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Housing busts and household mobility ☆

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ABSTRACT

Using two decades of *American Housing Survey* data from 1985 to 2007, we revisit the literature on lock-in effects and provide new estimates of the impacts of negative equity and rising interest rates on the mobility of owners. Both lead to substantially lower mobility rates. Owners suffering from negative equity are one-third less mobile, and every added $1000 in real annual mortgage costs lowers mobility by about 12%. Our results cannot simply be extrapolated to the future, but they do have potentially important implications for policy makers concerned about the consequences of the housing bust that began as our data series ended. In particular, they indicate that we need to begin considering the consequences of lock-in and reduced household mobility because they are quite different from those associated with default and higher mobility.

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1. Introduction

How do housing busts affect residential mobility? The housing market downturn that started in 2006 has raised fears that local communities will suffer as social capital is depleted due to foreclosures that force defaulting homeowners to move. Approximately 240,000 homes were repossessed by banks just during the second quarter of 2009, which is nearly triple the number over the same time period in 2007.[1] Default-induced moves are always the first mobility-related impact observed during a downturn[2], but they need not be the last or the most important economically. In fact, much previous research indicates that falling home prices or rising interest rates that typically are associated with housing market declines can 'lock-in' people to their homes—reducing, not raising mobility. (Quigley, 1987; Stein, 1995; Genesove and Mayer, 1997, 2001; Chan, 2001; Engelhardt, 2003).

Mobility can fall during a housing bust for various reasons. Housing finance researchers tend to focus on financial constraints that arise when low or negative housing equity and rising interest rates require the owner to put up additional cash beyond standard closing costs to be able to move (Stein, 1995; Chan, 2001). However, falling house prices are not necessary to generate a financial lock-in, as Quigley (1987) has shown. Because home mortgages generally are not assumable, if interest rates rise, the household may not be able to afford the debt service payments on a new loan that would be used to finance the purchase of the new residence, even if that house is no more expensive.

Prospect theory offers another mechanism by which mobility might be affected. For example, the loss aversion literature suggests that a household without any financial constraint can become less mobile if nominal loss aversion leads the household not to sell the home after its price has fallen. Initial research in this area primarily addressed the impact of nominal losses on time on the market conditional on the decision to sell, not on longer-run mobility *per se* (Genesove and Mayer, 1997, 2001). Engelhardt (2003) then found that loss aversion also leads to reduced mobility based on analysis of a sample of younger households.

The literature provides solid evidence that both the financial constraint and loss aversion mechanisms affect household mobility. We do not attempt to distinguish between these mechanisms in this paper, focusing instead on the overall impact of those financial frictions on household mobility. We revisit the net impact on

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[1] These data are from RealtyTrac, an online marketer of foreclosed properties. There were nearly a million foreclosure filings over this same period according to this source. Thirty-seven percent corresponded to pre-foreclosure defaults, 38% to a notice of auction, and 24% to bank repossessions. This highlights the fact that just because one enters the foreclosure process does not necessarily mean that a foreclosure or move will occur, as the foreclosure process takes at least a few months, and many defaults are cured. Also, see Gerardi et al. (2008) for a recent study of the rise in defaults and foreclosures among subprime borrowers in Massachusetts.

[2] The homeowner's default option is well studied in the real estate finance literature. See Deng et al. (2000).

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mobility because a new, more general, empirical analysis is useful for better gauging the size of the potential lock-in effects.

While previous empirical work suggests that the net effect of both negative equity and higher mortgage interest rates on household mobility is both negative and economically large, much of that research works with special samples that are restrictive in terms of geographic, temporal, or demographic coverage.[3] To ascertain whether we can reliably generalize from those results, we conduct a new analysis using national data from the biennial *American Housing Survey* (*AHS*) that covers metropolitan areas across the United States from 1985 to 2007. We estimate negative equity and interest rate effects in the same specification, as well as control for a host of other factors thought to influence household mobility. This approach reduces the likely omitted variable biases that could affect more narrowly defined studies which focus on one particular mechanism by which mobility might be affected, or on a single market or demographic group.

Our analysis begins by specifying a baseline empirical model of the household relocation decision that relies on the foundation established by Hanushek and Quigley (1979) and Venti and Wise (1984). The estimated impacts of lock-in on mobility are as large or larger than those reported previously. For example, having negative equity reduces the 2-year mobility rate by 4 percentage points (*ceteris paribus*), which is one-third of baseline mobility. A $1000 higher real annual mortgage interest cost is estimated to reduce mobility by 1.4 percentage points, or by about 12% of the baseline rate. We also test the impact of another financial friction that arises from property tax laws that provide incentives for homeowners that do not move to a different house.[4] The result is similar to the lock-in due to mortgage costs: a $1000 higher property tax benefits reduce mobility by 1 percentage point. Finally, the mobility effects of these financial frictions are shown to be robust to a number of specification checks.

Our findings cannot simply be extrapolated to the future because housing market conditions are not the same over time. For example, the subprime market was much smaller over most of our sample period, so the underlying risk associated with borrowers probably was lower in the past. In addition, our sample is restricted to owner-occupied homes and excludes investors and second homes, both of which may respond differently to negative equity situations (Haughwout et al., 2008).

However, the results do raise important questions about policy responses going forward because the social and economic consequences are markedly different depending upon whether negative equity or higher mortgage interest rates lower, rather than raise, mobility. Instead of dislocation from post-foreclosure moves, reduced mobility leads to inefficient labor market matching.[5] Reduced mobility also results in lower utility from not being able to access desired levels of housing or local public services if, for example, household size changes or children pass into or out of school attendance age.

The plan of the paper is as follows. The next section documents past and recent changes in market conditions that raise the potential for lock-in effects to become economically important once again. Section 3 follows with the specification of our econometric model of household mobility. The data used in the estimation are described in Section 4, with the empirical results reported and discussed in Section 5. The penultimate section then outlines the implications of reduced mobility. There is a brief conclusion.

2. Housing market conditions and implications for mobility

There have been pronounced shifts over time in house values, leverage, and mobility rates in some local housing markets. For example, California housing markets experienced a substantial boom and bust during the span of years from 1985 to 1997. Data from the *AHS* for metropolitan areas in that state show a peak in mean nominal house prices of $253,617 in 1989, with an average loan-to-value (LTV) ratio of 67%, and a 2-year mobility rate of just over 15%.[6] Prices in California then began to fall around 1991, but did not bottom out until 1997 when mean house prices reached $201,693, with an average LTV of 78%, and a 2-year mobility rate of only 11.7%. It was not until the 1998–1999 period that mobility returned to the pre-1989 peak levels (at 15.8%). Other markets, such as Boston, that also experienced sharp swings in house prices and loan-to-value ratios over time show similar mobility patterns.

