Home is Where the Equity Is:

Liquidity Constraints, Refinancing and Consumption

Erik Hurst
Graduate School of Business
University of Chicago
Chicago, Illinois 60637

and

Frank Stafford
Department of Economics
Institute for Social Research
University of Michigan
Ann Arbor, Michigan 48109 - 1220

July 2001

Home is Where the Equity Is:

Liquidity Constraints, Refinancing and Consumption

Abstract: This paper documents the extent to which homeowners use housing equity to smooth their marginal utility of consumption over time. Unlike drawing down other forms of saving, accessing accumulated home equity can be quite costly. As a result, households accumulating home equity could be liquidity constrained in the sense that they would like to access this equity to fund consumption but are unwilling to pay the costs to do so. Theoretically and empirically, a key distinction can be drawn between those refinancing their home mortgage to improve their wealth position from those who had a consumption smoothing motivation to refinance. Incorporating characteristics of a mortgage into a traditional permanent income model with exogenous liquidity constraints, one can understand household refinancing behavior in a world where mortgage interest rates are historically high and rising - up to now, an empirical puzzle. This model predicts a large consumption stimulus as mortgage rates are reduced allowing liquidity constrained households to more easily access their accumulated home equity. Using data from the Panel Study of Income Dynamics, households that experienced a negative income shock and who had limited liquid assets to draw upon are shown to have been 19 percent more likely to refinance in the early 1990s. On average, liquidity constrained households converted over 60 percent of the equity they removed while refinancing into current consumption as mortgage rates plummeted between 1991 and 1994. In contrast, no such behavior was found in non-liquidity constrained refinancers. There was a corresponding stimulus of *at least* $18 billion from the refinancing activity of liquidity constrained households during the 1991-1994 period.

Home is Where the Equity Is:

Liquidity Constraints, Refinancing and Consumption

I. INTRODUCTION

The home is the major asset for most households. Housing equity comprises over 35% of the median household's non-pension wealth - by far the largest single non-pension portfolio component (Hurst, Luoh and Stafford, 1998). However, unlike drawing down other assets, accessing home equity often entails large pecuniary costs. The fixed closing costs alone associated with refinancing a mortgage or applying for a second mortgage are estimated at 1.5 - 2.5 percent of the household's initial mortgage balance (Bennett, Peach and Peristiani, 1998). Adding in the costs of searching for a lender, filling out mortgage applications, preparing documentation, paying prepayment penalties and potentially paying a high marginal borrowing costs on the equity removed can significantly increase the actual amount that a household has to pay in order to access home equity.

According to standard consumption theory, when confronted with unexpected, negative income or expenditure shocks or in anticipation of rising future income, households would like to transfer resources from the future to finance added current consumption, thereby smoothing their marginal utility of consumption over time. If households have sufficient amounts of 'more-liquid' assets (checking account balances, stocks, etc.) it is relatively easy to smooth consumption. However, it becomes more difficult for a household to consume more than their earned income when these liquid asset balances are low. For households with low liquid assets, one option for them to increase their current consumption is to pay the associated costs and tap into their accumulated home equity. But, for a subset of homeowners, the housing equity is essentially trapped in the home; the gain in lifetime utility from increasing current consumption by drawing down home equity would not be sufficient to offset the costs incurred to access the home equity. These households may be appropriately characterized as being liquidity constrained even though they had equity in their home (positive wealth); they would like to increase current consumption by drawing down home equity but are unwilling to incur the cost to do so.[1,2] While there

---

[1] We assume that the cost associated with non-collateralized borrowing sources - such as credit card debt - are even greater than that of accessing home equity. This is likely to hold true for households looking for medium to large increases, but would likely not hold for small desired increases in current consumption.

[2] We refer to liquidity constrained households not only as households who cannot borrow, but also as households who would like to draw down their assets to increase current consumption, but who are unwilling to do so because of the high cost associated with accessing their savings. This notion of liquidity constraints is discussed by many authors, including Attanasio (1994) who wrote that "Fixed costs on some asset transactions might also be considered as liquidity constraints. Access to some forms of wealth can be extremely costly (housing wealth) or even impossible before a certain age (pension wealth)."

has been much academic work looking at whether households behave as permanent income consumers (for a survey see Browning and Lusardi, 1996), the extent to which households use home equity as a financial buffer has been relatively overlooked. This omission is surprising given, as noted above, that for most households, the home is where the equity is.

Additionally, if expansionary monetary policy is to lead to a spending stimulus in the household sector, families must respond either by reducing saving or increasing borrowing to finance current consumption. The majority of the academic literature on this subject finds little consumption sensitivity to interest rate movements. As many authors have pointed out, whether interest rate elasticities are actually small or whether these findings are due to measurement problems in aggregate or survey data is still up for debate (Browning and Lusardi, 1996). This literature, however, does not focus on how changes in interest rates effect refinancing behavior and consequently consumption. The effect of changes in interest rates on consumer spending can be large for liquidity constrained homeowners with equity available in their home. In periods when current mortgage rates are declining relative to the contract rate on existing mortgages, the net benefit of accessing home equity increases. The pecuniary costs of accessing home equity will remain fixed, but now a liquidity constrained household will receive _two_ benefits from refinancing their mortgage: the ability to access their home equity _and_ the fact that the household could lock in a lower mortgage rate on their existing mortgage balance during the refinancing process.[3] In such an instance, we would expect a large fall in nominal mortgage rates to be followed by a consumption increase as previously liquidity constrained households are able to access their home equity at a lower net cost.

