for duplexes in the 2009 AHS data is just over 9 percent, whereas more than 25 percent of sampled households in buildings with more than 50 units are organized as condominiums. This rise in condominium ownership is not sensitive to the location of housing within cities or across locations. Figure 2 reproduces Figure 1 for stratifications of the data by different geographic characteristics. We first categorize the data according to where the housing unit is located: within a central city, greater urban area or suburban area of an metropolitan region. We also display this graph for New York City, where there are a substantial number of large buildings. Finally, we graph the rate of condo ownership of housing units within multifamily buildings by region of the U.S. Northeast, Midwest, South and West. The fact that condominium ownership increases with building size is an important feature of the U.S. housing landscape.

Because one of our main goals is to explain homeownership rates as a function of building size, it is important to recognize that homeownership in multifamily buildings requires a particular brand of governance like condominium or cooperative ownership, which provides investors with a proprietary claim to use and occupy a residence.[1] In contrast, a limited partner in a partnership that owns a multifamily building has no *a priori* right to occupy a residence within the building. We would not consider the investor in this case to be a homeowner. (Nor for that matter would the Census or the IRS.) We do not directly model homeownership. Nonetheless, the ultimate connection between ownership and tenure should be evident. If joint ownership of multifamily buildings is disadvantaged relative to indirect ownership for certain types of buildings, we would expect to observe greater rentership in multi-family buildings, all else equal. Thus, our analysis represents a necessary step in establishing the structure-tenure connection.

Interestingly, the homeownership rate among units in small multifamily buildings is initially *higher* than the rate of condo ownership (Figure 3). A cross-tabulation of condo ownership and owner-occupation reveals that 26 percent of owner-occupied units in multifamily buildings are not owned as condominiums, and that 96 percent of non-condo owner-occupiers are found in buildings with 12 or fewer units (excluding single family residences). We interpret the presence of these non-condo owner-occupiers as sole owners who occupy one unit and rent the remainder. Therefore, sole owners of small buildings also comprise an important part of the multifamily homeownership rate.

The fact that the homeownership rate depicted in Figure 3 moves inversely with the condo ownership of units in very small buildings speaks to the fact that many condo investors rent their unit. While this is not an empirical fact that we pursue in this paper, it does suggest that both direct and indirect forms of ownership produce rental housing in competitive markets. The overall rate at which condo units are rented is 50 percent in the 2011 AHS.

Unlike Linneman (1985) and Williams (1993), we argue that economies of scale are not confined to rental buildings based on suggestive evidence from condominium markets. Using data from the state of Massachusetts in 2009, Figure 4 plots the propensity of condo associations to employ professional management services as a function of the number of units in the building.[2]

[1]Multifamily ownership arrangements may also encompass multiple buildings, including multiple single-family houses, which we do not directly address in this paper.

[2]This figure displays the smoothed rate at which buildings of different sizes are professionally managed as

The rapid rise in this probability suggests that smaller buildings do not have sufficient scale to overcome the fixed costs of bringing in outside management services. Importantly, and even though exact services provided may differ, we expect that both joint owners and sole owners of buildings face similar scale economies in management costs.

3. Model

In this section, we investigate two main forms of ownership. The first we refer to as "direct" ownership in which investors are the residual decision-makers with respect to their investment in a building. There many be a single investor, or multiple co-investors in this case so long as each investor retains the right to directly influence capital budgeting, and perhaps operational, decisions for the building. Therefore, direct ownership captures sole-investor ownership as well as arrangements like condominium ownership in which investors face problems of joint decision-making. Other sorts of joint ventures or partnerships where co-investors do not delegate all capital budgeting and operational control to a manager-partner are also considered forms of direct ownership.

Indirect ownership schemes are intended to capture forms of joint ownership in which more than one investor contributes money to make an investment but the co-investors delegate decision-making to a single general or managing partner (although the investors typically retain certain rights to sanction or terminate the general partner). Indirect ownership encompasses legal and tax-motivated entities like limited partnerships, limited liability corporations and real estate investment trusts.[3] In the case of indirect ownership, we will use the term limited partner (LP) to generally refer to the contributors of money, and general partner (GP) to refer to the party with decision-making authority. For simplicity, we will assume that GPs do not contribute money to the purchase of a building, but as we shall describe below, they may have claims to the value of the property *ex post*.

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revealed by condo listings on MLS PIN in the state of Massachusetts during 2009. N = 53,303 listings with non-missing information about the number of units in the building and whether the building is professionally managed (either by on-site or off-site management).

[3]These forms of ownership also typically limit investor downside risk by limiting financial and legal liability to the amount of their initial investment.

In both the case of direct and indirect ownership, the parties with decision-making power may hire third parties to help manage and maintain the building. The residual claim to decision-making that resides with direct investors and GPs is defined to include hiring and capital budgeting decisions at a minimum.

To examine how valuations vary with building size and form of ownership, we specify a one period, two date portfolio model in which investors with initial wealth w_1 choose between a risk-free asset and a risky housing asset in order to maximize expected utility. Figure 5 sets out the timeline for investors. At time one, investors are price-takers who select their quantity of housing investment (q) and compensation contracts for general partners and third-party management, subject to the proposed form of ownership and the number of co-investors. Investors only invest in a single building.[4]

While there are a number of costs and benefits associated with direct and indirect forms of ownership, our model focuses on three channels. First, we assume that there are economies of scale in the operation and management of buildings. This is a baseline assumption for both forms of ownership and while it does not help us to distinguish between them, it is important in order match empirical regularities in the data, as suggested by Figure 4. The second important aspect of the model concerns the case of direct ownership with multiple investors, as in the case of condominium ownership. In this case, investors under-invest in effort because of a free-rider problem. The third issue is an agency problem faced by limited partners because they are not able to perfectly monitor or observe GP actions. As such, some building profit needs to be allocated to the GP in order to induce her participation as well as to provide appropriate incentives.

While we stylize ownership into two forms, a special case of direction ownership – sole ownership – may represent the first best form of ownership because it avoids the coordination and agency problems associated with joint ownership. However, the possibility that costs of effort may differ between investors and general partners who specialize in building ownership

[4]In other words, we do not explicitly model the potential diversification benefit that may accrue to those who invest in a portfolio of buildings. This may be an advantage of a limited partnership not explored here.

may allow indirect ownership to dominate. Even absent such cost differences, it seems reasonable to assume that sole ownership cannot dominate all investments, because buildings are bulky and their numbers are likely to be greater than the number of individual investors with sufficient capital to fund them.[5]

Following time one but before time two, investors, general partners and/or third-party management exert effort to manage and maintain the property. An investor's indirect utility conditional on initial wealth, the number of co-investors l, and form of ownership is

$$U(w_1, l) = \max_{q,\beta} E\left[v\left(\tilde{w}_i\right)\right] \tag{1}$$

where q is the quantity of investment, $v(\cdot)$ is the investor's utility function, $\tilde{w}$ is uncertain time two wealth, $i = D, L$ indicates a direct owner or a limited partner, respectively, E is the expectations operator and β is the indirect investor's share of residual income (set equal to 1 in the case of direct ownership).

Having chosen a quantity of housing investment, investors place the balance of their initial wealth endowment in risk-free savings at the rate r. P is the price of a unit of housing services at time one and R is the periodic rent from a unit of housing services that is paid by a tenant at time one for the ensuing period. The net cost of investment in a unit of housing is therefore $P - R$. While we abstract from consideration of whether the housing investment is owner-occupied and from the taxation of profits, R can be interpreted as imputed rent in the case of owner-occupation. Housing investment and building size are both measured in units of housing services, which comprise both a quantity and quality measure.

There may be $l \geq 1$ co-investors in a building, and for simplicity we assume that co-investors own equal shares of a building. This ensures that buildings have homogenous investors who will choose equal amounts of maintenance effort and third-party services in the event of direct

[5] A complementary reason that sole owners do not dominate investments might be that demand for diversification across buildings limits the value of particularly large investments.

ownership.[6] Given l equal size investments, building size can be denoted $n = ql$. Investors choose q conditional on l such that building size changes with the quantity of investment and conveniently ensures that $q \leq n$.

We assume that costly management and maintenance of a building is required in order to produce housing services for occupants. Because we are interested in building-level issues created by different forms of building ownership, we set aside consideration of how a particular residence within a building is maintained. In their model of housing tenure, Henderson and Ioannides (1983) focus on maintenance externalities resulting from the utilization of a particular residence. In contrast, we focus on building-level capital and administrative decisions, as well as the maintenance of building systems and common areas, like lobbies, hallways and elevators. Knapp (1991) also examines demand for maintenance, but focuses on the transfer of control between developers and homeowners associations.

Management effort may come from both decision-makers (direct investors or GPs) and third-party managers, hereafter simply "managers." For simplicity, we assume that both investors and GPs can perfectly observe the effort of managers as well as their cost of effort. The introduction of an agency problem between managers and investors, while realistic, does not influence our main results since we assume the agency problem is the same in either ownership case.

After time one (but before time two), each direct investor non-cooperatively chooses effort a_D that he or she will contribute to building management. Similarly, general partners also choose a_G during this interval, and managers choose effort b. Investor and GP effort are perfect substitutes with third-party management effort, and the two sources of effort impact property value independently. We assume that direct investors and GPs share the same technology but allow parameters of the production function to differ between the forms of ownership.[7] Effort exerted in one period is assumed to positively influence the flow of housing services in the next

[6] Likewise, Knapp (1991) assumes homogeneity of owner demand within associations due to the expectation that households stratify themselves into homogenous groups.

