The Impact Of Deregulation And Financial Innovation On Consumers: The Case Of The Mortgage Market

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ABSTRACT

We develop a technique for assessing the impact of changes in the mortgage market on households. We start with an implication of the permanent income hypothesis: that the higher a household's expected future income, the more it desires to consume, ceteris paribus. If perfect credit markets exist, desired consumption matches actual consumption and current spending forecasts future income. Since credit market imperfections mute this effect, the strength of the relationship between house spending and future income measures the "imperfectness" of mortgage markets. Using micro-data, we find that over the past several decades, housing markets have become less imperfect in this sense. Mortgage securitization has played an important role in explaining this phenomenon.

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The U.S. mortgage market has experienced phenomenal change over the last 35 years. Gone are the days when most households got a cookie-cutter, 30-year, fixed-rate, level-payment mortgage from a savings and loan that took deposits at 3% and lent out at 6%. And gone are the days when the typical lender held that mortgage on its books until the maturity of the loan. Today, consumers choose from an extensive menu of mortgages offering flexibility along almost every dimension. Furthermore, most lenders hold the mortgage for a very short time; typically, they sell the mortgage on the secondary market.

Many researchers have argued that this transformation has enhanced efficiency by integrating the mortgage market with the broader financial markets. But, there has been comparatively little research investigating how or even whether the transformation of mortgage markets has directly affected the average homeowner. In this paper, we use a novel technique to assess the impact of changes in the mortgage market on individual households.

We start with an implication of the permanent income hypothesis: that the higher a household's expected future income, the more it desires to spend and consume, *ceteris paribus*. If perfect credit markets exist, desired consumption matches actual consumption and current spending should forecast future income. Since credit market imperfections mute this effect, we view the strength of the relationship between house spending and future income as a measure of the "imperfectness" of mortgage markets.

We apply this methodology using household-level data from the Panel Study of Income Dynamics (PSID) and consider the forecasting ability of a newly purchased home on future income. We find that households buying bigger houses have higher future incomes, all else being equal. Furthermore, we find that the forecasting relationship of housing purchases and future income has changed over time. The estimated sensitivity of future income to current housing expenditures increased by approximately 80% over the length of our sample, from 1970 to 2005. Further, the change was not smooth over time—the application of econometric techniques for locating

unknown structural breaks suggests that the relationship changed discretely in the mid 1980s. Following the logic of the previous paragraph, we view the increased sensitivity of future income to house spending as evidence that mortgage markets have become less imperfect over time.

As success has many fathers, we attempt to establish paternity of the improved system of housing finance. Was it deregulation? Was it the creation of a secondary mortgage market? Or was it the creation of new types of mortgage instruments that allowed households to better smooth real housing consumption over the life-cycle? The timing of the structural break, as well as further econometric analysis, suggests that increased securitization activity by the secondary mortgage market played an important role in our findings.

Our analysis is particularly important in light of the housing crisis which started in 2007 because many commentators have laid the blame for the crisis precisely on the changes in the mortgage market on which we focus – increased use of securitization and proliferation of new mortgage products. Barney Frank, the Massachusetts congressman who heads the House Banking Committee, recently claimed that, "If in fact residential mortgage loans were made only by banks or thrifts or credit unions, then we would not have a subprime crisis."[1] This paper provides two reasons to be skeptical about such claims. First, we provide evidence that the use of the secondary market and the proliferation of innovative mortgage products predates the lending boom of 2001 to 2005 by about 20 years. As Figure 1 shows, the secondary market, irrelevant in the 1970s, accounted for about 40% of new originations in the 1980s, and almost 60% in the 1990s before peaking at 73% in 2005. Further, in Section I.B we argue that many of the now maligned innovative mortgage products debuted and were highly popular in the 1980s. But our more powerful critique of the argument that securitization is the cause of the current crisis is that its expansion in the early 1980s was accompanied not by a wave of defaults but, as we show, by an increase in borrowing by pre-

Figure 1 here

[1] http://www.necn.com/Boston/Business/Barney-Frank-defends-his-foreclosure-plan/1210973732.html

cisely those borrowers that theory says should take advantage of a relaxation of credit standards: households whose future incomes are higher than their current incomes.

In Section I, we provide a brief review of the transformation of the mortgage market from 1970 to 2005, the period that we study. Section II presents a simple model that illustrates the possible effects of changes in borrowing constraints on the relationship between spending on housing and future income. Section III then describes our empirical specification and the data. In Section IV we present the estimation results, and interpret these results in Section V. The results are consistent with the predictions of our theory. In Section VI we assess the sensitivity of our findings to alternative specifications of the model, and finally, provide a brief conclusion in Section VII.

I. The Mortgage Market 1970–2005

This section briefly reviews developments in the U.S. mortgage market from 1970 to 2005.

A. Deregulation and securitization

From the Depression through the late 1970s, deposits in savings accounts provided almost all financing for home loans. Depression-era regulations, updated at various points, channeled low-cost deposits to the thrift industry (Mason (2004)). Regulations took many forms and included usury ceilings, interstate banking prohibitions, limits on branching, and perhaps most infamously, Regulation Q, which capped deposit rates and forbade banks from paying interest on checking deposits (England (1992), Gilbert (1986)). While these regulations provided some stability, they also, predictably, led to major inefficiencies. Most significantly, by making bank deposits the principal source of funds for mortgages, regulators forced lenders to finance long-term assets with

short-term liabilities, a situation referred to in the industry as the mismatch problem (Modigliani and Lessard (1975)).

Despite its flaws, the system basically worked until the mid 1960s. Low inflation and stable interest rates meant that the usury ceilings, interest-rate caps, and the mismatch problem did not generate major difficulties. However, starting in the mid 1960s, inflation and interest rates rose, driving up the cost of funds for the savings and loan industry. This forced Congress to act, beginning a process that would culminate, 20 years later, in the transformation of the U.S. mortgage market from a largely deposit-financed system to a largely capital-markets-financed system.

In 1968, Congress moved aggressively to develop a secondary market for mortgages, that is, a market in which banks could sell mortgages they had originated to other investors. It created two entities. The first was a government agency called GNMA (Government National Mortgage Association, later known as Ginnie Mae), which bought mortgages guaranteed by the Federal Housing Authority and Veterans Administration, and the second was a shareholder-owned but government-sponsored enterprise still called FNMA, which bought other mortgages. This period also saw the emergence of the mortgage-backed security, a bond whose cash flows are backed by homeowners' mortgage payments. Ginnie Mae issued its first security of this kind in 1970, and Fannie Mae and Freddie Mac followed shortly thereafter (Bartlett (1989)). Within a couple of decades, this innovation would transform the industry.

Despite these moves by Congress, the problems continued to mount. Boston Fed President Frank Morris described efforts to stabilize mortgage finance over the 1966 to 1975 period as a "decade of failure" (Morris (1975)). Secondary markets were slow to develop; deposits into banks and savings and loans remained the chief source of funds for home mortgage lending. The first privately issued mortgage-backed security appeared in 1977 and was generally considered a failure (Ranieri (1996)).

Continued instability and high interest rates in the late 1970s initiated the final phase of the reinvention of housing finance in America. In 1977, Merrill Lynch invented the Cash Management Account, in effect allowing non-banks to circumvent Regulation Q (Cocheo (2003)). This innovation, combined with many others, severely reduced the availability of funds for the thrift industry, which was still bound by Regulation Q. Even when regulators finally allowed them to pay competitive interest rates, thrifts confronted state usury laws. These laws often meant that the thrifts could not lend profitably, and so they simply stopped lending altogether (Shaman (1979)).

The impending collapse of the thrift industry spurred Congress and regulators to action, and over the next six years, legal and regulatory changes transformed mortgage lending (Bartlett (1989)). The Depository Institutions Deregulation and Monetary Control Act of 1980 ordered the phase-out of Regulation Q over the next six years and overrode or pre-empted state usury ceilings. In 1982, Congress passed the Garn-St. Germain Depository Institutions Act, which extended the 1980 act, pre-empting state laws that constrained the types of mortgage products originators could offer. In 1984, the Secondary Mortgage Market Enhancement Act solved many of the technical problems facing mortgage-backed securities.[2]

Two key events dramatically accelerated the development of a secondary market. The first occurred in October 1981, when the FHLBB, the main regulator of thrifts, introduced a change in accounting rules that had the effect of allowing lenders to sell mortgages on the secondary market without booking a large accounting loss (Mason (2004)). This change created a liquid secondary market for mortgages virtually overnight (Lewis (1989)). Secondary market sales of mortgages increased more than four-fold, from $12 billion in 1981 to $52 billion in 1982 (Bartlett (1989)).

The second influential event was the realization that issuers could skirt many of the problems that had bedeviled early mortgage-backed securities, by enlisting one of the Government Spon-

[2] Another noteworthy event was The Tax Reform Act of 1986, which created an investment vehicle called a REMIC (Real Estate Mortgage Investment Conduit) that allowed securitizers to divide the flows of principal and interest from mortgage-backed securities into different classes ("tranche securities") tailored to the needs of different investors.

sored Enterprises (Ranieri (1994)). The GSEs' federal charters meant, for example, that their securities were exempt from state investor protection laws. Freddie Mac, initially, and later Fannie Mae, worked closely with Wall Street firms and became the largest issuers of mortgage-backed securities.