Some, but by no means all, metropolitan areas have experienced very high house price volatility over the past few years, raising the prospect of future changes in mobility in these places especially. The San Francisco area is a prime example of a market that boomed from the mid-1990s through the first half the current decade, but recently has begun to experience sharp price declines. Fig. 1 depicts the evolution of mean and median nominal prices in the San Francisco market since the recent housing boom began in 1997.[7] The typical sales price rose fourfold from about $200,000 to $800,000 between 1997 and 2007, before beginning to fall. There has been a 21% decline in prices from that peak to 2008 (Q2). The most recent data from the S&P/Case-Shiller house price index for this market show a 45% decline in nominal prices from a peak in May 2006 to a (temporary perhaps) trough in May 2009, so there is no doubt that prices have dropped by substantial amounts.[8]

Because the extent to which a steep decline in housing prices might trigger a lock-in effect also depends on high levels of housing debt, Fig. 2 documents the very high loan-to-value ratios (LTVs) that became common in the Bay Area market. Mean and median LTVs are plotted for the same six county region from 1997 to 2008. The typical LTV on a home purchase was fairly stable at around 80% until the end of 2002.[9] Beginning in 2003, there was a sharp increase with the median LTV hitting 90% in 2004. Loan-to-value ratios stayed at that high level for a few years, but have

[3] For example, Quigley's (1987) analysis of mortgage interest rate lock-in effects, which found that a 200 basis point increase in rates was associated with about a one-third lower probability of moving over an 8-year horizon, worked with data from the 1979 to 1981 *Panel Survey of Income Dynamics*. Chan's (2001) study, which concluded that mobility was from one-quarter to one-third lower when equity constraints were present, was restricted to observations from the New York City metropolitan area. Engelhardt's (2003) study was based on the *National Longitudinal Survey of Youth* (1985–1996) and focused on younger owners who were most likely to be constrained.

[4] The empirical analysis uses Proposition 13 in California – see Ferreira (2007). All details of this property tax law are presented in Section 4.

[5] On a related topic, see Oswald (1999) and Green and Hendershott (2001) for studies of the relationship between homeownership rates and unemployment rates. One difference between their line of inquiry and ours is that they were interested in how relative differences in transactions costs of owning versus renting could affect mobility, and thus, unemployment rates. The financial frictions we consider certainly can be thought of as transactions costs, and we show they reduce mobility markedly. However, our empirical analysis focuses exclusively on homeowners, so we cannot make comparisons with renters.

[6] Prices and LTVs were calculated from a sample of recent movers who had occupied their homes for less than 2 years. Mobility rates use the full sample of homeowners.

[7] These data represent all housing transactions from the first quarter of 1997 through the second quarter of 2008 that were recorded in the six county region that comprises the heart of the Bay Area: Alameda, Contra Costa, Marin, San Francisco, San Mateo, and Santa Clara counties. The data were purchased from DataQuick, an industry data provider. No adjustments are made to control for quality shifts in the homes that sell in any particular quarter. The total number of transactions follows a similar pattern, as shown in Appendix Fig. A1.

[8] The S&P/Case-Shiller data for this market may be downloaded at http://www2.standardandpoors.com/portal/site/sp/en/us/page.topic/indices_csmahp/0,0,0,0,0,0,0,0,0,1,1,0,0,0,0,0.html.

[9] Information is available on up to three loans used to finance the home purchase. Our LTV figures are based on all reported mortgage debt, not just the first loan.

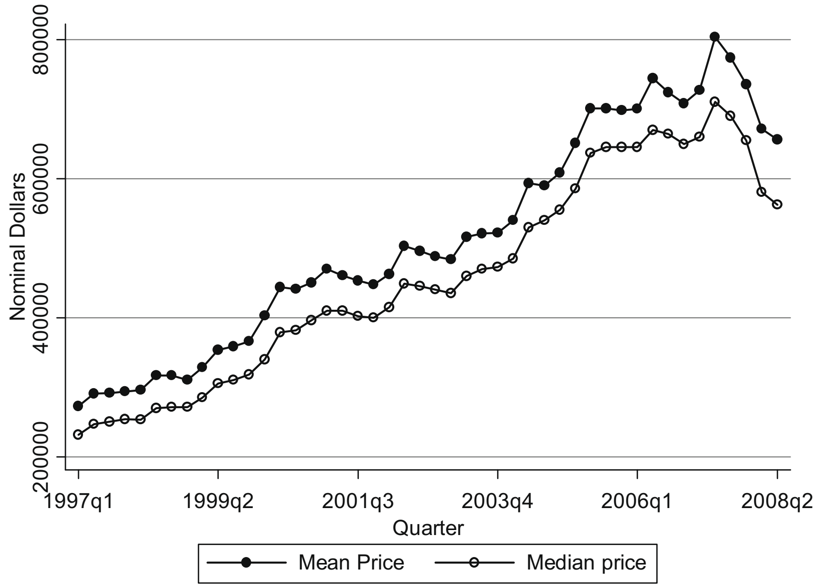

Fig. 1. Mean and median quarterly sales prices, SF Bay Area. Notes: calculations based on all housing transactions in the San Francisco Bay Area based on data from DataQuick.

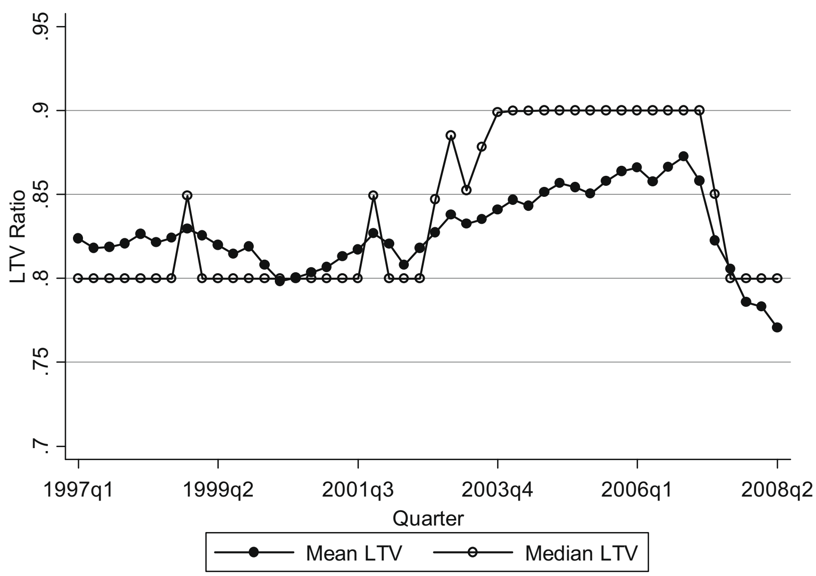

Fig. 2. Mean and median LTVs, SF Bay Area. Notes: calculations based on all housing transactions in the San Francisco Bay Area using data from Dataquick. LTVs are calculated by dividing the value of all mortgages taken by a homeowner by the price of the house.

come down since then, returning to the 80% level in the most recent data we have. Essentially, the typical new home buyer in the Bay Area bought a house for $800,000 in 2006 using a $720,000 mortgage. Given the more recent price declines implied by the S&P/Case-Shiller series, the underlying value of that house financed in 2006 is now well below the typical mortgage balance taken out that year, so both financial constraints and loss aversion could come into play in this market.

Fig. 3 reports information on the proportion of homeowners with different leverage amounts over time. Data are provided for four categories of LTVs: 0–75, 75–85, 85–95, and more than 95%. In the late 1990s, barely 10% of Bay Area borrowers had LTVs above 95%. That number then rose significantly from 2002 to 2006, ultimately reaching about 35% of buyers. Calendar year 2007 saw a fairly sharp decline, but 1-in-5 purchasers still bought a home with less than a 5% equity down payment that year. Over 50% of home buyers in the Bay Area in 2006 had leverage levels above 85%.[10]

Of course, owners also may be locked into their existing homes if mortgage interest rates rise. This may have been an important

[10] A large fraction of mortgages in 2005 and 2006 actually have LTVs of 100%. This was possible because of very lax lending standards, whereby banks based their lending on assessed values rather than on selling prices. Given the high expectations about price appreciation, assessed values were usually higher than transaction prices in those years. That said, not everyone took out high leverage, even in this market. Just under 10% of purchases were for all cash in most years of our sample period. Even more people pay down their loans, of course, with about one-third of all US homeowners having no debt on their homes according to the most recent *American Housing Survey* data (see Tables 3–15 at www.census.gov/prod/2008pubs/h150-07.pdf for the detail on the distribution of loan-to-value ratios across owners nationwide.).