[7] Allowing the parameters to vary also accommodates the fact that GPs may have to invest more effort than direct owners to obtain the same valuation benefit because the operation of leased and owner-occupied buildings, for example, are different.

period, and these future benefits are assumed to be perfectly capitalized into housing value at time two.

Building value under direct ownership at time two *per unit of housing services* is $P + 2\phi_a\sqrt{\sum_{j=1}^{l} a_j} + 2\phi_b\sqrt{b} + \tilde{u}$, where ϕ_a and ϕ_b are the marginal product of investor and manager effort, and $\tilde{u}$ is normally distributed noise with mean 0 and variance σ^2. In the case of direct ownership when $l > 1$, each investor's property value benefits from the collective effort of all building investors and from manager effort. Our choice for the functional form that converts effort into value follows the choice made in Edmans and Manso (2011) for similar productive effort from their work on block shareholders. In particular, the set-up ensures a constant technology between sole investors and joint investors, and the change in building value between times one and two is a concave function of effort.

We model the cost of a unit of investor and manager effort as linear in effort and concave in building size. Each direct investor or GP incurs a personal cost per unit of effort equal to $c_i\sqrt{n}$, where c_i is the ownership-specific cost parameter. The functional form of the cost of effort results in the same level of *effective* effort being more costly for a larger building (recall that a unit of effort benefits the entire building). Nonetheless there are economies of scale such that the marginal cost of effort falls as building size increases.

Recalling that $n = ql$ and allowing $t(b)$ to represent payment per unit of housing services to a third-party manager, second period wealth for a direct investor k conditional on l co-investors is

$$\tilde{w}_D = (w_1 - q(P - R))(1 + r) + q\left(P + 2\phi_a\sqrt{\sum_{j=1}^{l} a_j} + 2\phi_b\sqrt{b} - t(b) + \tilde{u}\right) - a_k c_D\sqrt{n}. \quad (2)$$

Time two wealth from indirect ownership differs from direct ownership because the LP does not incur a cost of effort, but rather compensates a GP for the GP's effort by allocating a portion of time two profits to the GP. We assume that GPs are risk neutral, and adopt a simple compensation scheme in which limited partners claim the fraction β of profit at time two and general partners are allocated the residual $1-\beta$. The LP's second period wealth is

$$\tilde{w}_L = (w_1 - q(P-R))(1+r) + qP + q\beta\left(2\phi_a\sqrt{a_G} + 2\phi_b\sqrt{b} - t(b) + \tilde{u}\right). \tag{3}$$

4. Management Effort

4.1. Investor Effort

In the case of direct ownership, investor k takes the effort of all other investors in the same building as given and chooses his own effort to maximize (2). This yields,

$$\sqrt{\sum_{j=1}^{l} a_j^*} = \frac{\phi_a\sqrt{q}}{c_D\sqrt{l}}. \tag{4}$$

If we assume a symmetric equilibrium (although asymmetric equilibria are feasible), the optimal contribution of any direct investor is:

$$a_D^* = \frac{q\phi_a^2}{c_D^2 l^2}. \tag{5}$$

The free-rider problem is evident in (5) by virtue of the fact that a_D^* is decreasing in the number of co-investors l, conditional on q. In addition, inspection of equation (4) reveals that a sole-owner for whom $l=1$ always provides effort that is greater than the sum of effort provided by co-investors ($l>1$) for the same building.

If ownership is through a limited partnership, we assume that the GP has a cost per unit of effort $c_G\sqrt{n}$. Given the GP's compensation β, she maximizes (with choice of b)

$$(1-\beta)\,n\left(2\phi_a\sqrt{a_G} + 2\phi_b\sqrt{b} - t(b)\right) - a_G c_G\sqrt{ql}. \tag{6}$$

The GPs choice of effort conditional on her participation is therefore

$$a_G^* = (1-\beta)^2\left(\frac{n\phi_a^2}{c_G^2}\right). \tag{7}$$

Rewriting (5) to faciliate comparison, $a_D^* = \frac{1}{l^3}\left(\frac{n\phi_a}{c_D}\right)$. Comparing this to (7) reveals a potential cost of delegating authority to a GP. Relative to a sole owner when $c_D = c_G$, GP effort is lower due to the fact that the GP is not the full residual claimant to the value of her effort. Because GPs of rental buildings must incur additional effort to periodically lease units in the building, it could also be that $c_D \leq c_G$ which exacerbates the agency cost. The possibility that $c_D > c_G$ means that the agency cost could be offset, however, if GPs are more efficient managers than direct investors, after accounting for differences in the nature of management tasks.

Comparing effort between GPs and direct investors when $l > 1$ shows that there are potential costs to either joint ownership arrangement. For condos, there is a free-rider problem and for LP's there is an agency problem. Of note, however, is the fact that the free-rider problem worsens with then number of co-owners, and hence with building size, when we hold q constant.

4.2. Third Party Management

Direct investors or GPs select the optimal level of management effort from third-party managers by setting the marginal value of manager effort equal to marginal costs. The manager's cost parameter is denoted d, and the manager's opportunity cost per unit of housing services is z. Therefore the manager's participation constraint requires

$$nt\,(b) - bd\sqrt{n} = zn. \tag{8}$$

Under the assumption that manager actions are observable, direct investors and GPs satisfy the manager's participation constraint and obtain full effort from managers equal to

$$b^* = \frac{n\phi_b^2}{d^2}. \tag{9}$$

Due to the assumption of economies of scale, optimal third party effort is increasing in n.

5. Solutions and Investor Bid Functions

Direct investors maximize utility by choosing q conditional on l, a_D^* and b^* for $\beta = 1$. Limited partners choose q and β subject to a_G^* and b^*. Given the assumed concavity of $v(\cdot)$, a unique solution (q_i^*, β_i^*) to each investor's problem exists. For $l = 1$, we can show that $q_D^*(w_1, 1) > q_L^*(w_1, l)$. However, $q_D^* \neq q_L^*$ generally speaking. If we assume investors have declining absolute risk aversion (DARA), then wealthier investors, who are less risk averse under DARA, invest in larger quantities of the risky housing asset than less wealthy investors using the same form of ownership.

For either form of ownership, building performance varies with building size. First, both forms benefit from scale economies as building size increases. Second, in the case of direct ownership with co-investors, there is a free-rider problem as building size increases. In order for identical investors to be indifferent between similar investments in different buildings, their bid price per unit of housing services will necessarily vary with building size.

Keeping in mind that $n = ql$, in order to derive the bid function for direct owners we invoke the envelope theorem and differentiate indirect utility in (1) with respect to l holding the investor's quantity of investment at its optimal level, which yields:

$$\frac{\partial P_D}{\partial l} = \frac{\sqrt{q_D^*}}{r\sqrt{l}} \left[\left(\frac{3-2l}{2l^2} \right) \frac{\phi_a^2}{c_D} + \frac{\phi_b}{2d} \right]. \tag{10}$$

For $l > 1$, the coefficient $(\frac{3-2l}{2l^2})$ is negative due to the free-rider problem and an additional co-investor puts downward pressure on bids for direct owners. The coefficient, however, is non-linear in l and the negative marginal impact quickly grows smaller. This non-linearity creates the possibility that the bid function is upward sloping when evaluated at a higher number of co-investors if the marginal cost of an additional investor is outweighed by the marginal gain from scale economies (represented by $\frac{\phi_b}{2d}$). With DARA, wealthy direct investors have steeper bid functions, all else equal, since their optimal investment quantity is larger than less wealthy investors.

We can also differentiate the indirect utility function of limited partners with respect to l as a means of deriving their bid function and obtaining results comparable to (10). The bid function for limited partners is:

$$\frac{\partial P_L}{\partial l} = \beta^* \frac{\sqrt{q_L^*}}{r\sqrt{l}} \left[(1-\beta^*) \frac{\phi_a^2}{c_G} + \frac{\phi_b}{2d} \right]. \tag{11}$$

Each set of terms in the limited partner's bid function is positive. Comparison of (10) and (11) suggests that a variety of outcomes could obtain with respect to competitive bidding for different size buildings under alternate forms of ownership. By assumption, an investor can bid the most for a building as a sole owner if the investor's cost of effort are similar to that of a GP because a sole-owner avoids the two types of governance costs associated with joint ownership. Comparison of bids between joint ownership forms, holding investor wealth constant, as the number of co-investors increases yields few clear predictions. The relative costs of direct investor and GP effort, the importance of manager contributions and the opportunity costs of GPs and managers will affect which bid curve dominates as building size increases. Importantly, however, conditions may exist under which both forms of ownership co-exist in buildings of similar size.

6. Empirical Models

The theoretical model in the previous section suggests that investor demand for properties in which they perforce share ownership is likely to be affected by the number of co-investors. For direct ownership with multiple investors, the negative marginal costs of free-riding are greatest when the number of co-investors are few, and the marginal impact of free-riding dissipates as the number of co-investors increases. This insight is consistent with the special case of direct ownership – condominium ownership – depicted in Figure 1. The graphs suggest that condo bid functions are first negative, and then upward sloping as more co-investors (and hence condo units) increase building size.