Figure 1 displays the evolution of securitization activity from 1970 to 2005. The figure shows the value of mortgage-backed securities (MBS) securitized by both the GSEs as well as private corporations. The figure shows both a "stock measure," the stock of MBS normalized by total home mortgage debt outstanding, and a "flow measure," MBS issues normalized by originations of home mortgages. These ratios have grown substantially over time. The percentage of the stock of outstanding mortgages securitized has increased dramatically from approximately 0% in 1975 to more than 55% by 2005.

B. Innovation in mortgage design

The menu of available mortgage choices in 2005 vastly exceeded the options that were available in the 1970s. In the 1970s, because of a combination of regulation and inertia, the mortgages available to borrowers consisted almost exclusively of fixed-rate, level-payment instruments. Among other things, consumer groups, as they do to this day, viewed features like variable interest rates as dangerous, and they worked assiduously to prevent adoption (Guttentag (1984)). Even when they allowed variable-rate mortgages, regulators established restrictions that severely limited their usefulness (Macauley (1980)).

However, the 30-year, fixed-rate mortgage was particularly unsuitable for the high-inflation, high-volatility environment of the 1970s. The combination of high nominal interest rates and fixed payments over time meant that households faced very high real payments early in the life of the loan. Some borrowers would have been better served by mortgage designs that allowed

relatively lower nominal payments early in the life of the loan, so that the real burden would be distributed more evenly over time. Regulators eventually relented in their opposition to alternative mortgage designs and allowed lenders to offer innovations, including the Graduated-Payment Mortgage (GPM, first offered in 1977) and the forerunner of today's Option ARM (first offered in 1980), both of which allow borrowers to make a monthly payment that falls short of the interest due on the mortgage (Phalan (1977), Harrigan (1981)). These alternative mortgage designs have been popular since the 1980s, and by no means confined to very financially sophisticated households (Kettell (2006), Stahl (1996)).

Initially, new mortgage designs merely inoculated borrowers against high inflation. With high inflation, a graduated-payment mortgage offered a flow of real payments comparable to that of a traditional mortgage with low inflation. However, although the appearance of high inflation enlarged the mortgage menu, its disappearance in the mid 1980s did not shrink the menu. Regulators made no effort to prohibit the alternative mortgages developed in the late 1970s and early 1980s. The use of these new products in a low-inflationary environment allowed lenders to offer borrowers much less rigorous repayment schedules than had prevailed even in the 1950s and 1960s. In other words, the net effect of regulators' responses to high inflation was to liberalize mortgage markets considerably when compared to the traditional system of the 1950s and 1960s.

C. Other changes

Three other changes in mortgage markets in this period are worth noting. First, concerns emerged in the early 1970s of race and gender-based discrimination in mortgage markets, leading to the passage of the Equal Credit Opportunity Act (ECOA) (Elliehausen and Durkin (1989)). Second, in the mid 1990s, lenders adopted automated underwriting procedures, which reduced the cost of originating new mortgages (Straka (2000)). Third, the subprime mortgage market,

the part of the mortgage business dedicated to borrowers with less-than-perfect credit histories, emerged in the mid 1990s, following the development of credit scoring. Until the mid 1990s, a borrower was either prime and got a loan at the going rate, or was subprime and did not get a loan at all (Munnell et al. (1996)). In the mid 1990s, a new generation of lenders began to offer loans to subprime borrowers, but they demanded much higher interest rates as compensation for the added risk. Subprime originations grew from $65 billion in 1995 to $332 billion in 2003 (Chomsisengphet and Pennington-Cross (2006)).

D. Prior research on innovations in the mortgage market

What was the impact of all these institutional changes in the mortgage market? Empirical researchers have focused on the extent to which mortgage markets and capital markets have become integrated over time. One way to investigate this issue is to look at the time-series relationship between interest rates on mortgages and Treasury yields. The idea is that if capital can flow freely in and out of the mortgage market, then Treasury yields and mortgage-market yields should move together over time. A variety of studies using this general approach have found that, in fact, the correlation between Treasury yields and mortgage yields was greater in the 1980s than in the 1970s. (See, for example, Devaney and Pickerill (1990), Hendershott and Van Order (1989), Goebal and Ma (1993), and Devaney, Pickerill, and Krause (1992)). While important and interesting, this tack removes the focus from where we believe it really belongs, which is the impact of securitization on *households.* What we care about ultimately is not the correlation between Treasury rates and mortgage rates *per se*. Rather, the key question is whether securitization (or any other development in the housing finance market) enhanced the likelihood that households could borrow enough to buy homes whose values were consistent with their lifetime incomes.[3] To address this question,

[3]Linneman and Wachter (1989) is the only study to our knowledge that attempts to assess the impacts of mortgage-market developments at the household level. They find a diminished impact of borrowing constraints on tenure choice over time, and they attribute their findings to the development of adjustable rate mortgages (ARMs) and the increased

we develop a model that allows us to investigate the impact of mortgage-market innovations at the household level.

II. Model

In this section, we develop a model of how changes in the market for housing finance affect individual households. We present a simple model with two types of households and two types of houses. A key result is that relaxing constraints on mortgage lending increases the coefficient in a regression of future income on housing expenditures.[4] We illustrate our points here graphically; the online appendix contains a formal derivation of the results, and also presents a necessary condition for obtaining such a result in a more general model with any number of household types.

Suppose we have two types of families who differ in future income, low (Y_L^f) or high (Y_H^f), and who face a choice between two types of house, small (H_S) or big (H_B).[5] Assume further that households have different levels of wealth and that they can borrow to finance their home purchase. Otherwise, the families are identical; in particular, they have the same level of *current* income, so that we can use "high future income" and "high future income growth" interchangeably. For purposes of this example, we assume that, if allowed to borrow an unlimited amount, the low-income-growth families would choose small houses, while the high-income-growth families would choose big houses. However, in the presence of credit constraints, this separation of types might not emerge. For example, lenders typically require that monthly housing expenditures fall below

use of seller financing and other "non-traditional" financing schemes. Campbell and Cocco (2003) examine the effects of different mortgage designs in a dynamic life-cycle model with borrowing constraints.

[4]See Artle and Varaiya (1978) for the first theoretical analysis of the implications of borrowing constraints on homeownership, Brueckner (1986) for a 2-period version of the same model in discrete time, and Engelhardt (1996) for an empirical implementation. For a discussion of the user cost of housing in a model without borrowing constraints, see Himmelberg, Mayer, and Sinai (2005).

[5]This discussion implicitly assumes that housing is entirely a consumption decision. In fact, housing is also purchased for investment purposes. However, under the conditions we assume, the basic results are independent of whether the motive is consumption or investment.

a certain percentage of current income. Thus, current income fixes some maximal amount the household can borrow. This need not limit the size of the house the family can buy if the family has sufficient access to other assets such as its own wealth or the wealth of its close relatives. If not, even a high-income-growth household ends up buying a small house.

In this example, credit constraints reduce the difference in average, observed income-growth rates between small- and big-house buyers. To see why, recall that under our assumptions, in the absence of credit-market constraints, every high-income-growth family purchases a big house and every low-income-growth family purchases a small house. In the presence of constraints, some high-income-growth families instead purchase small houses, and thereby drive up the average income growth associated with small-house buyers.[6] On the other hand, the income growth of large-house buyers stays the same. Hence, the borrowing constraints attenuate the observed relationship between income growth and the size of current home purchases.

This argument is laid out more formally in Figure 2. Suppose initially that 2/3 of the high-income-growth families buy a small house and that all of the low-income-growth families also buy a small house, so that the average future income of the small-house buyers is $Y(H_S) = \frac{2}{5}Y_H^f + \frac{3}{5}Y_L^f$. On the other hand, only high-income-growth families buy a big house, implying that $Y(H_B) = Y_H^f$. Now, suppose we relax the constraint so that only 1/3 of the high-income-growth families buy a small house. In this case, the average future income of small-house buyers falls to $Y(H_S) = \frac{1}{4}Y_H^f + \frac{3}{4}Y_L^f$, whereas the future income of big-house buyers stays the same. Figure 2 illustrates how the movement of high-income-growth families from small houses to big houses as the credit market constraint is relaxed raises the sensitivity of average future income to house size—that is, line AC is flatter than line BC. In an econometric context, this means that if we estimate a

Figure 2 here

[6] Holding current income and wealth constant, households with higher expected future income (Y_H^f) are more likely to be constrained than those with lower expected future income(Y_L^f). This is because high-income-growth households would like to borrow more than low-income-growth households in order to smooth consumption and consume more today, but their borrowing is limited by current income.

regression of future income on the value of current house purchases, then the less constrained the borrowing environment, the greater the coefficient on the value of current house purchases, *ceteris paribus.* As shown below, this is precisely what we find in the data. We present a formal, algebraic version of this argument in the online appendix.[7]

We chose a simple two-type model for expositional ease but the results are much more general. In the online appendix, we consider models with a continuum of types and one in which households can move in the second period and show that the basic claim continues to hold: relaxed constraints tighten the relationship between future income and house spending.