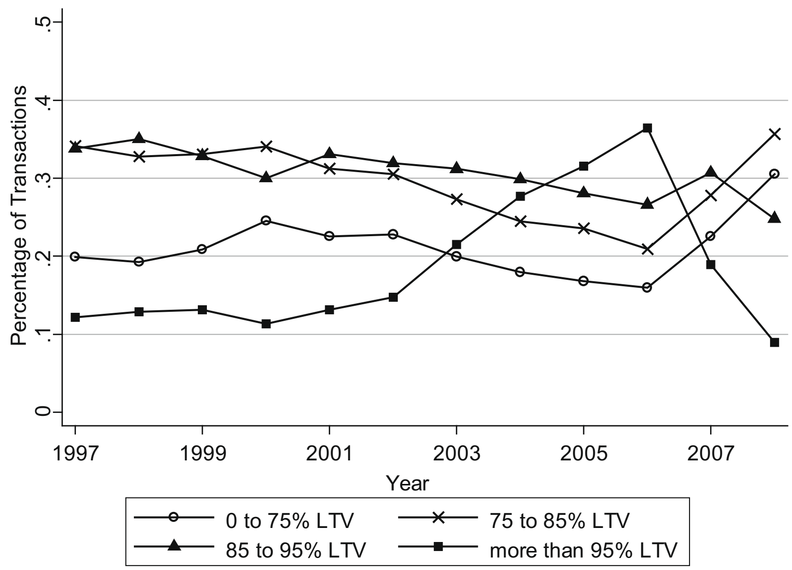

Fig. 3. Distribution of LTVs over time, SF Bay Area. Notes: calculations based on all housing transactions in the San Francisco Bay Area using data from Dataquick. LTVs are calculated by dividing the value of all mortgages taken by a homeowner by the price of the house.

constraint for borrowers who needed a jumbo mortgage to finance a trade-up purchase. From 2003 to 2006, the average spread between prime jumbo and prime conforming mortgage rates was 26 basis points. As financing dried up in the jumbo market in the Fall of 2007, the interest rate spread between prime jumbo and prime conforming mortgages widened significantly, reaching 150 basis points in late March of 2008.[11]

It will take time to know how mobility in the Bay Area and other markets experiencing similar price and leverage volatility will be impacted. We can, however, determine what happened in past cycles and what factors drove any changes. It is to that effort that we now turn.

3. Econometric model of household mobility

We begin by specifying a baseline empirical model for household relocation decisions that follows in the tradition established by Hanushek and Quigley (1979) and Venti and Wise (1984). For each household, we assume that the decision to move between survey periods is based on comparing the indirect utility associated with staying in the current residence with that of moving to a new residence. This new residence could be in the same metropolitan area or involve a longer distance move. A move takes place if the monetized value of the gain in indirect utility exceeds the transactions costs involved with the move.

Motivations for moving can include a wide variety of "quality-of-life" reasons, as well as job-related reasons. Examples of the former include the desire for a different amount or type of housing, a different set of neighborhood amenities, or a different set of natural/cultural amenities. Job-related moves can reflect factors such as reducing the commute time to work, as well as taking a new job in a different labor market. Factors such as having negative equity or higher interest rates can change the cost-benefit calculus of moving.

We summarize these numerous factors involved in a household's mobility decision by a latent index, I_{it}^*. This index captures the monetized net change in indirect utilities less the transaction costs of a move. We normalize this index so that a household is assumed to move between periods when this index is positive, and to remain in its current residence otherwise. Eq. (1) represents a simple linear specification for this latent index,

$$I_{it}^* = X_{it}\beta + \varepsilon_{it} \tag{1}$$

where X_{it} captures observed factors that affect household mobility and ε_{it} is a random error term.

For each household (i) and time period (t), there is an observed indicator, I_{it}, which takes a value of 1 if the household moves over the coming time period, and 0 otherwise. Thus,

$$I_{it} = \begin{matrix} 1 & \text{if } I_{it}^* > 0, \text{household moves} \\ 0 & \text{otherwise}, \ \text{household stays} \end{matrix} \tag{2}$$

We assume that the random error term has a normal distribution.

Further, let P_{it} denote the probability that the household moves between period t and the subsequent period. This probability of moving is characterized as follows:

$$P_{it} = \Pr(I_{it}^* > 0) = \Pr(X_{it}\beta + \varepsilon_{it} > 0). \tag{3}$$

Using data on I_{it} and X_{it}, we will estimate β using a Probit model.[12]

An alternative estimation approach is to focus on the current years of tenure of the household rather than on the mobility probability, P_{it} (e.g., Wasi and White, 2005). To contrast approaches, assume for the moment that a house only experiences transitions from one owner to another owner with no intervening periods of renting. By way of illustration, consider a house that was built five periods ago. The probability that we currently observe a housing tenure (T) of five periods is given by

[11] We computed these spreads with data obtained from a Bloomberg screen. The underlying data source is BankRate.

[12] Other research on this topic has employed a proportional hazard framework. We use a Probit for many of the same reasons that labor economists have employed it in their empirical work—namely, its flexibility. See Han and Hausman (1990) for an example. Both approaches readily can take non-linearities into account. All the factors that we really care about such as time, location, time-varying covariates, and variables that control for duration dependence (which are discussed more fully in the next section) can be controlled for within our estimation framework. Essentially, there is no relevant facet of a proportional hazard model that we cannot include within a Probit specification.

$$\Pr(T_i = 5) = \prod_{n=1}^{5}(1 - P_{it-n}). \tag{4}$$

That is, observing a current tenure of five periods given the initial condition on when the house was built implies that the household that initially moves into the new house does not move over the next five periods. Similarly, the probability that we currently observe a housing tenure of four periods is given by:

$$\Pr(T_i = 4) = P_{jt-5}\prod_{n=1}^{4}(1 - P_{it-n}). \tag{5}$$

In this case, after residing in the house for one period, household j sells the house to household i, after which household i then stays in the house for the next four periods.

The important thing to note about these two simple examples is that the likelihood associated with the current years of tenure in the house is a product of a set of current and historical mobility probabilities. If we model each mobility probability as in (1), then the current tenure is a function of current *and* past values of the explanatory variables for the current and possibly previous households. However, the typical empirical specification applied to cross-section data relates current tenure only to current values for the explanatory variables. We can see, though, that for time-varying explanatory variables such as the lock-in effects that are the focus of this study, the current tenure specification will not produce coefficients that have a ready interpretation. For this reason, we choose to directly model the mobility probabilities.

4. Data

The *AHS* is the primary data source for our estimation of tenure mobility probabilities. Since 1985, the *AHS* has been conducted every 2 years on a continuous panel of houses. The *AHS* contains a unique identifier for each house, an indicator for whether the house is currently owned or rented, and the year in which the house was purchased if the unit is owned. We restrict our analysis to owned houses. It is noteworthy that our sample likely is devoid of speculators: the survey process is such that the responding household is the primary resident of the home, and questions are clearly asked to identify tenure status.[13]

For this subsample, the house identifier and purchase year allow us to follow a household over time. If a household continues to reside in the house over the 2 year period between surveys, we observe this as the same purchase year associated with that house. If a household moves residences over the 2 year period between surveys, we observe this as a new purchase year associated with that house.[14] Since the *AHS* is a house-based, not a household-based panel, we cannot follow the household to its new residence, nor do we observe any information about the location of this new residence.