In this section we further investigate the implications of the model for condo ownership. Investigation of condos is convenient, since we can easily observe, at least approximately, both the ownership of the investments and the number of co-investors. In particular, under the assumption of DARA, wealthier condo investors should have steeper bid functions as the number of condo units in a building increases. Given the model's results and the evidence in Figure 1, it is plausible that that condo bid curves are initially downward sloping and then upward sloping at larger building sizes. Therefore, we predict several natural habitats for condo investors of different wealth. First, wealthier households will outbid the less wealthy for singe family ownership (for which $l = 1$ in the model). The wealthy will then have a more negative price gradient as the number of units in a building increases from one, making it more likely that less wealthy households occupy small multifamily buildings along the region of the bid curves that is downward sloping. Wealthy condo owners will then outbid the less wealthy for units in large buildings if bid functions are positively sloped at those sizes.

In order to estimate bid functions, we need data on household wealth, household demographic variables, individual condominium prices, and structural attributes of the condominiums, particularly including the floorspace and the number of units in the condo building. All of these, save wealth, are available in the American Housing Survey, and this is our primary source of data. Other surveys calculate household wealth, but are short on the detailed data needed to estimate hedonic price functions for condo prices. Our resolution of this quandary is to use the Panel Survey of Income Dynamics (PSID) to estimate the determinants of wealth as a function of household characteristics, and use this regression function to estimate wealth for the households surveyed in the American Housing Survey. This is the first step in our empirical procedure.

The second step should have been to estimate the hedonic price function for condos – that is, a regression function that maps condo structural and locational attributes into condo prices. However, we are faced with two selectivity issues. The theoretical model implies that for a multifamily structure, the equilibrium ownership of the building is not random and stresses that the number of co-investors is influential in this decision. Other quality dimensions play a role as well. The empirical literature on homeownership (Hanson 2012) speaks most directly to this point. It stresses that tax incentives such as the home mortgage interest deduction lead homebuyers to choose higher quality homes, in turn suggesting that buildings of higher quality are more likely to be condos. Quality is only partially observable, therefore the unobserved factors that influence the choice to become condo are correlated with the unobserved attributes that create the price. In other words it is necessary, in the hedonic model, to control for the selective nature of the condo sample. Secondly, as we outline below, the AHS surveys housing units, but of necessity, the interview subjects are the residents of the housing units. In the AHS condominium sample, about half of the respondents are owner-occupiers, and half are renters. The value of the condo investment (along with condo fees, if any) is reported only in the case that the interviewee is the owner-occupier. But the decision to be an owner-occupier is influenced by the same unobservable factors (albeit with different weights) as was the decision for the building to be organized as a condo in the first place.

Therefore, the estimation of the hedonic price model for condos consists of three stages. The first stage chooses between joint ownership through condominium governance and sole ownership by a landlord who rents the building's units. The building developer sells to the type of buyer that generates the highest bid. We do not directly observe the bids, but we assume they are summarized by the linear index

$$I_1^* = X_1\beta_1 + e_1 \tag{12}$$

where the index for observation number is suppressed. I_1^* is the net profit from condo organization relative to apartment organization, X_1 is a vector of structural and locational characteristics, and e_1 is the shock to relative profits encountered by the building developer. In the usual way, we do not observe I_1^* but only the decision, so we define $I_1 = 1$ if the building is a condo, and $I_1 = 0$ if not. Then

$$P\left(I_1 = 1\right) = P\left(e_1 > -X_1\beta_1\right) \tag{13}$$

and on the assumption that e_1 is normally distributed,

$$P\left(I_1 = 1\right) = 1 - \Phi\left(-X_1\beta_1\right) = \Phi\left(X_1\beta_1\right) \tag{14}$$

where Φ is the normal cumulative distribution function.

Stage 2 asks, given condo organization, whether a unit with specified characteristics will be owner-occupied or rented by unit's owner. Again, there are unobserved benefits and costs accruing to each decision, summarized by:

$$P\left(I_2\right) = P\left(e_2 > X\beta_2\right) \tag{15}$$

where we define the observable decision as $I_2 = 1$ if the unit is owner-occupied and $I_2 = 0$ if not. However, the owner-occupation decision is of necessity conditioned on the decision that the building be organized as a condo. Thus there is a selectivity issue if the unobservables that inform the second decision are correlated with those of the first. This suggests the joint estimation of stage 1 and 2 by maximizing the log likelihood function

$$\log L = \sum_{I_1=0} \Phi\left(-X_1\beta_1\right) + \sum_{I_1=1,I_2=0} \Phi_2\left(X_1\beta_1, -X_2\beta_2, \rho_{12}\right) + \sum_{I_1=1,I_2=1} \Phi_2\left(X_1\beta_1, X_2\beta_2, \rho_{12}\right) \tag{16}$$

where Φ_2 is the bivariate normal cumulative distribution function and ρ_{ij} is generically the correlation coefficient of e_i and e_j (Poirier 1980).

Turning now to the property values equation, we propose a standard hedonic equation of the form

$$\log value = X_3\beta_3 + e_3 \tag{17}$$

we note that there is also a selection issue here, since we only observe values in the case where the building is condo, and the owner elects to owner-occupy. Given that the unobservable quality features that informed the previous decisions also influence the price we have

$$E\left(e_3 \mid I_1 = 1, I_2 = 1\right) = \rho_{13}\xi_1 + \rho_{23}\xi_2 \tag{18}$$

with

$$\xi_1 = \frac{\phi(X_1\beta_1)\left(1 - \Phi\left(\frac{X_2\beta_2 - \rho_{12}X_1\beta_1}{(1-\rho_{12})^{1/2}}\right)\right)}{\phi_2(X1\beta_1, X_2\beta_2, \rho_{12})} \tag{19}$$

and

$$\xi_2 = \frac{\phi(X_2\beta_2)\left(1 - \Phi\left(\frac{X_1\beta_1 - \rho_{12}X_2\beta_2}{(1-\rho_{12})^{1/2}}\right)\right)}{\phi_2(X1\beta_1, X_2\beta_2, \rho_{12})} \tag{20}$$

as in Lahiri and Song (2005) and Hotchkiss and Pitts (2005). The variables ξ_1, and ξ_2 can be consistently estimated upon obtaining the parameter estimates from (16). Consistent estimates of value in the face of these two selection problems can be obtained through the least squares regression

$$value = X_3\beta_3 + \rho_{13}\xi_1 + \rho_{23}\xi_2 + e_3 \tag{21}$$

on the owner-occupied condos only.

Having obtained consistent estimates of the value function for condominiums, our next step is to derive the bid functions that underlie it. As noted in the hedonic literature (for example, Rosen 1974, Epple 1987) the hedonic function is the upper envelope of bids from different segments of the heterogenous pool of demanders. If the heterogeneity is due to resource constraints – characterized here as wealth, but in Rosen (1974) as income – then normality and concavity of the utility function ensures a single crossing to any pair of bids, and a matching between quality – here characterized as square footage – and wealth. The estimated bid function is a function that maps demographic and resource characteristics of the (successful) bidder, along with the structural characteristics, into the marginal price of the characteristic. That is, for some characteristic X^j we write the bid function as

$$\frac{\partial V}{\partial X^j} = Z\omega + X_3\tau + e_4 \tag{22}$$

where the dependent variable is the derivative of the hedonic function with respect to the characteristic – the marginal bid for a unit of that characteristic. Z is a vector of personal characteristics. Rosen (1974) suggested that the estimation of what is in effect a Hicksian demand function is subject to the same kind of endogeneity bias that "ordinary" supply and demand estimation suffers from. In housing market applications, it is reasonable, however to assume (and we do so here) that housing supply is exogenous.

Nevertheless, Bartik (1987) and Epple (1987) note that another kind of simultaneity is present. The hedonic function is by design nonlinear in the characteristics. It must be in order for there to be variation in the dependent variable of (22). The marginal price and quantity of the attribute are simultaneously chosen. If shifts in the error term are caused by unobserved taste differences across consumers, then those shifts which (conditional on Z) cause the choice of bid price, are correlated with the characteristic quantity on the right hand side of the equation. In short, because price and quantity are chosen jointly, quantity is endogenous. To consistently estimate the bid parameters, instruments are needed. Bartik (1987) notes that the instruments must be correlated with X, but uncorrelated with tastes, and variables that shift the budget constraint are therefore valid instruments. The particular implementation that is often used (Bartik 1987, Coulson and Bond 1990) is to allow the hedonic function to vary across (geographic) markets. The assumption is that hedonic variation is due to supply constraints and not differences in the distribution of unobservable tastes. Then market-specific variables – market binaries, for instance, but also these binaries interacted with Z – can serve as instruments. As Bartik (1987) notes, non-housing expenditure (or wealth) is an appropriate member of Z, which implies that total resources (i.e. total wealth) would be an appropriate instrument, when interacted with regional binary variables. We follow this procedure below, and estimate proxies for both total and non-housing wealth from the PSID data.

7. Empirical Results

In this section we present the three-stage estimation of the hedonic price function for condominium units. The first stage, recall, estimates the probability that the building in which the housing unit is located is jointly owned using condominium governance or solely owned. The second step estimates the probability that the specified unit, conditional on it being a condo, is owner-occupied (such that the value is observed). These two steps are estimated jointly in a maximum likelihood framework. The third step is estimating the hedonic function itself, conditional on the two selection criteria being fulfilled. While fully efficient estimates are realized only if the third step is estimated jointly with the first two, consistent estimates are possible in a two stage procedure, where the second stage merely adds the appropriate Mills ratios to the hedonic model.