III. Empirical Setup

The previous section provided a simple model to explain why imperfections in housing markets like borrowing constraints can weaken the observed relationship between housing purchases and future income and, conversely, how relaxing credit constraints can strengthen this relationship. Thus, by examining how the relationship between current home purchases and future income has changed over time, we can infer whether the market for housing finance has become less imperfect. This section develops an econometric model to implement this idea. We then discuss the data used to estimate the model. Finally, we provide a straightforward graphical summary of the evolution of the relationship between house values (normalized by current income) and income growth in our data and show that it is consistent with our theoretical framework.

[7]Our simple model assumes that households with a given level of income growth face the same borrowing constraints; they differ only by wealth. However, the analysis extends to any variable that affects a family's ability to buy a house, not just wealth. In particular, one could show that when families have the same wealth but differ in the borrowing limits they face, then if individuals' borrowing limits are all relaxed, the relationship between current house value and expected future income strengthens. This case is particularly important given the evidence in Munnell et al. (1996).

A. Econometric specification

We begin by writing down a model for forecasting future income in panel data. Specifically, suppose that it is period t and we want to predict household i's real income in f periods, $Y_{i,t+f}$. The forecasting model is

$$\ln(Y_{it+f}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(H_{it}) + \beta X_{it} + D_t + \xi_{i,t+f} \tag{1}$$

where Y_{it} is current real income,[8] H_{it} is the real value of the home that the household purchases in year t, X_{it} is a vector of socio-demographic variables such as age, education, race, and sex , D_t is a set of time effects,[9] and $\xi_{i,t+f}$ is household i's forecast error of future income at time t.

To test our claims above, we include the value of housing purchases as an explanatory variable. According to the permanent income model, consumption and expenditure should reflect households' information about future income. By this logic, if households have better information about their future income than is contained in income's own history, then consumption and expenditure variables should help to forecast income. Housing expenditures are a natural choice in this context, because for most households the purchase of a home is the largest purchase that it will make over its lifetime.

If we were to confront equation (1) with data, we would view a rejection of the hypothesis that $\alpha_2 = 0$ as evidence in favor of the joint hypothesis of forward-looking behavior and the ability of households to make reasonably accurate income forecasts. If households are forward-looking in their housing decisions but are very bad at predicting their future income, we will not find

[8] In other specifications we also inserted lagged values of income along with current income as explanatory variables. This did not affect the estimated coefficient on the value of the house, but reduced the estimated coefficient on current income. Because including lagged income values reduces our sample size and because our main concern is the estimated coefficient on house value, we include only current income.

[9] We include time effects to control for aggregate influences such as business-cycle effects.

a statistically significant relationship between the value of a newly purchased house and future income.

We now focus on the main goal of our paper, assessing the impact of changes in financial markets. Specifically, our model shows that a less imperfect housing finance system should lead to an increased observed elasticity of future income with respect to housing purchase expenditures. Hence, if housing market innovations over time have relaxed borrowing constraints, we expect the coefficient on housing expenditures in equation (1) to increase over time, *ceteris paribus*. Algebraically, this translates into the value of α_2 growing in magnitude over time. To test this notion, we begin by augmenting equation (1) with a series of terms in which the log of house value is interacted with dichotomous time effects. Specifically, let T_1 take a value of 1 if the observation is from 1970 to 1972, T_2 if it is from 1973 to 1975, and so on. We then estimate

$$\ln(Y_{it+f}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(H_{it}) + \sum_{j=1}^{10} \alpha_{3j} T_j \ln(H_{it}) + \beta X_{it} + D_t + \xi_{i,t+f} \qquad (2)$$

(We use three-year intervals to reduce noise associated with year-to-year variation.) If the relationship between housing expenditures and future income is in fact becoming stronger over time, then the value of the α_{3j}'s should be increasing in j.[10]

When it comes to making equations (1) and (2) operational, the first question one must confront is how to measure the left hand side variable, future income.[11] Including the sum of the entire stream of future earnings is clearly infeasible. Instead, we used several alternative measures of future income: realized income two years in the future, realized income 4 years in the future, the average of realized income 2 years and 4 years in the future, and the average of income for each

[10] An alternative strategy would be to interact the log of house value with a linear time trend, but this would be unduly restrictive.

[11] At least as far back as Friedman (1957, pp. 23–25), empirical investigators have been forced to deal with the ambiguous nature of the time horizon that is appropriate in the permanent income model. Friedman discarded both mean lifetime income and the short-term mean of the anticipated probability distribution of income as proxies for permanent income, instead advocating a measure based on an intermediate time horizon.

of the 5, 6, and 8 years in the future. The advantage of the measures based on averages is that they mitigate concerns that our results will be biased by a change over time in the mix of transitory versus permanent income or in the degree of random measurement error in households' responses. On the other hand, due to the structure of our data set (see below), we have a larger sample size if we use single years rather than averages.

B. Data

Our primary data come from the Panel Study of Income Dynamics (PSID) for 1970 to 2005. The PSID is an annual panel data survey, which contains, among other things, detailed information on family income and demographic variables. In addition, it includes information on home purchases and their value. Some of the issues involved in using the PSID to estimate our model, including the reliability of the data on homeownership and housing finance, are discussed in the online appendix.

Our basic sample includes all households that purchased a home in the period spanning 1970 to 2001.[12] This includes both first-time homeowners making the transition from renting to owning a home and existing homeowners who are moving into new houses. The PSID's measure of the purchase price is the value of the home as reported by the household during the first year of occupancy. Note that a household enters our analysis sample only in years when it purchased a home. Hence, although the underlying PSID is a panel data set, our analysis sample is a pooled cross-section.

Altogether, we identify 16,845 house purchases over this period, which corresponds to approximately 7.3% of the PSID sample from 1970 to 2001 (229,645 total observations). In several cases, the reported value of the purchased house is extremely low, even after converting from nominal to

[12] We excluded 1968 and 1969, the first two years of the PSID, because of problems with the question pertaining to whether the household had moved within the past year.

real values. In the majority of these cases, the household reports not having taken a mortgage, leading us to believe that these may be inheritances or transactions between family members that are not particularly relevant to our study. Therefore, we eliminate all observations for which the house's real value is less than $5,000. This reduces our sample of house purchases to 16,557. After deleting observations with missing values for income (current and future), demographic variables, and observations that were part of the Survey of Economic Opportunity (SEO) portion of the PSID,[13] we end up with a baseline sample of 6,147 for our 2-year average future income measure. The percentage of households purchasing a home as a share of the total number of households in our baseline PSID sample fluctuates between 5.6% (1983) and 9.6% (1978) for the 30-year span of our data, and it displays no noticeable patterns.

Our income measure is total income, including both labor and capital income and transfers, received by both the husband and wife and any other individuals in the household. In order to correct for changes in the price level over time, we deflate the income and house value variables by the Personal Consumption Expenditure (PCE) Chain-Type Index, with 2000 as the base year.

Our left-hand-side variable is income f years in the future. As discussed above, we use several alternative measures: realized income two years in the future, realized income four years in the future, the average of realized income 2 years and 4 years in the future, and the average of income for each of the 5, 6, and 8 years in the future. These choices are dictated in part by the structure of the data set. Because the PSID switched from an annual to a biennial survey in 1997, it turns out that values for f of 2 and 4 maximize our sample size.[14] In addition to losing observations, another

[13]The SEO sample is not a nationally representative sample as it over-samples poor and immigrant families; studies based on the PSID typically exclude it.

[14]Because of the 1997 change, we do not have data for the years 1998, 2000, 2002, and 2004. Therefore, we must discard house purchase data for the observations for which future income, Y_{it+f}, lies in these years. For example, if we were looking at income three years into the future, we would need to eliminate house purchases in 1995, 1997, 1999, and 2001; if we were looking five years ahead, we would be forced to throw away 1993, 1995, 1997, and 1999. Thus, using the average of two and four years as well as each of the individual years themselves, allows us to maximize the sample size. For the case of f = 2, we need to discard only 1994, 1996, 1998, 2000, and 2002 while for f = 4, we need to discard only 1994, 1996, 1998, and 2000.

problem with using larger values of f is that as f increases, the sample becomes less representative because the lost observations are at the end of the sample. For these reasons, we choose the average of realized income 2 years and 4 years in the future to be our main specification, and only report fully results from this specification. Estimation results using different future income specifications are all very similar, and are available in the online appendix.

As far as demographic variables, the X-vector of equation (1), we include: a cubic in age (MaCurdy, (1982)), education (a series of dichotomous variables), race, whether the head of the household is female, and family size.[15] The means and standard deviations of the variables for the different samples are reported in Table I. Table I here

C. A Preliminary Look at the Data

Our model posits that to the extent that the market for housing finance has become less imperfect over time, the relationship between income growth and the value of current house purchases should strengthen. To see whether such a relationship is present in the data, we began by computing for each household that purchased a home the ratio of the value of the home to family income. We then calculated the mean ratio for each quintile of the distribution as well as the mean value of income growth (over a 2-year period) for the families in the respective quintiles.[16] Figure 3 contains plots of house value relative to current income (in logs) against income growth for both the first half of our sample (pre-1985) and the second half of our sample (post-1985, inclusive). Figure 3 here

Several features of the graph are of interest. First, the relationship between house value relative to current income and income growth during both the first half and second half of our sample

[15] MaCurdy (1982) uses a quadratic in age for a first-difference specification. Since we are estimating our equation in levels, we use a cubic. The estimated coefficient on age-squared is negative, which is consistent with the hump-shaped income profile commonly estimated in the literature. We also estimated the model with a quadratic in age rather than a cubic, and the results were essentially unchanged.