This paper explores the use of home equity as a mechanism by which households can smooth their marginal utility of consumption over time. A model of optimal refinancing incorporating the household's desire to access home equity highlights two distinct reasons why a household may choose to refinance: 1) In periods of relatively low interest rates, the household would refinance to receive a lower stream of mortgage payments and consequently receive an increase in lifetime wealth - this is referred to as the 'financial' motivation to refinance, and 2) households may refinance so as to access accumulated home equity - referred to as the 'consumption smoothing' motivation to refinance. Households receiving a negative consumption or income shock or if they are impatient and have accumulated a large amount of equity in their home, are shown to be more likely to choose to refinance if their reserves of more-liquid

---

[3] In this paper we focus on the refinancing decision. A similar story can be told for second mortgages or home equity lines of credit. The rates on these two types of borrowing exceed current market mortgage rates for a primary mortgage. Brady, Canner and Maki (2000) argue: "Most Homeowners who can qualify for a refinancing will also be able to obtain funds through a home equity loan, a personal loan, or a credit card account. A first mortgage usually carries the lowest available interest rate, so refinancing is often the best choice for raising a large amount of new funds" (pg. 442). Furthermore, our empirical work focuses

assets are limited, all else equal. This consumption smoothing motivation explains what has been treated as an empirical anomaly in the housing literature (Stanton, 1995) – that some households will refinance even in a world of stable or rising interest rates. We also show that in periods of falling interest rates, refinancing households who were previously liquidity constrained were more likely than non-liquidity constrained households to remove equity to fund current consumption.

Using micro data from the Panel Study of Income Dynamics (*PSID*), strong evidence for our theoretical predictions is found - the house is used as a mechanism to smooth income shocks and to alleviate otherwise binding liquidity constraints. Households who received negative income shocks and who had low levels of liquid assets were 19 percentage points more likely to refinance during the early 1990s even after controlling for the present value wealth gain of locking in the lower mortgage rates that prevailed during this time period. These same households were also more likely to remove equity while they were refinancing. Furthermore, it is possible to distinguish empirically those who refinanced primarily to improve their balance sheet position (financial motivation) from those who were otherwise liquidity constrained and removed equity while refinancing so as to increase current consumption (consumption smoothing motivation). The latter group exhibits what can be termed as a high average propensity to convert home equity into current consumption. These liquidity constrained refinancers converted 60 cents out of every dollar they removed into current consumption. Non-liquidity constrained refinancers also removed equity during the refinancing process. However, these households, on average, did not convert any of the equity they removed into current consumption - they simply shifted that equity to other portfolio components. Finally, it is estimated that during the 1991-1994 period when mortgage rates fell substantially and the cost of accessing home equity was reduced for liquidity constrained households, these formerly liquidity constrained households increased aggregate consumption, via refinancing, by *a minimum* of $18 billion.

The paper is organized as follows. Section II reviews a selection of the existing literature on liquidity constraints, the use of the home as a buffer against shocks and refinancing behavior. Section III sets up the empirical work by incorporating a consumption smoothing motive via refinancing as a central element in the household's lifetime consumption decision. Predictions from this theory are consistent with aggregate time series data. In Section IV, micro data from the Panel Study of Income Dynamics (*PSID*) are used to test the conceptual approach. Here, empirical results consistent with the consumption smoothing motivation developed in Section II are presented. Section V outlines the difference in refinancing behavior between liquidity constrained and non-liquidity constrained households. Liquidity

---

on the early 1990s when refinancing was prevalent and the incidence of second mortgages and home equity lines of credit were extremely low. As discussed in the next section, the logic of our theory applies to the other means of accessing home equity.

constrained households were likely to pay a premium to access home equity and were far more likely to remove equity to fund current consumption. The last section offers some policy implications and concluding remarks.

II. SUMMARY OF PREVIOUS RESEARCH

There is growing evidence that the home is used as a buffer against adverse shocks.[4] Carroll, Dynan and Krane (1999) test for whether households with a greater risk of unemployment are more likely to hold assets to buffer the potential shocks - an implication of a model with precautionary savings. They found a significant precautionary motive in a broad measure of wealth that included home equity, but found no such precautionary motive in more liquid forms of wealth. The suggestion that homeowners use their home as a potential buffer is also supported in Skinner (1996). Households who were early in their lifecycle increased their consumption in response to an unexpected housing windfall. In contrast households did not alter their consumption in response to an unexpected housing windfall later in their lifecycle. Such households only responded to a rapid appreciation in house prices if they experienced adverse economic events. These disparate findings are reconciled by suggesting that "the home is used as a key component in insuring against retirement contingencies". Engelhardt (1996) finds similar results.   He finds that households do not decrease their savings when faced with unanticipated housing gains but they do increase their savings when faced with unanticipated housing declines. These results are also consistent with the hypothesis that homeowners treat housing equity as a buffer.