7.1. Data

Our data source is the 2011 American Housing Survey national sample. The AHS is a biennial survey of housing units and occupants conducting by the US Department of Housing and Urban Affairs. Table 1 outlines some initial facts about the survey.

There are 186,448 housing units surveyed. We eliminate those for which some basic information is not available, particularly tenure status, structural status (single or multifamily) or key structural characteristics. We also eliminate mobile homes and public housing. About 75,000 units' records were set aside, primarily because the building was not a permanent structure (i.e. mobile home), not a "typical" housing unit (e.g. group quarters), the unit was vacant, or a household member was not available to interview. Of the remaining 110,132 observations, the table indicates that just over 27,000 (25 percent) are in multifamily buildings. Of these 4,900 (18 percent) are condominium units, of which half are occupied by their owners, and the others rented to other parties. Presumably, the solely-owned multifamily buildings are renter-occupied. The difference between owner-occupied units in multifamily buildings and owner-occupied condo units represents almost 900 owner–occupier–landlords, who solely-own a multifamily building, occupy one unit and rent the remainder. Our interpretation is based on the fact that 65 percent of these owner-occupied units in non-condo buildings are located in duplexes, and, as noted above, 96 percent are found in buildings with 12 or fewer units. It seems plausible that owners would also be managers in such small buildings. Overall, the descriptive statistics exhibited here are similar to what has been found in the US Census.

Table 2 lists, for units in multifamily structures, means and standard deviations, stratified by three main tenure-ownership groups. In the first panel, the data summary is presented for units in solely owned buildings, in the second rentals in condo buildings and in the third, owner-occupied condos. The most obvious takeaway is that there are quality differences, sometimes substantial ones, across these various ownership arrangements. In particular, both types of condo units are larger, and embody more structural amenities, than rental units. Note also that condo units are, on average, newer, although this is partly due to the fact that in most states condominium and cooperative ownership arrangements were not permitted prior to the early 1960s. There are also notable differences between owner-occupied condos and rental condos, the latter being of lower quality than the former. These quality differences are expected, if only because of the greater tax advantages that higher quality units bring to owner-occupiers. These differences are important, since the observable quality differences may also herald unobservable quality differences which must be accounted for later.

A final element of data that we require is to impute wealth for our sample of AHS households. We estimate wealth functions using the Panel Survey of Income Dynamics that can be used to predict wealth for respondents to the AHS. The exact procedure is described in Appendix A.

7.2. Hedonic Function Estimation

Turning now to the estimation of the three stage hedonic model, note that we first cull from the sample observations with unrealistic rents (< \$50 per month) or values (< \$1000). In both cases these are either properties with extremely low quality, not arms-length transactions, or transcription errors, so that it is appropriate to delete them. We also exclude condominiums with prices that exceed $\$2,000,000$ because they exert undue influence on the estimated coefficients, causing several to inflate dramatically. In estimating these models it is useful to have "identifying variables" – i.e. variables that influence the choice of condo ownership that do not influence the decision to owner-occupy, and variables that influence the choice to owner-occupy but do not influence value (Lahiri and Song 2005). This can most easily be seen in the third stage estimation, where the bivariate Mills ratios are entered into the linear regression model of value. If the regressor set in each stage is similar, there can be collinearity issues between the Mills ratios and the determinants of value.

Aside from the nonlinear transformations of the characteristics vector that are used in the construction of the Mills ratios, valid exclusion restrictions appear to exist in the differing functional forms regarding the age or vintage of the building. Given the legal restrictions that prevented the establishment of condos before the early 1960s (and the costs of subsequently converting a rental building to condo ownership) the probability of a building with a pre-1960 vintage being in that category is lower than similar buildings of later vintages. Similarly, changes in tax laws regarding the homeownership deduction, depreciation, and passive losses as part of both the 1982 Economic Recovery Tax Act and the 1986 Tax Reform Act will change the likelihood that a building built during the appropriate windows will be a condo rather than a rental building. We therefore create three variables: $builtpre1960$, $built6080$, and $built8085$ to represent three distinct building vintages, with vintage post 1985 as the baseline category.[8] These are all used in the estimation of (22). In the ownership and hedonic regressions, however, the actual age of the building is used as a regressor, since this more accurately represents the changes in the utility flow from the building as it ages. This re-specification the age and vintage effects across models aids in the identification of the parameters of the hedonic function.

Additionally, the existence and tenure status rely on state laws, so that in the bivariate probit models we use state fixed effects. However, the geographic area that encompasses a housing market is generally thought to be similar to a metropolitan area. Thus in the hedonic function that models house prices, we eschew state fixed effects in favor of MSA fixed effects. The fact that multiple MSAs are in many states, and that MSAs often cross state lines creates additional exclusion restrictions that aid in identification.

The results of the first two (jointly estimated) stages are in Table 3. There are three notable results. The first result is that both condo and owner-occupied probability are strongly associated with unit quality. Almost every observable quality dimension has a coefficient that is both economically and statistically significant, although there are some deviations from this general rule. This confirms an earlier point, that the motives of housing consumers are influenced by the tax incentives to owner-occupation. Higher quality units are more likely to be condos, and owner-occupied condos. The second result is, corresponding to Figure 1, that the probability of a building being a condo is strongly, and nonlinearly, associated with the number of units. Figure

[8]The AHS does not measure vintage more finely than that for vintages before 1995.

6 (which is a smoothed curve of the average predicted probability of condominium ownership across building sizes) shows a steeply rising probability of condo ownership, followed by a flattened profile of this probability, as in Figure 1. It must be noted, however, that the polynomial cannot imply a flattening of the probability profile over larger unit counts, and that beyond 20 units or so, the implied probability rises with the unit count more strongly than that implied by Figure 1.

Moving to the probability of owner-occupation, it is of substantial interest to observe that the probability of being owner-occupied is not a function of the number of units. This is highly suggestive: our theoretical model suggests that there are strong investment motives that govern the organization of building ownership. However, we have also noted in this section that the probability of condo ownership might also be influenced by tax incentives of housing consumers. If the unit count were a consumption motive for building organization (i.e. was indicative of higher quality) we would expect it to be a significant determinant of owner occupation, but it is not. Therefore the importance of unit count is strictly as it pertains to investment motives, as suggested by the theory. The third result is that, the test of correlation between the residuals of these two stages indicates that the hypothesis of no correlation can be rejected; accounting for selectivity is important, presumably because omitted quality variables influence both decisions.

We turn now to the estimation of the value functions. As noted previously, we stratify the sample by geographic markets – in this case, Census regions. Note that we still include binaries for metropolitan areas, so that intra-regional variation in the hedonic functions is still allowed, but we restrict this variation to intercept terms. The marginal valuations of structural attributes are homogenous within regions, but heterogeneous across. The functional form uses value as the dependent variable (and not, say, its log) and the nonlinearity required to create sufficient variation is created by allowing floorspace to be entered as a cubic polynomial. The number of units is also entered in the regression as a cubic. Table 4 presents these estimates in which the dependent variable is value in thousands of dollars and the coefficients for the cubic polynomials as well geographic variables are suppressed. The parameter estimates vary substantially across regions, especially for the quality binaries such as fireplace, air conditioning, and the like. They also exhibit considerable heterogeneity in the unit count polynomial, but very few of these parameters are significant at standard levels of type I error. The number of bathrooms and the floor of the unit are all large and significant. Importantly, the polynomial factors of square footage are jointly significant, but even the linear term is not estimated particularly precisely. Of equal interest is the fact that the two Mills ratio terms do not have statistically significant coefficients, except in the West, indicating that the unobserved quality factors that determined condo and ownership probabilities do not seem to have a particularly definable impact on the price of the unit.

7.3. Bid Functions

The final stage in this exercise is to estimate bid functions for various wealth levels and unit counts. As a first look at the data from this point of view, we first estimate a bivariate nonparametric relationship between price per square foot and number of units. This is contained in Figure 7. The purpose of the bid function estimation is to map portions of this curve to various wealth groups. In particular, the theory model, which presents theoretical bid curves for various wealth groups, predicts that if low wealth investors invest in real estate, they will only do so for buildings of small size, i.e. low unit counts. If that occurs, we should also observe a downward (in unit count) sloping bid function for those low wealth investors. At higher unit counts, however, higher wealth investors should be the winning bidders, but at this point, the slope of the bid functions for these wealthier people should be relatively flat or even upward sloping.

We use the value functions for the four regions in the previous sections to compute marginal prices-per square foot of interior floor space. These are displayed in Figure 8. Note that there are, as desired, differences across the four regions (although the South and Midwest are fairly similar) with the West having the highest marginal prices. As discussed above, these marginal floorspace prices are calculated for each owner-occupied condo and become the dependent variable in the estimate of (22). In order to most clearly see the difference in marginal bid functions for different wealth groups we split the sample into two parts, labeled "Low Wealth" and "High Wealth" with the dividing line at the approximate median wealth level of $\$240,000$. We separately estimate (22) for these two groups. We include the income of the household and the age of the household head as the demographic variables, Z, and include the housing characteristics from above as well. As noted, the unit square footage is included here, but is clearly endogenous, and so we instrument using regional binaries and these binaries interacted with total wealth. The cubic polynomial of unit count is importantly included as well. The results are displayed in Table 5 (geographic variables are suppressed).