[16] Our decision to use quintiles is somewhat arbitrary; the results are broadly comparable when we use either octiles or deciles instead.

period is generally positive. This is consistent with the notion of forward-looking behavior of households. Second, over time income growth has become more sensitive to normalized house value for households with relatively low levels of housing, but has stayed the same for households with relatively high levels of housing. This makes sense in terms of our theory—the families who bought large homes at the beginning of our sample period presumably were less constrained than those who bought small homes. Therefore, the loosening of constraints that took place over time likely affected their behavior less.

A third and related observation is suggested by a comparison of income growth at the low end of the house value distribution pre- and post-1985. Average income growth for the low-housing group was lower in the post-1985 period. Our framework provides a straightforward explanation for this phenomenon. In the presence of the relatively severe capital market constraints during the pre-1985 period, some households consumed little housing because their expected income growth was low, and some consumed little housing because their expected income growth was high but they could not borrow. In effect, there was a mixture of low- and high-income growth households at the low end of the housing expenditure distribution. But, with the less severe constraints of the post-1985 period, fewer high-income growth individuals ended up spending relatively little on housing, so there were fewer high-income growth households in this part of the housing distribution. Thus, when we average over income growth rates in this part of the distribution pre- and post-1985, there are more low-growth households post-1985, which accounts for the relative positions of the two graphs.

While it is encouraging that Figure 3 is consistent with our theoretical framework, we must be careful not to place too much stock in it, because it does not take into account other variables that could be contributing to such a pattern in the data, including changes in the macroeconomic environment and a variety of other factors that we discuss later in the paper. A multivariable analysis is required, to which we now turn.

IV. Results

This section presents the results of our basic model, including a specification that allows for the possibility of structural breaks in the relationship between the value of a current house purchase and future income. In the subsequent sections, we explore alternative explanations for the breakpoint, and the robustness of our findings to alternative specifications of the empirical model.

A. Basic Results

The top panel of Table II shows results for estimating equation (2) with future income defined as the average of income two and four years in the future.[17] Consider first the estimated coefficient on the log of house value, α_2. The estimate is 0.087 and it is significantly different from zero at conventional levels. Thus, during our base time period (1970 to 1972) every 10% increase in the value of a new home is associated with a roughly 0.87% increase in future income. Table II here

Our main interest is the estimated coefficients on the interactions between our 3-year dichotomous variables with house value, which tell us whether the relationship between house value and future income has become stronger over time. We report the estimated coefficients on the interaction terms in the top panel of Table II. Roughly speaking, the estimated coefficients before 1985 are not statistically different from zero, while the ones after 1985 are statistically different from zero. We discuss below the implications of this pattern. In the bottom panel of Table II, we plot the sum of the respective estimated coefficients on the interaction terms with the estimate of the base time period (1970 to 1972), which gives us the total estimate of the responsiveness of future income to new housing expenditures during the respective time intervals. Two features of the plot are noteworthy. First, the responsiveness of future income to new housing expenditures has increased

[17] The results corresponding to alternative definitions of future income (5-year average, two years ahead, and four years ahead) are virtually identical to those presented in the table.

over time. Second, the increase appears to be fairly discrete, as the estimates fluctuate between 0.08 and 0.12 in the 3-year intervals between 1970 and 1984, but then increase in the 1985 to 1987 interval, and remain elevated through the 1999 to 2001 interval, fluctuating between 0.14 and 0.17. In the 1970 to 1972 interval a 10% increase in the value of a new home is associated with a 0.87% increase in future income, while in the 1999 to 2001 interval the same 10% increase in house value is associated with a 1.6% increase in future income. Thus, the relationship between the value of housing purchases and future income increased by approximately 80%.

We now briefly discuss the other coefficients in our basic specification. Most of the demographic variables have statistically significant effects, with signs that are consistent with prior research. The coefficient of 0.57 on current income replicates the usual result that income has an autoregressive component. Future income is increasing in age, *ceteris paribus*, consistent with typical analyses of age-income profiles. The coefficient estimates on the education variables imply that future income is approximately 9% higher for high school graduates with some college experience than for high school drop-outs, and about 16% higher for college graduates. Households that are black and households that are neither caucasian nor black (*other race*) have future income realizations that are lower than those of white households, but the estimated effects are not statistically different from zero. Female-headed households have future incomes that are almost 21% lower than those of male-headed households. Size of household is also statistically significant and positive.[18] It suggests that for each one-person increase in the size of a household, its income in the future is approximately 1.6% higher. The coefficient estimates for the time effects are omitted from the table to conserve space; however, they are included in all of the regression models. For the most part, they are statistically significant.[19]

[18]We also estimated a variant of the model in which number of children was included instead of family size. No substantive differences emerged.

[19]These findings are not sensitive to the way in which future income is measured. We have estimated equation (2) using the 5-year average of future income and do not find significantly different results. These results are available in the online appendix.

We note in passing that our baseline specification implicitly assumes that the relationship between house value and future income is the same for all groups in the population. However, we would expect that the predictive power of house value would be less for groups that are *a priori* relatively likely to be constrained in the housing finance market. This suggests another approach to testing our model, to which we will turn in Section V below.

B. Breakpoint Analysis

As suggested above, casual observation of the regression results suggests that there may have been a discrete structural change in the relationship between future income and housing purchase expenditures in the early to mid 1980s. To investigate whether this observation can be confirmed by a more formal analysis, we use Bai's (1999) likelihood-ratio-type test for multiple structural changes in regression models. The test determines both the number of structural breaks and the location of each break in the data. The particularly novel aspect of the test is that both the null and alternative hypotheses allow for the possibility of breakpoints.[20] A detailed explanation of the methodology is contained in Bai's paper.

Our key finding is that there was in fact a statistically discernible, single breakpoint in 1985. Column (2) of Table III shows that the estimated effect of house prices on future income increases from 0.10 to 0.15 after 1985. The fact that there was a single breakpoint indicates that the ability of house purchases to forecast income was not increasing gradually. This finding sets a high bar for any explanation that depends on a phenomenon that changed gradually over time.

Table III here

[20]The limiting distribution of the test statistics for tests of only a single structural break are derived assuming the absence of breaks. Thus, when the null hypothesis is rejected for such a test, only a single breakpoint is estimated.

V. Explaining the results

The documentation of the existence of a breakpoint, while useful, does not by itself help us understand why housing markets became less imperfect. In this section, we use our model to investigate a variety of possible explanations for the patterns in Figure 3 and Table II.

A. Development of a Secondary Market

When we go back to Figure 1, which shows a sharp increase in securitization in the 1980s, it is natural to conjecture that the development of the secondary market generated the increase in the responsiveness of future income to the value of home purchases, which also occurred in the 1980s. We now use our econometric model to investigate this possibility.

To begin, we create a measure of the importance of securitization in a given year, SEC_t defined as the proportion of the flow of all home mortgages in year t that were securitized.[21] This index is displayed in Figure 1, and includes securitization by the GSEs as well as securitization by private corporations. A substantial increase in securitization activity in the early to mid 1980s is very apparent from the graph. Between 1970 and 1982, annual securitization rates gradually increased from approximately 0% to almost 20%. However, in 1983, the percentage of residential mortgages that were securitized dramatically rose to almost 60%. From 1983 to the present, securitization rates have fluctuated between 35% and 70%. On the surface, this pattern appears to support the idea that increased securitization activity by the secondary mortgage market played a role in the loosening of borrowing constraints documented above. In order to test this idea in a more for-

[21] We also looked at the corresponding stock measure, and we found no substantive differences in the results.

mal manner, we interact the securitization flow variable, SEC_t with house value in our regression model:

$$\ln(Y_{it+f}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(H_{it}) + \alpha_3'' SEC_t * \ln(H_{it}) + \beta X_{it} + D_t + \xi_{i,t+f}. \quad (3)$$

A positive value of α_3'' implies that more extensive secondary market activity is associated with H_{it}'s being a better predictor of future income, which in turn implies an improved ability for households to purchase homes that are in line with their future income prospects. In short, a positive value of α_3'' is consistent with the notion that the development of the secondary market has helped to make the housing finance market less imperfect.

The results are reported in column (3) of Table III. The coefficient on the interaction term is 0.12 with a standard error of 0.03. Hence, as hypothesized, the development of the secondary market played a significant role in making the housing finance market less imperfect. In terms of magnitudes, this implies that moving from a situation of zero securitization activity (1970 level) to a scenario in which 40% of mortgage originations are securitized (early 1980s levels), increased the elasticity of future income to the value of new house purchases from 0.09 to approximately 0.14.