We restrict the sample to single detached homes located in a metropolitan area and owned by a household head between 21 and 59 years of age. The timing convention is as follows: the mobility indicator captures moves between the survey conducted in year t and the subsequent survey conducted in year $t + 2$. Changes in household or neighborhood characteristics refer to changes between the survey conducted in year t and the prior survey conducted in year $t - 2$. For households in their first survey since moving in, these changes are set to zero.

The *AHS* contains a rich set of detailed demographic information about each owner-occupied household which is useful in helping to control for the many other forces which influence mobility. We employ several *AHS* variables as controls, starting with those used by Quigley (1987). One set is family size and changes in family size. Family size may proxy for a variety of costs of moving, while changes in family size may trigger a move as households attempt to optimize their housing space per capita. Other standard controls include a set of characteristics of the household head such as age, race, and education.[15] In addition to these characteristics, we include the sex of the household head, marital status and the change in marital status of the household head. Holding constant the change in family size, the nature of the change in family size as captured by changes in marital status may have important mobility implications. Quigley (1987) also controlled for family income. In addition to the level of family income, we allow for changes in family income to affect mobility. In particular, we allow for asymmetric effects between gains and losses in family income.

We further expand on Quigley's specification using some additional information provided in the *AHS*. The *AHS* identifies first-time homebuyers, so we include an indicator for first-time buyers to capture any systematic differences in their mobility relative to trade-up purchasers. Because the *AHS* provides the year the household bought the house, we are able to calculate the length of time that the household has lived in the current residence. We control for duration dependence in the mobility decision by including a 3rd order polynomial in the current duration. The *AHS* also asks households to rate the quality of their neighborhoods. We code two indicator variables capturing whether the household reported a significant improvement or a significant decline in the neighborhood quality between surveys in order to ascertain whether changes in the local area affect mobility.

4.1. Financial friction variables: data and definitions

We are particularly interested in the roles of negative equity and increasing interest rates, which tend to vary significantly over the cycle and help characterize housing busts. To measure negative equity, we first construct the homeowner's current LTV ratio using the value of the mortgage balance and the owner's self-reported current value of the house. We code an indicator that takes a value of one when the current LTV exceeds 100%.

We follow Schwartz (2006) to determine mortgage rates, assuming that for fixed rate loans the first reported interest rate, term and mortgage balance are the most accurate.[16] We then use the annual average mortgage rate on 30-year fixed-rate mortgages to measure the rate a household would receive on a new mortgage. The annual payment difference is computed assuming that the new mortgage would match the existing mortgage's balance and duration. We control for the real annual difference in mortgage payments, where we set any negative payment differences to zero.[17]

The *AHS* also can be used to investigate another monetary friction akin to the one created by higher mortgage interest rates. This friction arises from California's Proposition 13, which has been

[13] Consider an investor who misrepresents his occupancy status as owner-occupied to a lender. If the house is rented and part of the overall *AHS* sample, the tenant would respond to the survey that she rents. If the house is vacant and listed to be sold, it would not be included in our sample. Mortgage-based data, in contrast, would list the property as owner-occupied.

[14] We use demographic information on the household to help edit the panel structure of the data in order to eliminate false moves that would be generated by measurement problems with the purchase year. Information on all data cleaning and sample preparation procedures are available upon request.

[15] Where Quigley assumed linear age and education effects, we allow for nonlinear effects. We enter age as a 3rd order polynomial, and for education we include indicators for graduating from high school, attending some college, graduating from college, and attaining post-graduate education.

[16] For these mortgages, we hold the mortgage balance constant at this initial reported value when calculating the current LTV discussed earlier.

[17] Quigley (1987) also included a measure of the present value of this difference in mortgage payments over the remaining life of the mortgage.

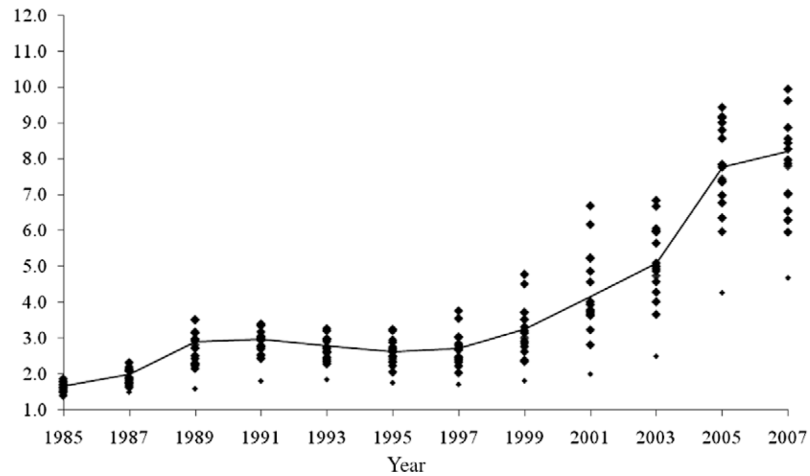

Fig. 4. Cumulative house price appreciation in California since 1978. Notes: each dot represents the cumulative price appreciation since 1978 for a metropolitan area in California based on the Freddie-Mac conforming house price index. The solid line represents the overall sample weighted average.

recently studied by Wasi and White (2005) and Ferreira (2007). Proposition 13 essentially required that the maximum property tax could not exceed 1% of house value at the time of purchase, plus some minor annual adjustments. The *AHS* provides information on the homeowners' self-reported house value as well as their current annual property taxes, so for residents of California we create a tax subsidy variable which is equal to the difference between 1% of the self-reported house value and the reported annual property taxes. For non-CA residents this tax subsidy variable is set to zero. Because this variable also is denominated in dollar terms, it provides a useful gauge of the reliability of our estimates of mortgage lock-in effect. As discussed below, a dollar of added cost should have the same impact on mobility no matter the underlying source of that cost (e.g., higher interest rates or higher property taxes).

4.2. Financial friction variables: measurement error and attenuation bias

Each of our key financial variables relies on self-reported values, so it is likely they are measured with error. There is a lengthy literature on such errors in self-reported housing data (e.g., see Kain and Quigley, 1972 for the seminal work), with Bayer et al. (2007) more recently noting that self-reported house values tend to be less accurate for homeowners that moved-in less recently. Therefore wide swings in house prices over time tend to increase dispersion of the self-reported house values. Schwartz (2006) also points to measurement error (in interest rates) as a source of concern in her research.

Measurement errors are known to cause attenuation bias (see Greene, 2007 for a description), which suggests that using these variables directly will result in underestimating any lock-in effects. The standard solution to this problem is to develop an instrumental variable estimator. Our strategy mimics the work of Ashenfelter and Krueger (1994). They developed an alternative measure for the "treatment" variable of interest, and then used that alternative measure as the instrumental variable.

We construct alternative measures for each one of the lock-in treatment variables. The instrumental variable for negative equity is an indicator variable, based on whether our alternative measure of house equity is negative. In lieu of using self-reported house values, our new house equity variable is constructed using the purchase price of the house and any house price appreciation implied by the Freddie Mac repeat-sales price index for the relevant metropolitan area.[18]

The instrumental variable for mortgage lock-in is created by substituting the average mortgage rate on 30-year fixed-rate mortgages during the year in which the house was purchased for the self-reported interest rate. Following this, the real annual difference in mortgage payments is calculated as described above.