The coefficients of importance are first of all, that of unit square feet itself, which is negative for both high and low wealth households, as is quite appropriate for bid functions that display diminishing marginal rates of substitution. Note furthermore that the slope is greater for low wealth households, indicating that high wealth households outbid low wealth ones for larger units. More importantly for our purposes, note the coefficients for the polynomial in the number of units. From the linear terms, we can directly see that, for low unit counts at least, there is a pronounced negative slope for the bids from low wealth households, and that the bids from high wealth households are relatively flat. In Figure 9 we present bid functions for low and high wealth households that are otherwise identical (in both X and Z).[9] Low wealth households are observed to be very sensitive to unit count, and by extension to the free rider problem. High wealth households are not as sensitive to this, and so as the free rider problem worsens, and the expense from condo management rises, they begin to outbid low wealth households at around 35 units, in bigger condo buildings. This is exactly what our theory would predict.

8. Conclusions

The literature on housing tenure has largely failed to address the type of housing which households occupy, focusing instead on the households themselves. This paper confronts the trade-offs incurred by the need or desire to co-own buildings. We find that while small multi-family buildings are particularly disadvantaged for condo ownership – and this comprises much

[9] X are set at approximate means for condo owners in the Seattle CMSA. The unit is 1000 square feet, with 1.5 baths and a full set of amenities, and was built in 1985. The head's age is set at 50 years and income is set to $80,000.

of the U.S. multifamily housing stock – economies of scale in the cost of third-party management may make joint ownership valuable in relatively larger buildings. In particular, the empirical estimation of bid functions confirms that wealthier households will tend to outbid the less wealthy for ownership of condominiums in larger buildings. These insights have implications for our understanding of homeownership in cities. For example, they may help to explain phenomenon like the differential rate at which housing units in certain types of buildings filter down to lower income occupants (Rosenthal 2015).

We also note that the theoretical and empirical results in this paper rely on an underlying legal system that effectively addresses governance issues with respect to owner contributions towards common building expenses, like water and sewer charges. This may not be an appropriate assumption in some legal environments and the failure of legal institutions to enforce such rights will further reduce the likelihood of observing joint ownership arrangements like condominiums. Conversely, the failure of laws to support landlord rights *vis a vi* tenants may result in a preference for joint ownership arrangements (Casas-Arce and Saiz 2010).

Our results also shed light on the fundamental correlation between single family structures and ownership. The reason that single family homes are owner-occupied is that maintenance for smaller units does not scale up, at least under traditional business models. Unit size aside, it is surely more difficult to manage 500 (possibly dispersed) single family units than one building with 500 units. This issue is of vital importance due to the large amount of newly-vacated homes in the wake of the recent housing crisis. The conversion of these properties to rental units by large investors is underway, although it surely remains to be seen whether this is sustainable practice in the long run.[10]

[10] See, for example, Olick (2013), although other reports (Hallman and Berman 2013) reinforce our point that maintenance is indeed quite costly to scale up in single family portfolios.