B. Changes in the Macroeconomic Environment

A potential problem with our notion that the development of the secondary market played a key role is that the broader macroeconomic environment was changing at around the same time. In particular, the mid 1980s saw the end of the high-inflation, high-interest-rate environment as well as the end of the great disinflation of the early 1980s.[22] The problem arises because our theory

[22]For a detailed discussion and documentation of this disinflation and its effects on the macroeconomy, see Goodfriend and King (2005). In addition, recent research suggests that the 1980s saw a secular reduction in macroeconomic volatility. See McConnell and Quiros (2002).

suggests that a fall in nominal rates, holding real rates constant, would have the same effect as a relaxation of borrowing constraints. To see why, recall that with traditional mortgages, a high nominal rate drives up the real value of initial monthly payments without raising the real interest cost. High nominal rates increase the monthly payment for a given home, and if the lender's allowable maximum fraction of monthly income that can be spent on housing remains constant, then this effectively makes the borrowing constraint more stringent. However, we doubt that the reduction in nominal interest rates during the mid 1980s is driving the results. If that were the case, we would expect to see two structural breaks, because relatively low nominal rates prevailed both before 1979 and after 1985.

In any case, we can use our model to test whether changes in nominal interest rates and inflation rates can explain the increased sensitivity of future income to the value of new homes. We augment equation (3), with a term that interacts the inflation rate (as measured by the CPI) with the log of house value, and another term that interacts the nominal interest rate with the log of house value. If inflation and interest rates were the driving forces, then we would expect the coefficients on these interaction terms to be positive and statistically significant. In column (4) of Table III, we present the results when the interest rate is measured as the 6-month LIBOR, and in column (5), when it is measured by the 10-year Treasury rate. In both cases, the interaction terms are individually and jointly insignificant, while the securitization term remains positive and significant, and essentially unchanged. Thus, one can reject the hypothesis that changes in the inflation and nominal interest rates were the driving forces behind the improvement in housing finance markets.

C. Increase in Household Level Income Volatility

Some research suggests that, despite the decrease in aggregate income volatility since the 1980s, there has been an increase in household-level volatility (Dynan et. al. (2006)). Further-

more, Shore and Sinai (2005) have shown empirically that greater income risk can actually lead to increases in housing consumption. This raises the possibility that we should attribute the changes in the relationship between house value and future income to changes in income variability rather than the development of the secondary market. To investigate this possibility, we compute each household's income volatility (measured as the variance of the log of income) using all observations for each household, and insert this variable into our model, as well as its interaction with a time-trend and with the log of house value.[23] The results are reported in columns (6) and (7) of Table III. From our standpoint, the key result is that the coefficient on the interaction between the log of house value and the extent of securitization activity is essentially unchanged. Differences in household level income volatility do not change our assessment of the role of the secondary market in explaining the improvements in the market for housing finance.

D. Regional Differences in the Growth of House Prices

An additional concern is that expected income growth and expected house price growth are correlated. In particular, there is evidence that house prices tend to be higher in markets with higher expected future house price growth (Sinai and Souleles (2005)) and that income growth and house price growth are linked (Van Nieuwerburgh and Weill (2007)). If the correlation between price growth and income growth also increased in the 1980s, then it might be the case that regional differences in housing markets are driving the results. To examine this possibility, we augment our model with a set of state dichotomous variables as well as the interaction of these variables with a time-trend. The results for this specification are displayed in column (8) of Table III (we suppress the state dichotomous variables for the sake of brevity). Again, the estimated coefficient on the interaction between securitization activity and log of house value is essentially unchanged.

[23] We are grateful to an anonymous referee for suggesting this idea.

We conclude that changes in the correlation between house price growth and income growth are not driving our results.

E. Differences across sub-groups

At the heart of our analysis is the claim that we can use the relationship between house spending and future income to measure the effects of borrowing constraints on a group of households. Our approach has been to compare groups of households over time – homebuyers in 1971 versus homebuyers in 1981, for example – but our method, if valid, should also work across other divisions of the population. In this section, we consider groups of households that we think are *a priori* more or less likely to face financial constraints. If our theory is correct, then α_2, the coefficient on house value in equation (3), should be smaller for the more constrained groups. Furthermore, more constrained groups would be more likely to benefit from securitization, which means that α_3'' in equation (3), the coefficient on the interaction of the log of house value and the flow of mortgage securitizations, should be larger for these groups. In this section, we estimate our basic model for a variety of subgroups in our data, and find that these predictions hold in every case. Our conclusions, then, do not depend solely on variations in the data over time.

(1) First-time homebuyers versus repeat homebuyers

We expect families that currently or previously owned a home to have advantages over first-time homebuyers when it comes to financing the purchase of a new house. For example, existing homeowners have an established credit history and may have a cushion of available equity that is not available to first-time homebuyers. Therefore, if mortgage-market improvements really are efficacious, they should have a relatively large impact on first-time homebuyers. Thus, we estimate equation (3) separately for first-time and repeat homebuyers. To begin, we construct a first-time homebuyer sample. While the PSID does not directly identify first-time homebuyers, the data

allow us to construct a reasonable sample. If a household that purchased a home never reported owning a home in previous interviews, then we label it as a first-time homebuyer.[24] Because we are interested in households that are most likely to have been borrowing constrained, we restrict both our first-time homebuyer and repeat homebuyer samples to those who financed their purchase with a mortgage.

Panel 1 of Table IV exhibits the results. The estimated effect of house value on future income, Table IV here
α_2, is statistically insignificant for first-time homebuyers, and larger (by a factor of 3) and statistically significant for repeat homebuyers. In addition, α_3'', the estimated effect of securitization on the relationship between house value and future income, is twice as large for first-time homebuyers than for repeat homebuyers. Both of these patterns are consistent with our intuition from Section II.[25]

(2) High-income homebuyers versus low-income homebuyers

As another check on our model, we divide our sample according to real income. Previous research shows that higher income households have more stable income and higher wealth, both of which would make them more creditworthy.[26] In addition, since the income elasticity of housing demand is less than one according to most empirical housing demand studies,[27] high-income households devote a smaller share of their income to housing compared to low-income households, ceteris paribus. Thus, low-income households are more likely to be constrained by debt-to-income restrictions.

There is bound to be some arbitrariness in defining a "high-income" versus a "low-income" household. To keep things simple, we categorize a household as being high income in a given

[24] See the online appendix for a discussion of households for which we lack a complete tenure history.

[25] A Wald test of the difference between α_2 for first-time homebuyers and repeat homebuyers is statistically significant at the 5% level, while the same test for α_3'' is not statistically significant. A test of the joint hypothesis that α_2 and α_3'' are different between the two groups is statistically significant at the 10% level.

[26] See Carroll and Samwick (1997) on the first point and Dynan, Skinner, and Zeldes (2004) on the second.

[27] See Hanson, Formby, and Smith (1996), and Mayo (1981) for a few examples.

year if it is above the median level of household income in the PSID in that year, and it is low-income if it is below the median.[28] Panel 2 of Table IV displays the parameter estimates for both of these samples. The estimate of α_2 is larger by approximately a factor of three for the high income sample, and is not statistically different from zero for the low-income sample. The estimate of α_3'' is twice as large for the low-income sample as it is for the high-income sample.[29] Both of these patterns are consistent with our theoretical model.[30]

(3) Woman- or black-headed households versus white- or male-headed households

There is also evidence that minority, and female-headed households earn less income and accumulate less wealth than nonminority, and male-headed households, *ceteris paribus*.[31] Furthermore, as discussed briefly in Section I.C above, there is evidence that households headed by blacks and by females have traditionally experienced poorer access to credit in mortgage markets than households headed by whites and males. If so, we would expect black- and female-headed households to have relatively small values of α_2 and relatively large values of α_3''. Our sample does not have enough black- and female-headed households to estimate the model separately for the two groups. Therefore, we pool the female- and black-headed households into one sample and all other house-

[28]The median income cutoff is calculated using the entire PSID sample. Since low-income households are less likely to purchase homes than high-income households, the sample of low-income households is smaller than the high-income sample. To check the robustness of these results, we also estimated the model using a different method for classifying households. We used the 25th percentile of the income distribution for our low-income sample, and the 75th percentile of the income distribution for our high-income sample. The results are broadly similar, although the smaller sample sizes resulted in slightly higher standard errors.

[29]A Wald test of the difference between α_2 for high-income homebuyers and low-income homebuyers is statistically significant at the 10% level, while the same test for α_3'' is not statistically significant. A test of the joint hypothesis that α_2 and α_3'' are different between the two groups is statistically significant at the 10% level.

[30]Some individuals with high incomes may nevertheless be constrained if they live in states with high-cost housing. Therefore, we include a full set of state and time effects (and interactions) in our estimates of equation (6.1) for these two samples.

[31]According to the Survey of Consumer Finances (1983, 1989), nonwhite and hispanic households have significantly lower net worth compared to white households. According to the 1984 and 1989 wealth supplements to the PSID, male-headed households have approximately three times the total wealth of female-headed households, on average. In addition total wealth for non-black households in these two periods is more than five times larger on average than for black households.

holds into another. The results are displayed in panel 3 of Table IV, and are consistent with our predictions.[32]

VI. Alternative Specifications

In this section, we assess the robustness of our results to alternative econometric specifications.