The property tax subsidy variable is also constructed from two self-reported variables. To help address the likely measurement error, we create an instrument defined as the difference between the growth in the metropolitan area repeat-sales house price index and the maximum allowed growth in the property tax over the same period, all multiplied by the fully assessed property tax on the purchase value of the house. Obviously, the value of the implied subsidy still is zero for non-California households.

4.3. Proposition 13 as a robustness check on other financial frictions

Since the Proposition 13 lock-in variable is measured in dollar terms, it provides a natural benchmark for judging the magnitude of the interest rate lock-in variable, which is also measured in dollars. More specifically, the different variables should have a similar impact on household mobility decisions for a given dollar change in their worth.

Because this tax subsidy measure is our most important robustness test regarding the magnitude of our estimates, some of its properties are examined here. We focus exclusively on positive subsidies and set all negative values of the variable equal to zero. Since the property tax wedge is a function of the degree of house price appreciation, it is useful to get a picture of the different housing markets in California over our estimation period. Fig. 4 shows the distribution of cumulative growth in house prices since 1978 as measured by metropolitan area level repeat-sales price indices. The line represents the weighted average cumulative price growth, where the weights are the share of observations from each metropolitan area in our estimation sample. The figure makes clear that there is considerable cross-sectional heterogeneity in the rate of price appreciation. This heterogeneity in house price appreciation is reflected in the implied property tax subsidies. Fig. 5 then displays different percentiles of the tax subsidy for California residents over time. This heterogeneity will allow us to include

[18] See: http://www.freddiemac.com/finance/cmhpi/current/excel/msas.xls.

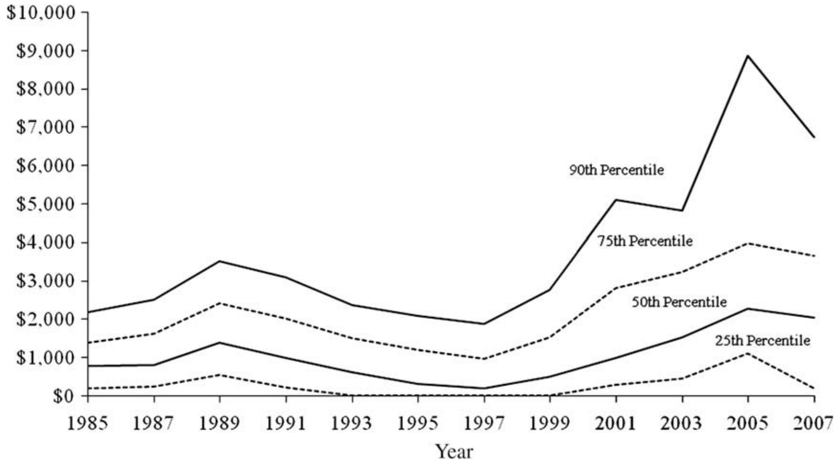

Fig. 5. Distribution of property tax subsidies in California over time. Notes: data from the *AHS* 1985–2007. The property tax subsidy is calculated as the difference between actual property tax payments (based on historical prices) and the counterfactual tax payment based on current prices and is expressed in 2007 dollars.

California-specific year effects in our mobility specification to sweep out any omitted time effects that might be specific to that state.

5. Empirical results

Descriptive statistics for our sample, which is comprised of 61,803 observations, are provided in Table 1. All monetary variables are expressed in constant 2007 dollars. The average 2-year mobility rate for the estimation sample is 11.4%. Only 3% of our observations involve a household in a negative equity situation, although this fraction varies widely across markets and time, as discussed above.

Table 2 then provides our baseline estimates of the determinants of residential mobility. The coefficients can be interpreted as changes in the 2-year mobility rate.[19] In addition to a range of covariates, each specification also controls for metropolitan area fixed effects, as well as for region-specific and California-specific year effects. This sweeps out much variation and helps guard against us conflating various possible geographic and temporal trends with lock-in effects on mobility. Bootstrapped standard errors are reported as discussed in the notes to the table.

The first column of Table 2 is based on a specification that uses the unadjusted measures of the negative equity, mortgage interest rate lock-in, and Proposition 13 property tax lock-in variables based on self-reported values from the *AHS* as described above. The second column reports results using the instrumental variables for each of the three main financial descriptions. This is our preferred specification.

5.1. Financial frictions and mobility

Comparing the coefficients on the three financial frictions reported at the top of Table 2 provides empirical content to our worries about attenuation bias. The coefficients on the three financial variables in column 1 are economically small in magnitude and tend to be imprecisely estimated. Only the mortgage cost variable approaches statistical significance at conventional levels. The coefficients on the three instrumented variables reported at the top of column 2 are much larger in absolute value, and each is statistically significant at the 5% level (or close to it). This is strong evidence that attenuation bias from using self-reported variables to construct the lock-in variables is large, and that sensible instruments must be created if one wants to gauge the likely size of any mobility impacts.[20] Finally, and as expected, there is virtually no change in the coefficients on the other covariates.

The magnitude of the coefficient on the negative equity variable reported in the first row of column 2 of Table 2 indicates that the 2-year mobility rate is 4% points lower if there is negative equity (*ceteris paribus*). This is just over one-third of the baseline mobility rate of 11.4%, so the impact is economically large and at the top end of range of previous results reported for this effect. The coefficient on the mortgage lock-in variable reported in the next row of column 2 implies that a $1000 annual real mortgage interest difference is associated with a 1.4 percentage point reduction in the mobility rate for households with fixed-rate mortgages, and obviously holds controlling for negative equity. This is about 12% of the baseline mobility rate, so this impact also is economically meaningful. It is both comforting and interesting to find a similar impact for the Proposition 13 variable in the third row. A $1000 annual real property tax difference for California residents generated by Proposition 13 reduces household mobility by 1 percentage point. One would expect a given dollar of financial lock-in have the same impact on mobility regardless of the source of that dollar of added cost. In fact, the data can not reject the hypothesis that the fixed-rate mortgage lock-in effect and the Proposition 13 lock-in effect are of the same magnitude.[21]

[19] As explained in Section 3, another estimation method in this literature uses current years of tenure as the dependent variable instead of mobility probabilities. Since this alternative method only relates current tenure with current values of the independent variables, its estimates could greatly differ from what we believe is a more appropriate model. Indeed, treating our data as cross-sectional, we find that such a method generates estimates for several demographic variables that have counterintuitive and opposite signs to the ones found in this paper.

[20] That the instruments are, indeed, sensible is supported by Shea's partial R^2 (t-statistics in parentheses). For the negative equity indicator, mortgage lock-in and Proposition 13 tax subsidy, respectively, they are 0.140 (101.1), 0.302 (182.2) and 0.084 (109.4). These statistics were calculated using a linear regression first stage as follows. Each individual financial friction variable was regressed on all other right-hand side variables, including the other two financial frictions. The residual was then regressed on the instrument itself to estimate the partial R^2 and t-statistic. That this variation (which by definition is orthogonal to everything else on the right-hand side) is highly statistically correlated with the instrument itself suggests that our instruments are good alternative measures of the lock-in variables.

[21] We also estimated an IV linear probability model of household mobility, and found similar results for coefficients and standard errors: negative equity: −0.051 (0.021), fixed-rate mortgage lock-in: −0.015 (0.004), and Proposition 13 lock-in: −0.011 (0.005). In addition, the standard errors of an identical IV linear probability model using clustering at the household level are virtually identical.