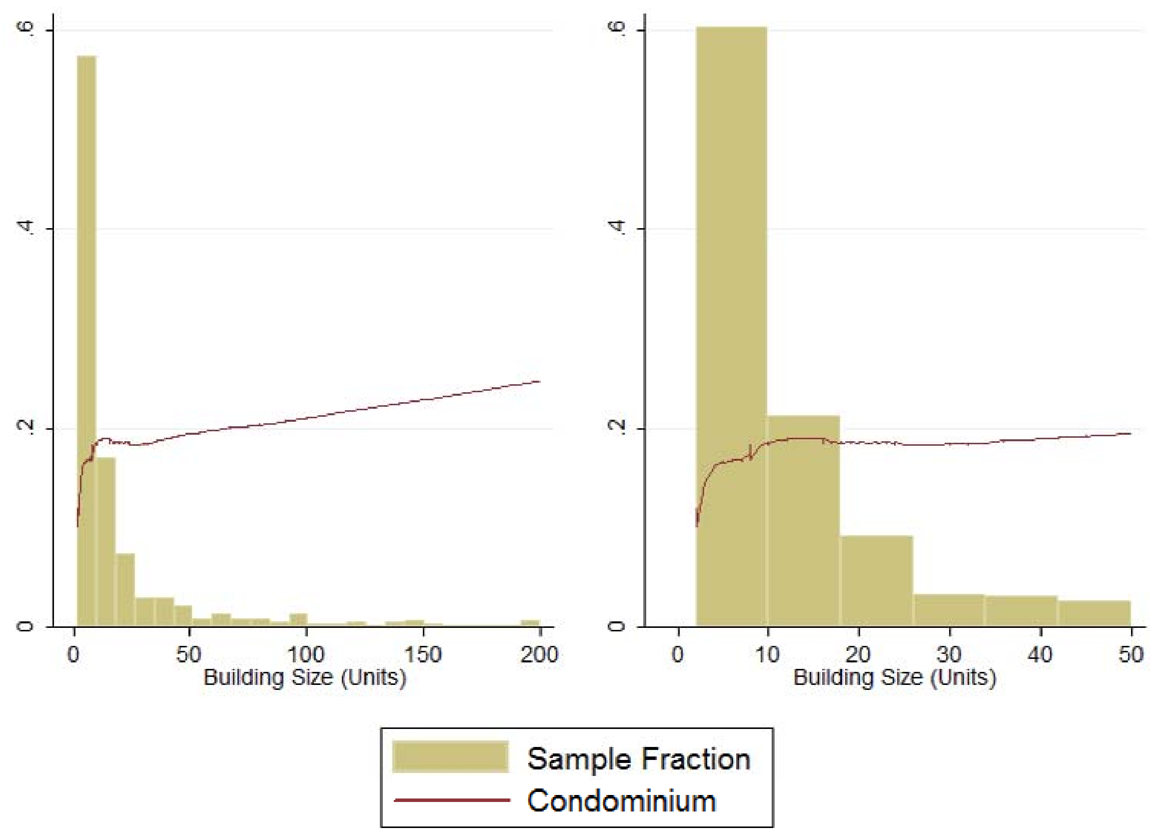

Figure 1: Condo Ownership Share of Units, All Multifamily

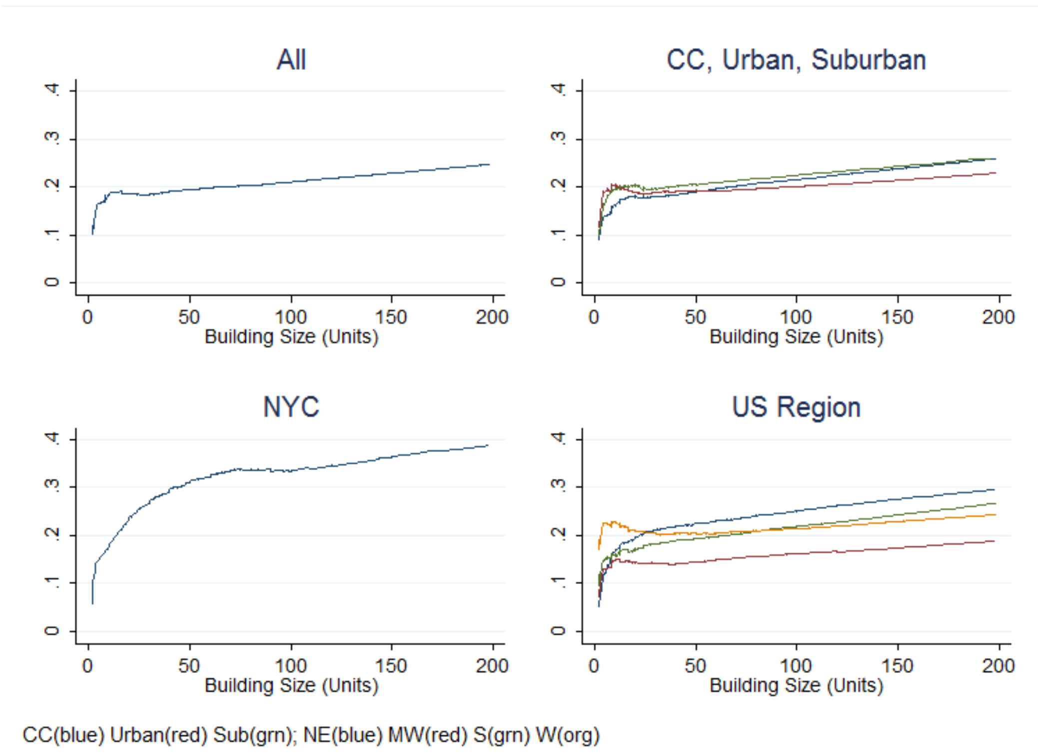

Figure 2: Condo Ownership Share of Units, Subsamples

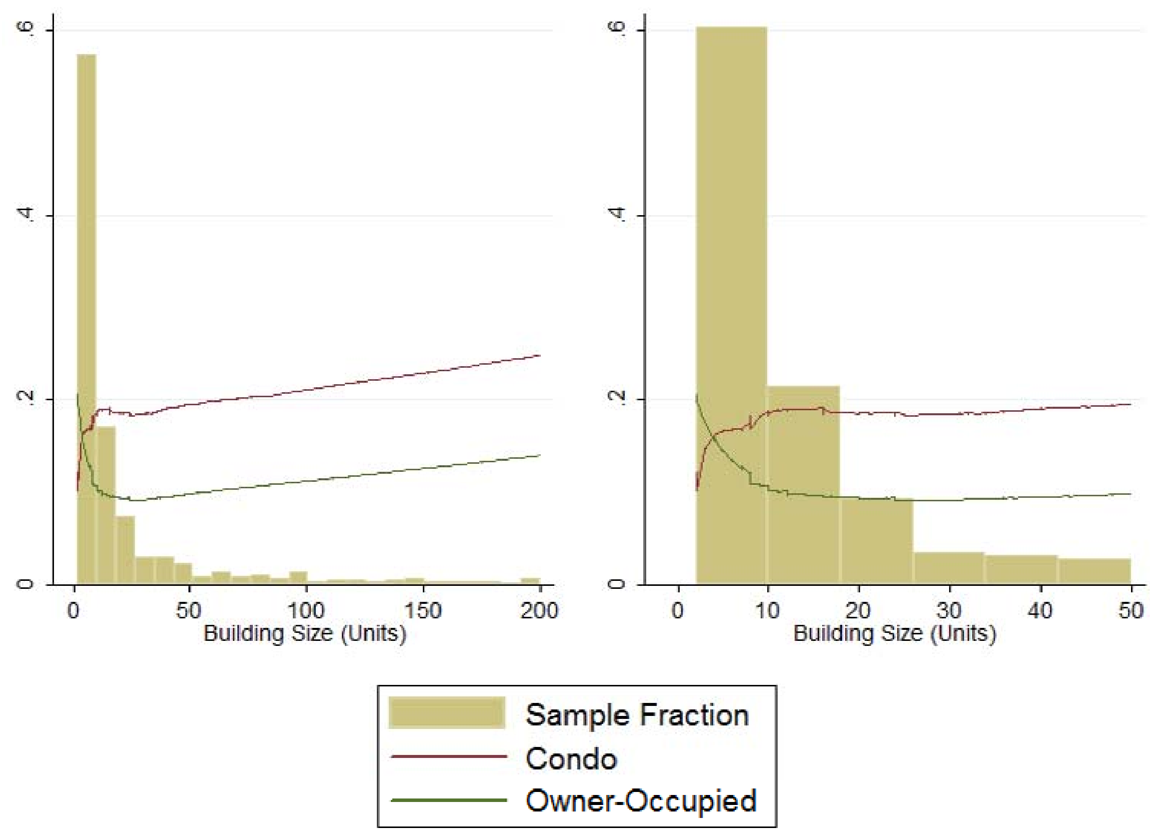

Figure 3: Condo Ownership and Homeownership (Share of Units)