A. The Role of Labor Market Decisions

Our model posits that people decide on the purchase of their home given their beliefs regarding future earnings, and we find such a relationship in the data. However, an alternative interpretation is that causality runs in the other direction—households decide to purchase a house that is beyond their means, and then work harder in the future to earn enough income to make the mortgage payments. The most plausible way a household could do this is either by working more hours or by obtaining a second job. To see whether the correlation between the value of a current house purchase and future income is driven by increases in labor supply, we estimate a regression of total future annual hours worked on the value of the house purchase, current hours worked, income, and our usual set of demographic variables, two years (as well as five) after a house purchase. If the increased labor supply scenario were operative, we would expect to see a statistically significant, positive coefficient estimate associated with house value. However, the estimated coefficient is not statistically different from zero in any of our specifications.For example, in the regression where the independent variable is hours worked 2 years in the future, the coefficient estimate of the logarithm of house value is 0.0026 with a standard error of 0.0068.[33]

[32] A Wald test of the difference between α_2 and α_3'' for the two groups of homebuyers is not statistically significant.

[33] In the five-year specification, the coefficient estimate is 0.0039 with standard error 0.0067. These results are available in the online appendix.

A second channel through which a household might affect its income in the short run is occupational change. The PSID contains information about the occupation of both the head of the household and the spouse.[34] We use this information to construct a dichotomous variable that takes a value of 1 if either the head of the household or the spouse switched occupations during the two (four) years after a house purchase, and 0 otherwise. We then estimate a probit model for occupational switches, in which we include the value of the house purchase, current labor income, a set of occupation indicator variables, and a set of demographic variables. If households are buying homes that they cannot afford and then switching jobs in an effort to increase income, we would expect that higher expenditures on housing would increase the probability of switching occupations. However, we find that the value of the house purchase has no statistically discernible effect on the probability of switching careers within two years of a purchase. The estimated marginal effect is -0.0088 with a standard error of 0.0093. Exactly the same result is obtained when we look at a 4-year time horizon.[35]

B. Measurement Issues

House values in the PSID are self-reported. Measurement error associated with self-reported asset values is a common problem in the empirical literature (Miniaci and Weber (2002)), and could lead to inconsistent parameter estimates. To address this problem, we take advantage of the fact that the PSID provides information about whether the value of the house was edited or imputed. When we estimate our models including only those values that were not edited in any way, we find no substantive changes in our results.

[34]The coding of occupation in the PSID presents some technical issues. In the early years (up to 1980), occupation was coded at the 1-digit or 2-digit Census level, while in the later years it was coded at the 3-digit level. To construct an occupational code that is consistent for the entire span of the data, we used the 1968 to 1980 Retrospective Occupation-Industry Files, a PSID supplement that provides 3-digit occupation codes for household heads and spouses pre-1980. We then constructed a 1-digit code for the entire sample (9 different classifications).

[35]These results are available in the online appendix.

Another measurement issue relates to income. In particular, should capital income be included as well as labor income? We believe the answer is yes, as forward-looking households likely consider all sources of income when contemplating a house purchase. However, because capital and business income might be more difficult to forecast than labor income, it is useful to confirm that our results are not sensitive to the way that income is defined. Therefore, we re-estimate all of the forecasting equations using only household labor income.[36] We find no substantive differences from the previous results.

C. Length of Horizon

Another potential issue with our empirical specification is the fixed length of horizon over which we choose to measure future income. Households may differ in their expected length of stay in the home, so that our choice of a fixed horizon may be a good proxy of the true horizon for some households and a bad proxy for other households. If this is the case, then we would expect to see a higher correlation between house value and future income for households where the proxy is a better measure of the truth.[37] If there is a change in the composition of true horizon lengths over time, then it is possible that the results discussed above could be due to heterogeneous horizon lengths across households. For example, suppose we were using a short horizon to measure future income, such as two years, and that most households before 1985 had long expected length of stays in their respective homes. Now, suppose that after 1985, many households who purchased homes had short expected length of stays, perhaps due to improvements in technology that reduced moving costs and increased mobility. In this case, we would expect to find an increased correlation

[36] Another issue is whether income should be measured in real or nominal terms. We have used real income, because it is more consistent with the basic permanent income hypothesis. However, to make sure that our results are not sensitive to this distinction or our choice of deflator, we re-estimated the model using nominal magnitudes for house value and income, and we found that the results were essentially unchanged.

[37] Non-classical measurement error in the left-hand-side variable (future income) is an equivalent way of thinking about this problem.

coefficient between the value of housing purchases and income two years in the future after 1985, as the average length of horizon became more consistent with the horizon used to measure future income.[38]

To explore this possibility, we re-estimated our empirical model, equations (2) and (3), using different horizons to compute future income. In addition to using a five-year average specification, which we have previously discussed, we also used a six-year average as well as an eight-year average. The estimation results from these different income horizon assumptions are all broadly similar and consistent with the results reported in Tables 2 and 3. We find that the coefficient estimate associated with the log of house expenditures increases in the mid 1980s, and that the interaction term of house expenditures and our proxy for securitization activity is positive and statistically significant in all specifications.[39]

VII. Conclusions

Taken together, our results suggest two main conclusions: First, the housing finance market has become substantially less imperfect over time. Second, there appears to have been a discrete improvement in the housing finance market in the early to mid 1980s. We conjecture that this was due to the development of a secondary market in mortgages.

The innovations in the early 1980s that are the focus of this paper emerged as a response to a crisis in the mortgage market, which, although smaller in magnitude than the current one, bears some similarities. In both episodes, large parts of the home mortgage industry were rendered insol-

[38] We thank an anonymous referee for bringing this issue to our attention.

[39] An alternative approach to this problem would be to generate a proxy for expected mobility, interact with housing expenditure, and see whether that affects our estimated effects of securitization. To implement this approach, we used the actual number of times that the household moved over the course of our sample as a proxy for expected mobility. When we entered the interaction of this mobility proxy with housing expenditure, we found that there were no substantive effects on our results. These results and the others discussed in this paragraph are available in the online appendix.

vent by a macroeconomic shock. In the former case, the problem was inflation and the associated interest rate risk that lenders were unable to manage and the innovations discussed in this paper were designed to address those problems and they largely succeeded. Large swings in interest rates that occurred between 1985 and 2005 never disrupted the market.

The problem this time is house price risk and lending institutions were as poorly prepared for collapsing house prices in 2005 as they were for soaring interest rates in the late 1970s. Following the example of the 1980s, one policy response to the current crisis is to develop instruments to allow investors to trade house price risk in much the same way that the innovations of the 1980s allowed investors to trade interest rate risk.

References

Ambrose, Brent W., and Thomas Thibodeau, 2004, Have the GSE Affordable Housing Goals Increased the Supply of Mortgage Credit? *Regional Science and Urban Economics* 34, 263–273.

Artle Roland, and Pravin Varaiya, 1978, Life Cycle Consumption and Homeownership, *Journal of Economic Theory* 18, 38–58.

Bai, Jushan, 1999, Likelihood Ratio Tests for Multiple Structural Changes, *Journal of Econometrics* 91, 299–323.

Bartlett, William W., 1989, *Mortgage-Backed Securities* (New York Institute of Finance, New York. NY).

Brueckner, Jan K., 1986, The Downpayment Constraint and Housing Tenure Choice, *Regional Science and Urban Economics* 16, 519–525.

Campbell, John Y., and João F. Cocco, 2003, Household Risk Management and Optimal Mortgage Choice, *The Quarterly Journal of Economics* 118, 1449–1494.

Carroll, Christopher D., and Andrew A. Samwick, 1997, The Nature of Precautionary Wealth, *Journal of Monetary Economics* 40, 41–71.

Chomsisengphet, Souphala, and Anthony Pennington-Cross, 2006, The Evolution of the Subprime Mortgage Market, *Federal Reserve Bank of St. Louis Review* 88, 31–56.

Cocheo, Steve, 2003, 25 years later Merrill's CMA Is Still Making Waves, *ABA Banking Journal*, August.

Devaney, Mike, and Karen Pickerill, 1990, The Integration of Mortgage and Capital Markets, *Appraisal Journal* 58, 109–113.

Devaney, Mike, Karen Pickerill, and Fred Krause, 1992, Cointegration and Causal Relations in Mortgage and Capital Markets, *Journal of Financial Services Research* 5, 341–353.

Dynan, Karen E., Jonathan Skinner, and Stephen P. Zeldes, 2004, Do the Rich Save More? *Journal of Political Economy* 112, 397–444.

Dynan, Karen E., Douglas W. Elmendorf, and Daniel E. Sichel, 2006, Financial Innovation and the Great Moderation: What Do Household Data Say? Federal Reserve Bank of San Francisco Conference:*Financial Innovations and the Real Economy*, November.

Elliehausen, Gregory E., and Thomas A. Durkin, 1989, Theory and Evidence of the Impact of Equal Credit Opportunity: An Agnostic Review of the Literature, *Journal of Financial Services Research* 2, 89–114.

Engelhardt, Gary V., 1996, Consumption, Down Payments, and Liquidity Constraints, *Journal of Money, Credit and Banking* 28, 255–271.

England, Catherine, 1992, Lessons from the Savings and Loan Debacle: The Case for Further Financial Deregulation, *Regulation: The Cato Review of Business & Government* 15(3).

Friedman, Milton, 1957, *A Theory of the Consumption Function* (Princeton University Press, Princeton, NJ).

Gilbert, R. Alton, 1986, Requiem for Regulation Q: What it Did and Why it Passed Away, *Federal Reserve Bank of St. Louis Review* 68, 22–37.

Goodfriend, Marvin, and Robert G. King, 2005, The Incredible Volcker Disinflation, *Journal of Monetary Economics* 52, 981–1015.