Table 1
Descriptive statistics.

	Mean	Standard deviation
Move	0.11	0.32
First-time homebuyer	0.50	0.50
Duration in house	8.16	7.41
Married	0.72	0.45
Single to married	0.02	0.13
Married to single	0.02	0.13
High school graduate	0.26	0.44
Some college	0.26	0.44
College graduate	0.24	0.43
Some graduate school+	0.17	0.38
White	0.84	0.37
Male	0.72	0.45
Age	42.34	8.98
Household size	3.23	1.52
Positive change in household size	0.11	0.41
Negative change in household size	0.13	0.46
Log real household income	11.23	0.79
Positive change in log real household income	0.15	0.43
Negative change in log real household income	0.16	0.52
Positive change in neighborhood quality	0.08	0.27
Negative change in neighborhood quality	0.11	0.32
Negative home equity (indicator)	0.03	0.16
Fixed-rate mortgage lock-in ($1000)[a]	0.23	0.61
Proposition 13 property tax subsidy ($1000)[b]	1.32	1.65
Recent nominal loss in house value ($1000)	0.66	2.80

Notes: Data is based on the *American Housing Survey* from 1985 to 2007.
Income, fixed-rate mortgage subsidy, property tax subsidy, and nominal loss in house value are measured in constant 2007 dollars.
[a] Conditional on household having a fixed-rate mortgage.
[b] Conditional on household residing in California.

While this gives us confidence that our mortgage interest lock-in variable is capturing what we think it should, we can also test the reliability of the Proposition 13 property tax variable by re-estimating the specification in column 2 on observations from outside California. This counterfactual tax subsidy is created as if Proposition 13's restrictions on property tax increases applied to non-California residents, too. This counter-factual Proposition 13 variable should have no impact on the mobility of non-Californians because moving does not really generate a higher property tax bill. That is precisely what we find for the non-California sample, as the coefficient on the counter-factual Proposition 13 variable is 0.001, with a standard error of 0.014.[22] Hence, this makes us confident that the Proposition 13 variable truly is reflecting the higher property taxes that would result from moving in California.

Before getting to the other covariates, we first comment on a number of other models we estimated that expand upon our baseline specification reported in column 2 of Table 2 and help serve as robustness checks on the empirical magnitudes of the lock-in effects. These results are reported in Table 3.[23]

The first specification in Table 3 adds a control for whether there was a recent nominal loss experienced by the home owner. This variable is measured continuously, and the timing works as follows. Recall from above that our mobility variable measures whether the owner moved between years t and $t+2$. Our nominal loss variable is measured over years $t-2$ to t, so the coefficient captures the effect of a recent nominal loss on the probability of moving in the next 2 year window. Because the underlying change in house prices determining this variable is self-reported and likely measured with error, we again instrument using the change in

[22] The coefficients on the negative equity and mortgage interest lock-in variables are not materially affected, but are a bit smaller. Their magnitudes (standard errors) are as follows: −0.033 (0.020) for the negative equity indictor; −0.010 (0.004) for the mortgage interest variable. The standard errors increase for the negative equity indicator because of the loss of observations from CA which is a large state with considerable house price variability.

[23] The coefficients on the other covariates are suppressed to save space. They are essentially unchanged from those reported in Table 2 and are available upon request.

Table 2
Household mobility results.

Variable	(1) Probit-no V	(2) Probit-IV
Financial variables		
Negative equity (indicator)	−0.002	−0.040**
	(0.008)	(0.018)
Fixed-rate mortgage lock-in ($1000)	−0.004*	−0.014**
	(0.003)	(0.004)
Proposition 13 property tax lock-in ($1000)	−0.001	−0.010*
	(0.002)	(0.005)
Demographics and other covariates		
First-time homebuyer	−0.009**	−0.009**
	(0.003)	(0.003)
Married	0.003	0.003
	(0.004)	(0.003)
Single to married	0.015	0.014
	(0.009)	(0.009)
Married to single	0.041**	0.039**
	(0.012)	(0.011)
High school graduate	0.018**	0.017**
	(0.006)	(0.007)
Some college	0.025**	0.024**
	(0.006)	(0.007)
College graduate	0.033**	0.032**
	(0.007)	(0.006)
Some graduate school +	0.043**	0.041**
	(0.007)	(0.007)
White	0.029**	0.027**
	(0.004)	(0.003)
Male	−0.010**	−0.010**
	(0.003)	(0.003)
Household size	−0.009**	−0.008**
	(0.001)	(0.001)
Positive change in household size	0.017**	0.016**
	(0.003)	(0.003)
Negative change in household size	0.001	0.001
	(0.003)	(0.003)
Log real household income	0.008**	0.008**
	(0.002)	(0.002)
Positive change in log real household income	0.002	0.001
	(0.003)	(0.003)
Negative change in log real household income	0.008**	0.008**
	(0.003)	(0.002)
Positive change in neighborhood quality	0.004	0.004
	(0.005)	(0.005)
Negative change in neighborhood quality	0.006	0.006
	(0.004)	(0.004)
Observations	61,803	61,803

Notes:
1. The table reports Probit marginal effects with standard errors given in parentheses. Bootstrap standard errors are reported based on 250 sample replications.
2. * indicates significance at the 10% level; ** indicates significance at the 5% level.
3. Each specification also contains a cubic in years in the current house, a cubic in the age of the household head, MSA fixed effects, region-specific year effects, and California-specific year effects. Those coefficients are available upon request. The mobility impacts of length of tenure and age are plotted in Figs. 6 and 7, respectively.
4. All monetary values are measured in constant 2007 dollars using the full urban workers CPI.
5. There are 22,156 unique households, with an average of 2.8 2-year observations per household.
6. The results in column 2 use instruments for the Negative Equity indicator variable, the fixed-rate mortgage lock-in variable and the proposition 13 property tax lock-in variable as noted below. (See the discussion in the text for more detail.)
a. Instrument for negative equity uses an estimate for the current house value based on the value of the house at purchase and the appreciation in value based on a repeat-sale house price index for the relevant metropolitan area.
b. Instrument for fixed-rate mortgage lock-in is the implied increase in mortgage payments assuming that the current mortgage interest rate is the average rate for fixed-rate mortgages for the year the mortgage was originated.
c. Instrument for proposition 13 property tax lock-in is the implied subsidy calculated using the metro-area repeat-sale house price appreciation.

Table 3
Additional results on lock-in effects.