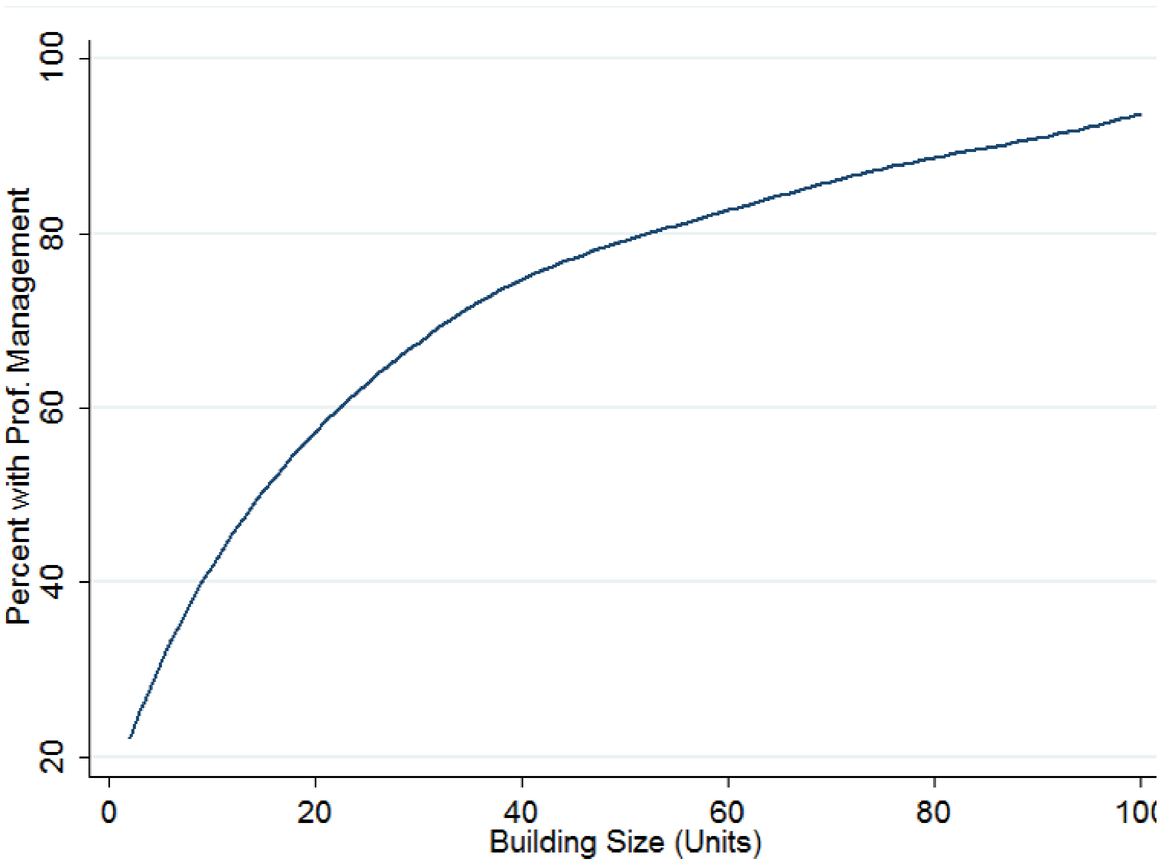

Figure 4: Professional Management in Condominiums

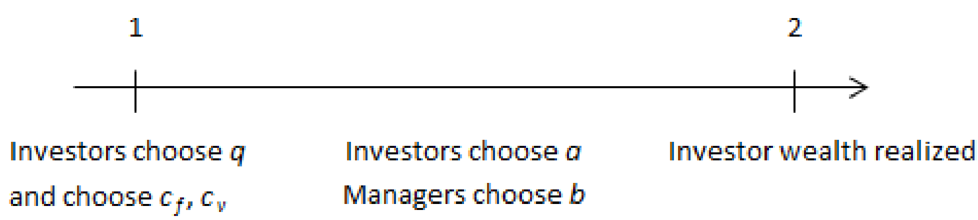

Figure 5: Model Timeline

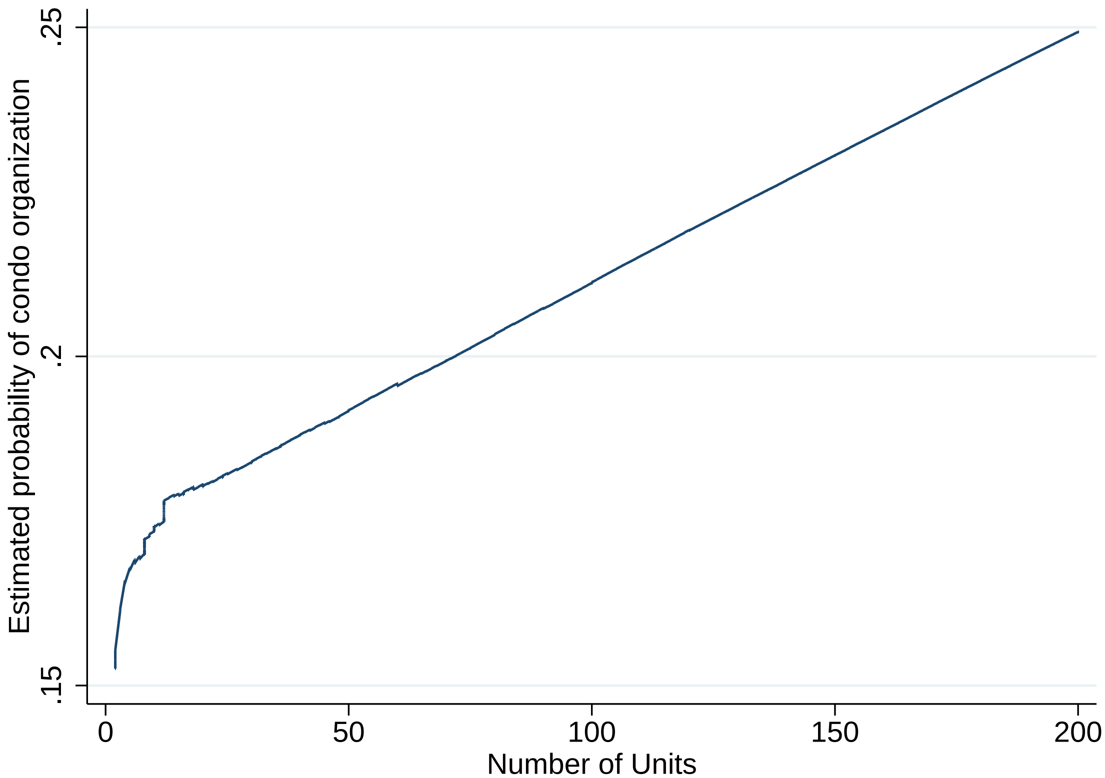

Figure 6: Predicted Probability of Condo Ownership

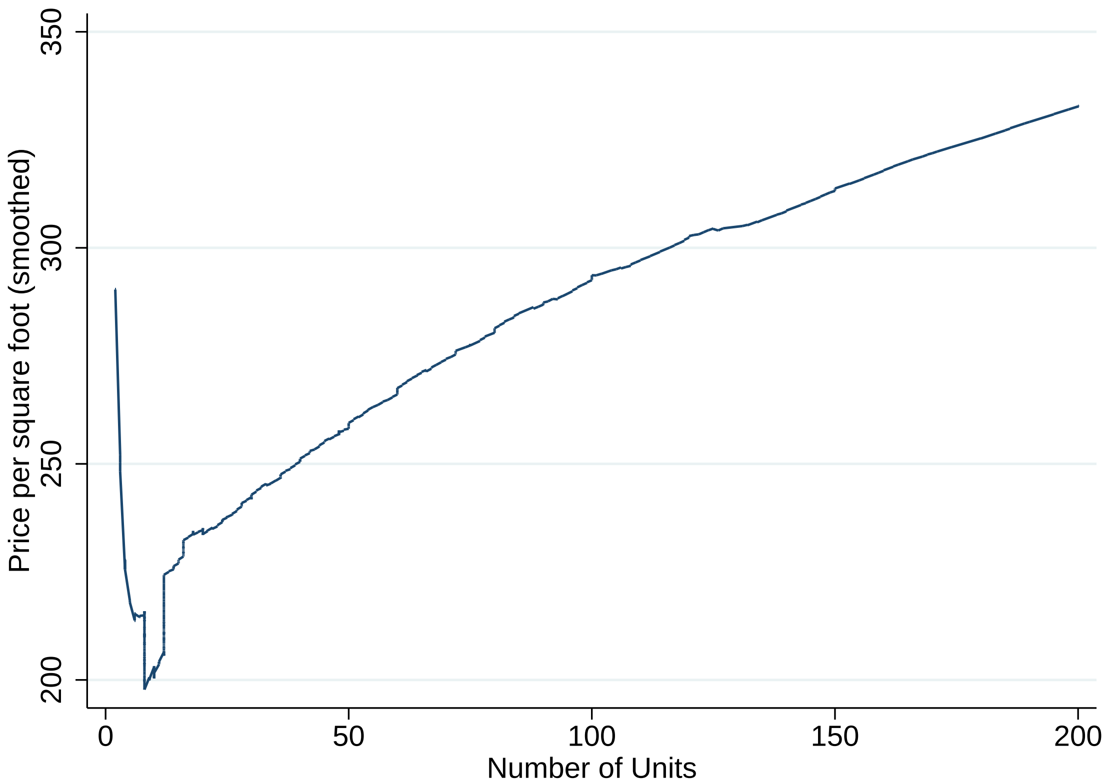

Figure 7: Smoothed Condo Price Per Square Foot and Building Size

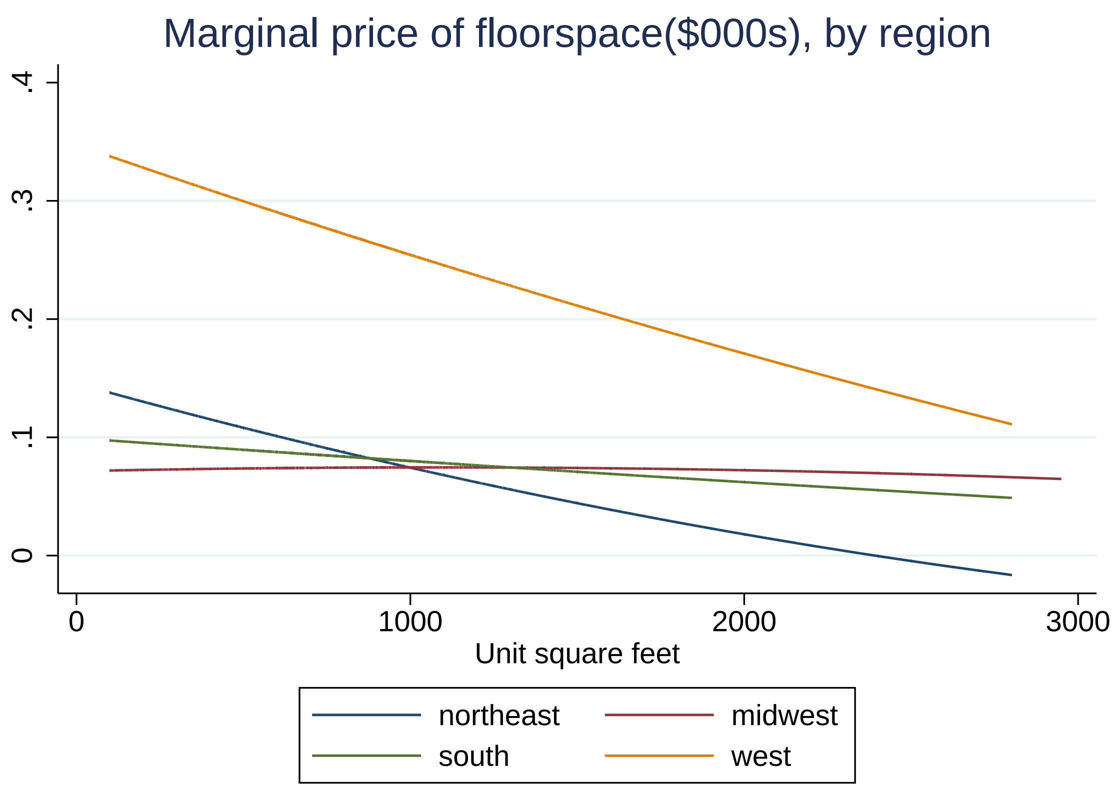

Figure 8: Predicted Bids for Marginal Quality by Region

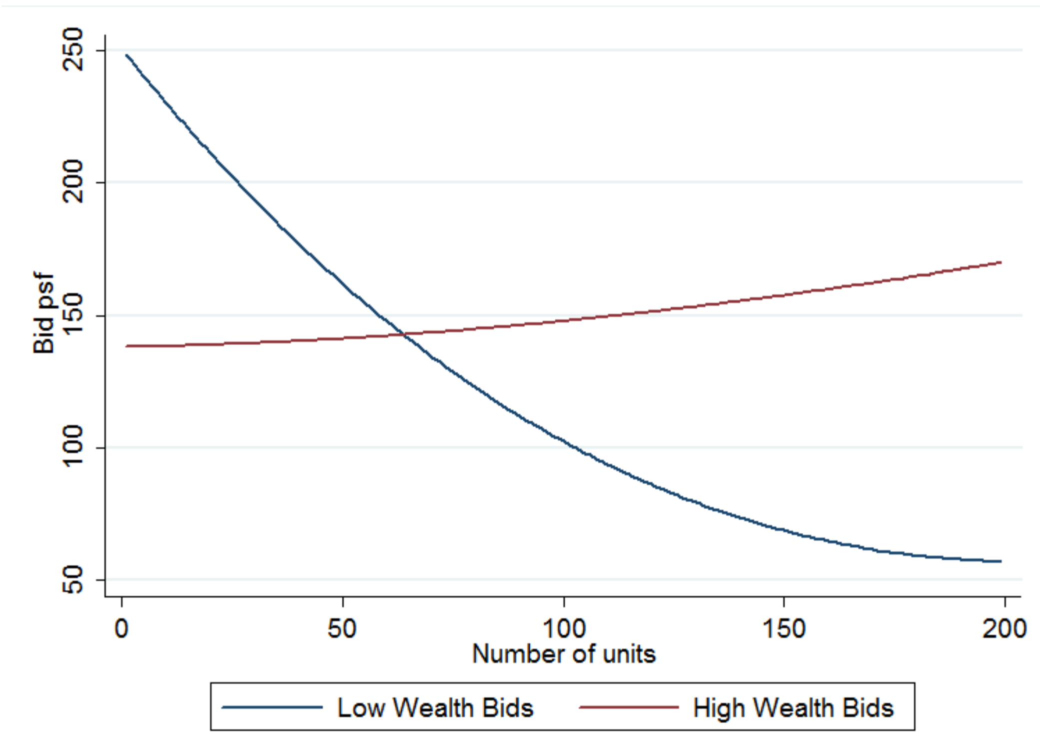

Figure 9: Predicted Bids by Low and High Wealth Households

Table 1: 2011 AHS Sample

	Housing Units			
Total Records	186,448			
Mobile Homes, etc.	-5,586			
Public housing	-4,217			
Missing data	-66,513			
Sample Housing Units	110,132			
	Single Family		**Multi-family**	
Total Housing Units	83,077		27,055	
Owner-Occupied	68,890	(83%)	3,324	(12%)
Units in Solely-Owned Bldg			22,154	
Units in Condo Bldg			4,901	
Owner-Occupied			2,427	(50%)

Homeownership rates shown in parentheses.