Guttentag, Jack, 1984, Recent Changes in the Primary Home Mortgage Market, *Housing Finance Review* 3, 221–254.

Hansen, Julia L., John P. Formby, and W. James Smith, 1996, The Income Elasticity of Demand for Housing: Evidence from Concentration Curves, *Journal of Urban Economics* 39, 173–192.

Harrigan, Susan, 1981, Wachovia Has Other Bankers Taking Notice, *Wall Street Journal*, April 27.

Hendershott, Patric H., and Robert Van Order, 1989, Integration of Mortgage and Capital Markets and the Accumulation of Residential Capital, *Regional Science and Urban Economics* 19, 189–210.

Himmelberg, Charles, Mayer, Christopher, and Todd Sinai, 2005, Assessing High House Prices: Bubbles, Fundamentals and Misperceptions *Journal of Economic Perspectives* 19, 67–92.

Jaffee, Dwight, 2003, The Interest Rate Risk of Fannie Mae and Freddie Mac, *Journal of Financial Services Research* 24, 5–29.

Kettell, Russell W., 2006. Golden West Financial at Credit Suisse First Boston Financial Services Conference – Final, February 8.

Lewis, Michael, 1989, *Liar's Poker: Rising Through the Wreckage on Wall Street* (Penguin Putnam, New York, NY).

Linneman, Peter, and Susan Wachter, 1989 'The Impacts of Borrowing Constraints on Homeownership, *Real Estate Economics* 17, 389–402.

Macauley, Ian T., 1980., Banks Offer New Choices In Mortgages, *New York Times*, May 25.

MaCurdy, Thomas E., 1982., The Use Of Time Series Processes To Model The Error Structure Of Earnings In A Longitudinal Data Analysis, *Journal of Econometrics* 18, 83-114.

Mason, David L., 2004, *From Buildings and Loans To Bail-Outs: A History of the American Savings and Loan Industry, 1831–1995* (Cambridge University Press, Cambridge, United Kingdom)

Mayo, Stephen K., 1981, Theory and estimation in the economics of housing demand, *Journal of Urban Economics* 10, 95–116.

McConnell, Margaret and Gabriel Perez Quiros, 2002, Output Fluctuations in the United States: What Has Changed Since the Early 1980s? *American Economic Review* 90, 1464-76.

Miniaci, Raffaele and Guglielmo Weber, 2002, Econometric Issues in the Estimation of Household Portfolio Models, in Guiso, Luigi, Michael Haliassos, and Tullio Jappelli, ed.: *Household Portfolios* (The MIT Press).

Morris, Frank E., 1975, Solving the Long-Range Problems of Housing and Mortgage Finance, in Modigliani, F., and D. Lessard, ed.: *New Mortgage Designs for Stable Housing in an Inflationary Environment*, Conference sponsored by the Federal Reserve Bank of Boston, U.S. Department of Housing and Urban Development, and Federal Home Loan Bank Board.

Munnell, Alicia H., Tootell, Geoffrey M. B., Browne, Lynn E., and James McEneaney, 1996, Mortgage Lending in Boston: Interpreting HMDA Data, *American Economic Review* 86, 25–53.

Passmore Wayne, Roger Sparks, and Jamie Ingpen, 2002, GSEs, Mortgage Rates, and the Long-Run Effects of Mortgage Securitization, *Journal of Real Estate Finance and Economics* 25, 215–242.

Phalon, Richard, 1977, A Mortgage Plan To Help the Young, *New York Times*, May 26.

Ranieri, Lewis S., 1996, The Origins of Securitization, Sources of Its Growth, and Its Future Potential, in Leon Kendall and Michael Fishman, ed.: *A Primer on Securitization* (The MIT Press).

Shaman, Diana, 1979, Mortgage Seekers Find Few Doors Open, *New York Times*, September 30.

Shore, Stephen, and Todd M. Sinai., 2005, Commitment, Risk, And Consumption: Do Birds Of A Feather Have Bigger Nests? *NBER Working Paper 11588*.

Sinai, Todd, and Nicholas S. Souleles, 2005, Owner-Occupied Housing As A Hedge Against Rent Risk, *Quarterly Journal of Economics* 120, 763–789.

Stahl, David, 1996, A COFI break, *Mortgage Banking*, November 1.

Straka, John W., 2000, A Shift in the Mortgage Landscape: The 1990s Move to Automated Credit Evaluations, *Journal of Housing Research* 11, 207–232.

Van Nieuwerburgh, Stijn, and Pierre-Olivier Weill, 2007, Why Has House Price Dispersion Gone Up? Unpublished manuscript, University of California Los Angelos.

Figure 1. Secondary market activity: Stock and flow measures. This figure shows the proportion of the flow of mortgages that were securitized each year ("flow measure"), and the proportion of the stock of mortgages that were securitized each year ("stock measure").

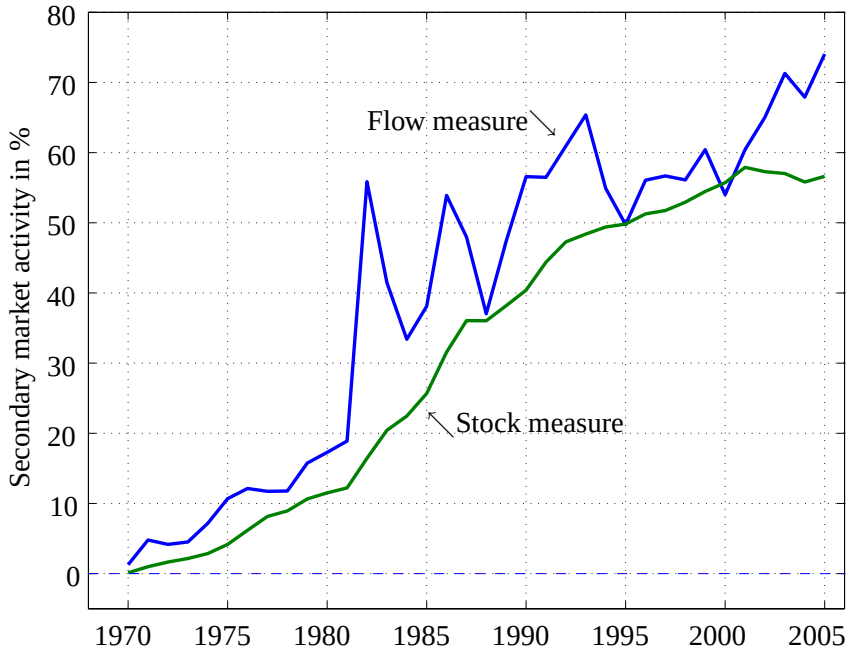

Figure 2. Borrowing Constraints, Income Growth and Housing Expenditure. This figure shows how borrowing constraints attenuate the observed relationship between house size and income growth.

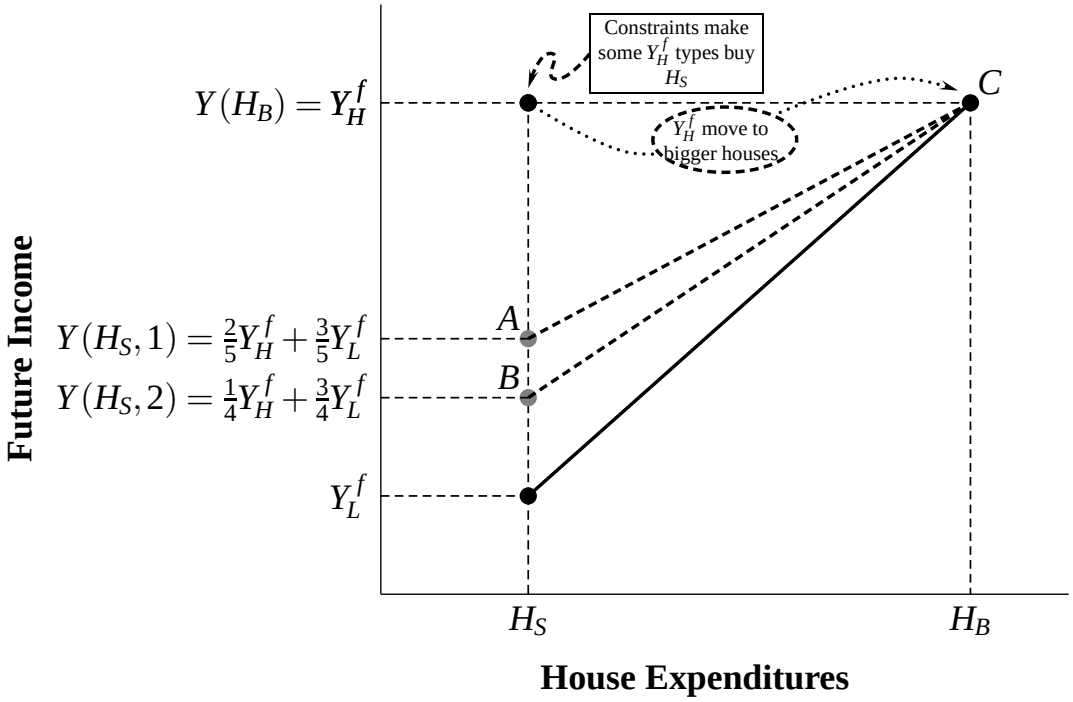

Figure 3. Housing Expenditure and Future Income. For each quintile of the distribution of the ratio of housing expenditure to income, this figure shows the corresponding average income growth.