Variable	Probit-IV regressions		
	(1)	(2)	(3)
Negative equity (indicator)	−0.035**		−0.026
	(0.017)		(0.030)
Fixed-rate mortgage lock-in ($1000)	−0.016**	−0.014**	−0.014**
	(0.004)	(0.004)	(0.004)
Proposition 13 property tax lock-in ($1000)	−0.005	−0.010**	−0.010*
	(0.006)	(0.005)	(0.006)
Recent nominal loss ($10,000)	−0.010**		
	(0.005)		
Low negative equity (indicator)		−0.032	
		(0.032)	
High negative equity (indicator)		−0.046	
		(0.029)	
Continuous negative equity			−0.001
			(0.002)
Observations	61,803	61,803	61,803

Notes:
1. The underlying sample is the same as in Table 2.
2. All financial friction variables are instrumented as discussed in Table 2 and in the text.
3. Results for all other covariates are suppressed for space reasons and are available upon request.
4. All other notes from Table 2 apply here, too.

house values implied by the relevant metropolitan area repeat-sales house price index.[24]

The coefficient of −0.010 (row 4 of column 1 of Table 3) implies that each $10,000 in recent nominal losses reduces mobility by 1.0 percentage points. Thus, there is solid evidence that recent losses are associated with lower mobility, controlling for any mobility effects from negative equity.[25] It is noteworthy, however, that this does not alter the coefficient on the instrumented negative equity indicator very much. The point estimate only falls from −0.040 (column 2 of Table 2) to −0.035 (column 1 of Table 3), so the results indicate that households in a negative equity situation still have substantially lower mobility even after controlling for any impact arising from recent reported losses on the house.[26]

We also estimated two other specifications that check to see if the mobility effect arising from negative equity varies importantly with the extent of the negative equity. They are reported in the second and third columns of Table 3. The results in column 2 are from a specification that includes two different indicators of the extent of negative equity, in lieu of the single negative indicator we have been using. The first indicator measures whether the owner has a LTV ratio of 100–113% (labeled Low Negative Equity in the Table), where 113 is the median value of those with negative equity. The second indicator is for whether negative equity is greater than the median (labeled High Negative Equity). Because self-reported house values underpin both variables, each is instrumented using indicator variables based on the relevant metropolitan area's repeat-sales price index.

The coefficients can be interpreted in the same way as for the single negative equity indicator. Thus, the −0.032 point estimate on the Low Negative Equity variable indicates that mobility is 3.2 percentage points lower than for an otherwise equivalent owner with positive equity; and the −0.046 coefficient for High Negative Equity implies that mobility is 4.6 percentage points lower than for the otherwise equivalent owner with positive equity. The relative magnitudes of these coefficients suggest that mobility declines are larger when negative equity is higher, although the data are not rich enough to provide precise estimates.

The final specification reported in Table 3 uses a continuous measure of negative equity, in addition to our standard negative equity indicator. The continuous measure also is instrumented using metro-area repeat-sales price indexes. Consistent with the results in specification (3) the coefficient on the continuous negative equity variable is negative, but is imprecisely estimated. The results from specifications (2) and (3) indicate that one cannot make fine distinctions regarding mobility based on differences in the extent of negative equity without better quality data.

In sum, we find negative equity and mortgage lock-in effects that are as large or larger than those reported in previous studies. Recent nominal losses are also associated with lower mobility. Attenuation bias from the self-reporting of house values and mortgage interest rates is very large, and it is critical that this measurement error be controlled for when estimating mobility effects. Our national sample spanning a two-decade period indicates these sizable impacts are not peculiar to more narrowly-defined samples of people, geographic areas, or time periods. While our estimates are reduced form in nature, our more general specification that includes both negative equity and mortgage interest rate effects simultaneously, as well as a host of other demographic and economic controls, increases confidence that the effects are not driven by omitted variable bias.[27]

5.2. Demographics, other covariates and mobility

Returning to our baseline specification from the second column of Table 2, we find the estimated impacts of the other demographic and economic variables broadly consistent with Quigley (1987), whose estimates were derived from hazard analysis using data from 1979 to 1981 *PSID*. For example, the first row of the results on demographic variables shows that first-time homebuyers have a lower mobility rate than other households. Duration in the house is also important, as illustrated by Fig. 6's plot of the marginal effect of years living in a house on the likelihood of a move. Mobility increases with years of tenure up to 9, and then decreases with years of tenure. This is consistent with a life-cycle pattern of housing choices where households go through several trade-up purchases before owning a home that they will live in for an extended period of time.[28]

Various demographic characteristics of the household are also important determinants of mobility. Being married is not a statis-

[24] Note that households may report a nominal loss since the last survey but still have positive equity, and households can be in a negative equity situation and still report no nominal loss on their house since the last survey. In our data, just over 16% of households with positive equity report a nominal loss since the last survey. Conversely, nearly 50% of households with a negative equity position report no nominal loss since the last survey.

[25] We also checked for evidence of a nonlinear response to this nominal loss by estimating a two-piece linear spline. We set the break point at a loss of $20,000, which is between the median and 75th percentile, conditional on a loss being reported. The results did not indicate any change in the response of mobility as the magnitude of the loss increases.

[26] There is very little impact on the mortgage lock-in effect, too. The largest impact is on the Proposition 13 property tax lock-in variable, which falls in magnitude by over 50%. We do not think much should be made of that, as statistical significance is marginal because of the measurement error discussed above and the consequent need to instrument.

[27] While we control for changes in household income as well as metropolitan area and region-specific year effects, the most worrisome potential confounder of our interpretation of the results arises from an economic shock that differentially affects high loan-to-value owners. Consider a shock that reduced house prices and employment simultaneously, but harmed the job prospects of highly leveraged borrowers more. If our income, time, and location variables do not fully control for this, it is possible that part of our estimated mobility effect could be due to the reduced employment opportunities of high leverage borrowers, not a housing lock-in mechanism. Future work should focus on accessing the magnitude of this potential confounder, as the literature to date has not properly addressed this issue.

[28] Not coincidently, this same pattern is exhibited by the typical sequence of job durations over a worker's career.

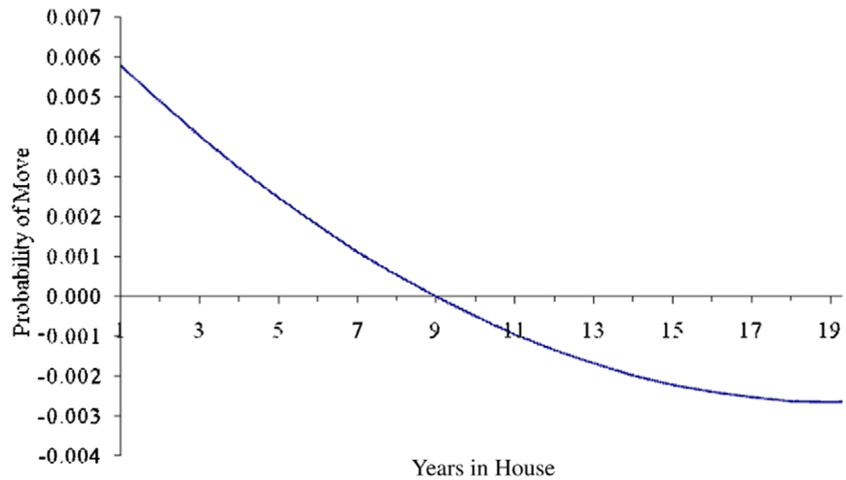

Fig. 6. Marginal effect of year in current house on mobility. Notes: figure shows the marginal impact of one additional year in the house on the probability of moving to another house. Marginal effects are estimated using Eq. (3) in the text based on the specification reported in column 2 of Table 2.