Table 2: Sample Statistics for Units in Multifamily Builidings, 2011 AHS

	Rental Bldg Unit		**Condo Rental**		**Condo Own-Occ.**	
	(N = 22,154)		**(N = 2467)**		**(N = 2434)**	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Number Units	29	64	39	84	43	89
Unit SF	917	841	1000	765	1349	1176
Baths	1.19	0.43	1.35	0.51	1.59	0.58
Half Baths	0.11	0.35	0.19	0.45	0.29	0.51
Fireplace	0.12	0.32	0.21	0.41	0.35	0.48
Porch	0.67	0.47	0.76	0.43	0.84	0.37
A/C	0.52	0.5	0.65	0.48	0.67	0.47
Garage	0.33	0.48	0.47	0.55	0.68	0.47
Yr. Built	1966	25	1974	21	1975	23
Central City	0.46	0.5	0.42	0.49	0.44	0.5
MSA, not CC	0.49	0.5	0.52	0.5	0.52	0.5

Table 3: Estimates of Probability of Condo Ownership, Owner-Occupation

Dependent Variable:	Condo	Owner-Occupancy
No. Units	0.0043***	0.0005
	[0.000]	[0.001]
No. Units Sq.	-1.3E-05***	-2.04E-06
	[0.000]	[0.000]
No. Units Cu.	9.90E-09***	1.26E-09
	[0.000]	[0.000]
Floor		0.0160**
		[0.007]
Baths	0.4059***	0.1702*
	[0.021]	[0.100]
Half Baths	0.3836***	0.0731
	[0.023]	[0.078]
Fireplace	0.3827***	0.0725
	[0.026]	[0.090]
Porch	0.1246***	0.1530**
	[0.024]	[0.065]
A/C	0.1355***	-0.016
	[0.023]	[0.050]
Garage	0.4244***	0.3026**
	[0.021]	[0.125]
Unit SF	0.0001***	0.0001***
	[0.000]	[0.000]
Yr. Built	0.0027***	-0.0067***
	[0.000]	[0.001]
Constant	-6.7298***	13.2685***
	[0.952]	[1.857]
Observations	27,055	27,055

Standard errors in brackets
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Estimates of Hedonic Price Function

	Northeast	Midwest	South	West
Number Units	0.3371	0.7327***	0.3023	1.8577***
	[0.63]	[0.27]	[0.36]	[0.42]
Units Sq	-0.0013	-0.0028***	-0.0009	-0.0052***
	[0.00]	[0.00]	[0.00]	[0.00]
Units Cu	0.0000	0.0000**	0.0000	0.0000**
	[0.00]	[0.00]	[0.00]	[0.00]
Floor	9.0509***	10.6551***	8.1431***	15.2199***
	[2.89]	[2.08]	[2.22]	[2.63]
Baths	109.68**	29.60*	30.19*	166.13***
	[48.41]	[16.20]	[17.46]	[27.95]
Half Baths	56.56	13.64	22.44*	127.26***
	[47.50]	[14.85]	[11.76]	[26.28]
Fireplace	82.02*	-2.35	-6.12	163.38***
	[42.64]	[16.02]	[16.42]	[25.91]
Porch	-11.5535	3.8005	-9.8611	9.7387
	[27.19]	[15.77]	[19.81]	[21.69]
A/C	-7.8825	-27.7735*	-59.3312*	-47.3837***
	[27.94]	[16.73]	[34.19]	[17.08]
Garage	-47.9825	-14.5952	16.6931	88.5543***
	[40.32]	[18.45]	[16.34]	[30.71]
Unit SF	0.1455**	0.0714**	0.0993***	0.3475***
	[0.07]	[0.03]	[0.02]	[0.06]
Unit SF Sq	0.0000	0.0000	-0.0000**	-0.0000**
	[0.00]	[0.00]	[0.00]	[0.00]
Unit SF Cu	0.0000	0.0000	0.0000	0.0000
	[0.00]	[0.00]	[0.00]	[0.00]
Yr Built	-1.4724***	0.8662***	-0.1921	-2.0333***
	[0.44]	[0.28]	[0.33]	[0.34]
ξ_1	-53.94	-22.61	-38.01	338.08***
	[128.73]	[34.87]	[41.47]	[80.27]
ξ_2	76.9003	9.5392	46.9811	-53.1543
	[53.32]	[24.77]	[30.27]	[39.22]
Constant	3,000.37***	-1,666.13***	409.91	2,992.19***
	[908.13]	[541.30]	[654.40]	[694.20]
Observations	361	420	506	1,105
Adjusted R-squared	0.41	0.36	0.27	0.40
Standard errors in brackets				

Standard errors in brackets
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5: Estimates of Bid Function

	LowWealth	HighWealth
Unit SF	-0.0004***	-0.0003***
	[0.00]	[0.00]
Number Units	-0.0012***	0.0001
	[0.00]	[0.00]
Units Sq	0.0000***	0.0000
	[0.00]	[0.00]
Units Cu	-0.0000***	0.0000
	[0.00]	[0.00]
Income	0.0000	0.0000
	[0.00]	[0.00]
Head HH Age	0.000	0.0007*
	[0.00]	[0.00]
Yr. Built	-0.0005	-0.0006*
	[0.00]	[0.00]
Constant	1.3111	1.3456**
	[1.22]	[0.68]
Observations	788	1,604

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Note: IV regression. Coefficients for housing characteristics and geography not shown.

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A. Appendix

We use the 2011 wave of the PSID; data on persons defined as household heads were downloaded, although total household wealth is the variable of interest. The response coding in the PSID is different from that used in the AHS, which required adjustments to the PSID responses. For instance, in coding education levels, the PSID uses responses 1 through 16 to code actual grad levels completed, while the AHS uses response 31 to code completion of first to fourth grades. For added predictive power, polynomials of age and income are also included in the specification. To additionally aid in the predictability of the sample, we eliminated observations with very large (over $\$4,000,000$) or very negative (less than $-1,000,000$) wealth. It is literally impossible to predict wealth that great or that far underwater using demographic variables. There were 47 observations all together in those two categories.

The R-squared of the wealth regression is 31 percent which, while not large, is respectable for this sort of exercise. The coefficients are sensible; age maps into wealth in a highly nonlinear manner, as would be expected, however wealth seems to be a linear function of income. The schooling and ethnic coefficients coincide with prior expectations, however it is of interest to note that those with between 1 and 10 years of schooling seem to do worse than those with no schooling at all (the omitted category). Figure A.1 displays the density of both wealth (solid bars) and predicted wealth (clear). The regression model accurately reproduces the skewed nature of the wealth distribution displayed in the PSID, however it under-predicts the fraction of participants with wealth near the mode of the actual distribution and under- predicts the number with slightly higher amounts of assets.

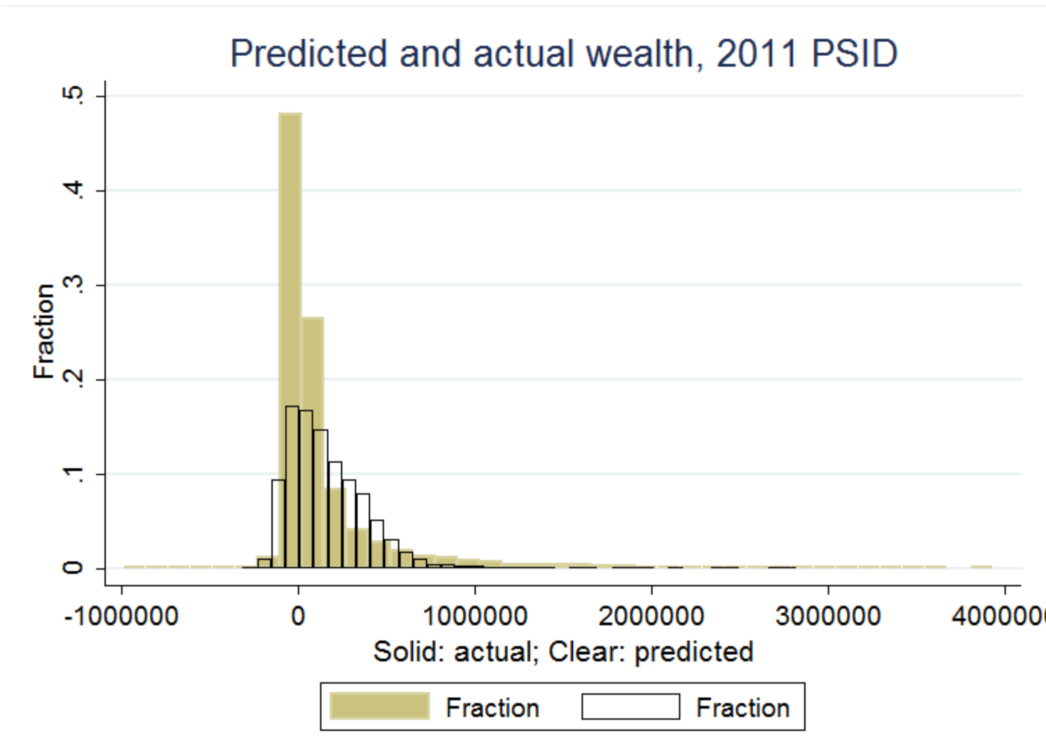

Figure A.1: Actual and Predicted Wealth