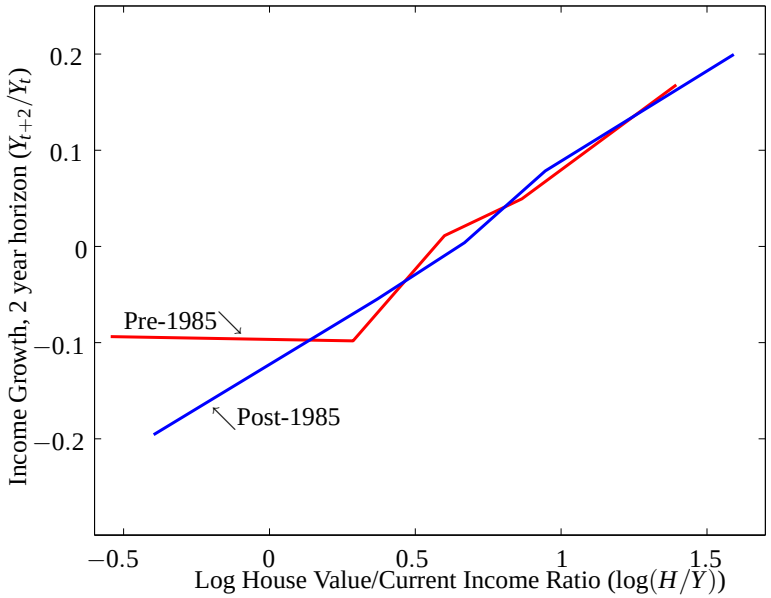

Table I
Summary Statistics.

The baseline sample includes all home buyers in the PSID over the years 1970-2005 excluding those in the SEO Poverty Sample.

	(obs = 6,147)		
	Mean	St. dev.	Median
Size of household	3.0	1.4	3.0
Age of head	39	14	35
Real Amounts (2000 Dollars)			
Total family income	65,633	67,303	53,992
Labor income	53,955	45,156	46,838
House value	129,487	127,759	102,389
Size of mortgage	95,603	83,177	78,842
Percentages of household heads who are...			
Male		90.0%	
White		93.5%	
Black		4.6%	
Other race		1.9%	
Educ $<$ High School		5.4%	
Educ = High School		26.0%	
High School $<$ Educ $<$ College		36.6%	
Educ = College		21.6%	
Educ $>$ College		10.5%	
First-Time Buyers		21.3%	

Table II
Baseline Specification.

Estimation of equation (2) in the text, which forecasts future income using a set of variables including the log of house value. The diagram shows, for each time period j, the sum of α_j and α_{3j} from equation (2). This sum is the total estimated effect of house size on future income. The estimated effects indicate that the ability of house size to forecast future income has increased over time.

Dependent variable is the log of the average of income 2 and 4 years ahead					
Variable	**Coeff.**	**(Std. Error)**	**Variable**	**Coeff.**	**(Std. Error)**
log(Total Family Income)	0.570	(0.016)	Female	-0.209	(0.024)
log(House Value)	0.087	(0.024)	Size	0.016	(0.004)
Age	0.039	(0.010)	$= 1$ if year $\in (1973, 1975)$	0.020	(0.031)
Age$^2\times$1e3	-0.849	(0.212)	$= 1$ if year $\in (1976, 1978)$	-0.008	(0.031)
Age$^3\times$1e6	4.870	(1.440)	$= 1$ if year $\in (1979, 1981)$	0.027	(0.032)
High School	0.036	(0.024)	$= 1$ if year $\in (1982, 1984)$	0.029	(0.031)
Some College	0.092	(0.024)	$= 1$ if year $\in (1985, 1987)$	0.073	(0.032)
College	0.164	(0.026)	$= 1$ if year $\in (1988, 1990)$	0.054	(0.028)
$>$ College	0.219	(0.028)	$= 1$ if year $\in (1991, 1993)$	0.082	(0.030)
Black	-0.024	(0.023)	$= 1$ if year $\in (1995, 1997)$	0.053	(0.034)
Other Race	-0.041	(0.034)	$= 1$ if year $\in (1999, 2001)$	0.073	(0.031)

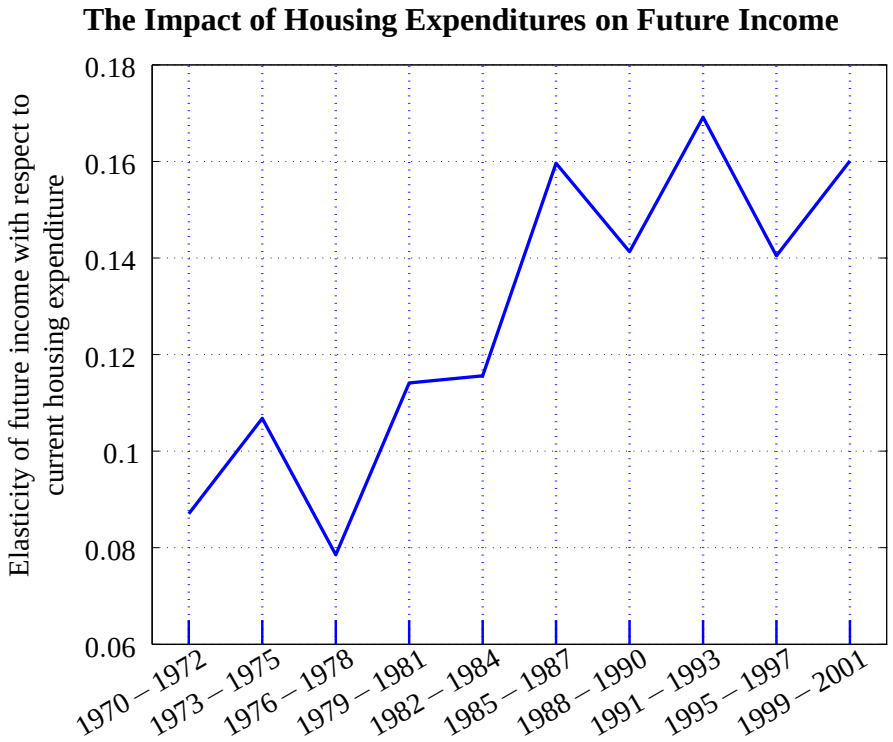

Table III
Alternative Specifications.

Each column shows the estimates of a regression of the logarithm of the average of income 2 and 4 years in the future on the indicated right-hand-side variables. Each regression also includes the demographic variables in the baseline regression in Table II, which are not reported for the sake of brevity. The figures in parentheses are standard errors. The coefficients on the interaction between the flow measure of securitization and the log of house value indicate that increased securitization increases the predictive power of house value. The variable CV is the variance of the log of income.

	Dependent variable is the log of the average of income 2 and 4 years ahead							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log(Total Family Income)	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***
log(House Value)	0.09	0.10	0.09	0.08	0.09	0.09	0.05	0.10
	(0.02)***	(0.01)***	(0.01)***	(0.03)***	(0.03)***	(0.01)***	(0.02)***	(0.02)***
Following variables are interacted with log(House Value)								
= 1 if year $\geq$ 1985		0.05						
		(0.01)***						
Securitization (Flow Measure)			0.12	0.12	0.12	0.11	0.11	0.12
			(0.03)***	(0.04)**	(0.04)***	(0.03)***	(0.03)***	(0.04)***
Inflation (CPI)				-0.02	0.08			
				(0.39)	(0.35)			
6-month LIBOR				0.04				
				(0.29)				
10-year Treasury Rate					-0.15			
					(0.34)			
CV						-0.34	-1.41	
						(0.08)***	(0.43)***	
CV $\times$ Time-Trend						0.03	0.02	
						(0.00)***	(0.00)***	
CV $\times$ log(House Value)							0.10	
							(0.04)**	
3-yr Time Dummies	Yes	No	No	No	No	No	No	No
State Fixed Effects	No	No	No	No	No	No	No	Yes
Observations	6147	6147	6147	6147	6147	6147	6147	6129

Table IV
Alternative Subgroups.

Each panel shows the estimates of α_2 and and α_3'' from Equation (3) for the associated subgroups of the sample. The dependent variable is the log of the average of income two and four years ahead. Each regression also includes the demographic variables from the baseline regression in Table II, which are not reported for the sake of brevity. The figures in parentheses are standard errors. The first column in each of the three panels shows the estimates for subgroups that one might expect to have had relatively poor access to housing finance. The point estimates on the respective interaction terms suggest that increased securitization has particularly benefitted members of these groups.

	(1)		(2)		(3)	
	First-Time Homebuyer	Repeat Homebuyer	Income $\leq$ Median	Income $>$Median	Female or Black	Male and Non-Black
log(House Value)	0.042	0.120	0.038	0.112	0.041	0.103
	-0.0299	(0.0222)***	(0.0327)	(0.0199)	-0.0617	(0.0184)***
Securitization Flow x	0.206	0.114	0.198	0.109	0.269	0.107
log(House Value)	(0.0707)***	(0.0459)**	(0.0749)***	(0.0441)**	(0.1281)**	(0.0404)***
Observations	1,287	3,083	1,917	4,212	478	3,946