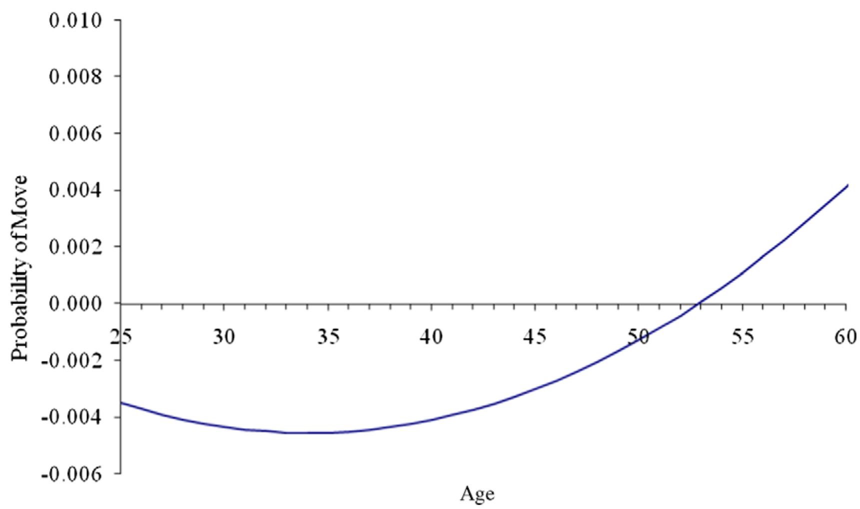

Fig. 7. Marginal effect of age of household head on mobility. Notes: Fig. 7 shows the marginal impact age of the head of the house on the probability of moving to another house. Marginal effects are estimated using Eq. (3) in the text. Baseline results shown in column 2 of Table 2.

tically significant predictor of mobility (second row of the panel of demographic coefficients), but divorce is. Transitions out of marriage are associated with much higher mobility, with the point estimate being more than double that for transitions into marriage (compare the third and fourth rows of the panel of demographic results). The next few rows show that household mobility increases with the education of the household head. A household headed by someone with at least some graduate education has a 2-year mobility rate that is 4.1 percentage points higher than a household headed by someone without a high school education (the omitted category). Whites are more likely to move than non-whites, while male-headed households are less likely to move than female-headed households.

Fig. 7 depicts the marginal effect for the age of the household head on household mobility. Each additional year of age reduces household mobility until the household head reaches his early fifties. After this point, aging raises the likelihood of a move. Finally, larger households tend to move less frequently, as indicated by the significantly negative coefficients on the household size control. This is consistent with the hypothesis that children increase the transaction costs involved in moving. However, the results in the next two rows show that, controlling for family size, mobility is higher in response to increases in family size, but is not significantly impacted by decreases in family size.[29]

Household income and its dynamics also impact household mobility. Households with higher income are more likely to move all else equal. Given a household's income level, declines in household income are associated with higher mobility. Finally, changes in neighborhood quality, whether positive or negative, are not significantly associated with changes in mobility.

6. Implications of reduced household mobility

Because market conditions differ over time and the mobility impacts play out over a period of years, one cannot simply use our point estimates to precisely gauge mobility effects associated with price declines subsequent to our latest data from the 2007 *AHS*. However, it is clear that the consequences of lock-in and reduced mobility are very different from those associated with foreclosure and increased mobility. For example, lower mobility is likely to result in more inefficient matching in the labor market, as some

29 Quigley (1987) finds this same asymmetry in the effects of changes in family size.

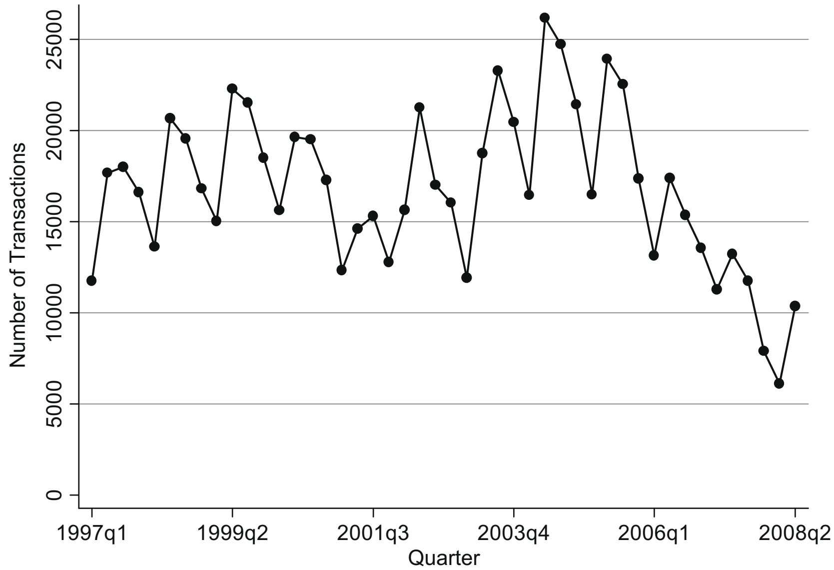

Fig. A1. Housing transactions volume over time, SF Bay Area. Notes: calculations based on all housing transactions in the San Francisco Bay Area using data from Dataquick.

households will not be able to move to access better jobs in alternative labor markets. Utility will also be lower to the extent households are not able to move as readily as they would like in order to access different amenities or public services (e.g., good schools), or just a differently-sized home if family size changes.

Recent research also suggests that owners with negative equity behave more like renters and reinvest less in their residences (Gyourko and Saiz, 2004). Harding et al. (2007) document the important role of maintenance expenditures at reducing the depreciation rate on housing. It is also possible that the reduced mobility associated with mortgage lock-in can have local public finance effects. Previous research has shown that even households without children often support investments to improve school quality because these improvements are capitalized into house values (Hilber and Mayer, 2004; Cellini et al., 2010). However, for households with negative equity in their home, that linkage is broken because it is the lender, not the owner, who would benefit from any initial increase in property values resulting from the improved public services.

Research is urgently needed to examine these potential consequences and assess their importance. More thought and analysis is necessary to determine whether there is a case for public policy to intervene in response to the potential for lock-in.[30] For example, it seems likely that lenders would internalize the home maintenance/reinvestment externality. However, it is not at all clear that they would do so with respect to the inefficiencies in labor market matching and housing market matching (in terms of accessing local services or amenities). Whether such costs would justify government intervention is not obvious, but a clear accounting of the potential benefits of such action is needed to weigh against the typical costs (e.g., moral hazard) that economists rightly associate with such policies. Whatever the correct answer, the calculus is sure to be very different from that associated with worries exclusively focused on the externalities associated with foreclosure.

[30] The same comment applies to the federal government's current mortgage modification policies. Two factors suggest their policies will lead to reduced mobility. First, negative equity, when it exists, has been left in place in most modifications. Second, interest rates as low as 2% are used to restructure payments to reduce the debt service-to-income ratio. These low rates are not assumable and should generate lock-in as estimated above.

7. Conclusion

Weakness in some local housing markets following the dramatic boom that peaked in 2006 raises new questions about an old issue in housing research—namely, lock-in effects. We use a panel data set from the *American Housing Survey* over a two-decade period to estimate the influence of negative equity and rising mortgage rates on household mobility, controlling for a host of other factors known to influence mobility. Higher interest rates are shown to lower mobility substantially, and we are able to confirm the magnitude of this result using data on a comparable financial friction generated by property tax differentials associated with California's Proposition 13.

Having negative equity in one's home reduces mobility rates by even more—by about 35% from its baseline level according to our estimates. That the net impact of negative equity is to reduce, not increase, mobility certainly does not mean that defaults and foreclosures are insignificant consequences of this condition. However, it does signify that the preponderant effect is for *owners* to remain in their homes for longer periods of time, not to quickly default and move to another residence.

Finally, reduced mobility has its own unique set of consequences which have not been clearly identified or discussed in the debate about the current housing crisis. Substantially lower household mobility arising from negative equity is likely to have various social costs including poorer labor market matches, diminished support for local public goods, and lesser maintenance and reinvestment in the home. Whether these costs are sufficient to warrant government intervention is unclear, so more research is urgently needed to address this and other issues pertaining to the financial frictions associated with potential mortgage lock-in.

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Appendix A

See Fig. A1.

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