Refinancing activity was on the rise during the early 1990s. Not only was it a period of relatively low mortgage rates, but it has been argued that mortgage markets were under going structural changes. Bennett, Peach and Peristiani (1998) have concluded that accessing home equity has become much easier in the 1990s relative to the 1980s. They find that competition in primary mortgage markets, improvements in information processing technology, the streamlining of the mortgage application and approval process and an increase in financially savvy homeowners have led to a dramatic reduction in the costs associated with accessing home equity. The reduction in these costs appear to have led to more refinancing during the early 1990s than was predicted by traditional models of prepayment. Brady, Canner and Maki (2000) report that, in 1994, 45% of mortgage debt holders had refinanced their mortgage at some time in the past. A majority of these homeowners had refinanced in the 1993-1994 period.

---

[4] The existence of binding liquidity constraints is well documented in the literature.   See, for example, Hayashi (1985), Zeldes (1989), Jappelli (1990), Deaton (1991), Attanasio and Browning (1995), Browning and Lusardi (1996), and Gross and Souleles (2001).

Despite the potential for housing equity to be used as a financial buffer, there is little formal empirical or theoretical work that explores whether households access home equity so as to smooth consumption. Much of the work on mortgage refinancing has focused on purely 'financial' motivations (Curley and Guttentag (1974); Green and Shoven (1986); and Quigley (1987)).[5] When current mortgage rates are below the existing mortgage contract rate, households have an incentive to replace their existing fixed rate mortgage with one at a lower rate. The benefit to the household is a present value wealth gain.[6] This benefit only need exceed the time and money costs of acquiring the new mortgage - which, as discussed above, can be quite large. Noting that a fixed rate mortgage contract conveys a valuable call option to the borrower, Chen and Ling (1989) and Kau and Keehan (1995) extended this approach by developing a contingent claims framework embodying a dynamic model of the decision to refinance. Empirically, refinancing behavior is like other call options: the value of the option is positively related to remaining term to maturity, to volatility in interest rates, and to the contract rate on the existing loan.

While interest rate movements and expected future interest rate movements (the financial option approach) can forecast a great deal of refinancing behavior, Stanton (1995) notes that it fails to explain some important empirical patterns. Some fixed rate mortgages are prepaid even when current market mortgage rates are above the household's contracted coupon rate and some fixed rate mortgages are not prepaid even when current market mortgage rates are well below the household's contracted coupon rate. Gilberto and Thibodeau (1989), Dickson and Heuson (1993) and VanderHoff (1996) suggest that a household may choose to refinance so as to remove equity to invest in the stock market or to expand their housing stock as family size grows. While these papers illustrate circumstances in which households would refinance in periods of high interest rates, none of them formalize a model of the consumption smoothing benefits from accessing home equity, nor do they relate the refinancing behavior to income shocks or explain differences in behavior between liquidity constrained and non-liquidity constrained borrowers.

When discussing refinancing behavior it is important to consider not only the borrower side but also the decisions made by lenders.[7] According to traditional U.S. banking practices, a household with an loan-to-value ratio (ratio of outstanding mortgage balance relative to current house prices) of under 0.8

---

[5] There is little existing literature on second mortgages or home equity lines of credit. For an analysis of second mortgages, see Manchester and Poterba (1989). See Salandro and Harrison (1997) for a discussion of home equity lines of credit. Dickson and Hueson (1993) model the household's decision to refinance when faced with other methods of accessing home equity.

[6] In periods of low mortgage rates, refinancing households can receive a present value gain to wealth along three margins: by reducing their monthly mortgage payments, by removing household equity or by reducing the remaining mortgage term.

[7] Recently, some authors have tried to explain why mortgages are not prepaid even when the financial option is in the money by focusing on optimal lender behavior. Caplin, Freeman and Tracey (1997), Archer, Ling, and McGill (1996) and Peristiani et al. (1996) focus on lender concerns over collateral and borrower credit-worthiness to explain a lack of refinancing in the face of lower mortgage rates. Additionally, for a full discussion of mortgage lending behavior including credit and debt to income tests, see Caplin, Freeman and Tracey (1997).

will be accepted, conditional on meeting the established credit and debt to income tests. If a household has a loan-to-value ratio of above 0.8, the lenders require that the household purchase private mortgage insurance, thereby boosting marginal borrowing costs associated with refinancing (usually by raising the average rate by 25 basis points). A household with a loan-to-value ratio above 0.9 may be relegated to an even higher rate segment of the mortgage market; in recent years some lenders have been offering 'zero equity mortgages' or even mortgages at 125 percent of house value. These zero and negative equity mortgages embody a sharply rising marginal borrowing cost presumably targeted to those with a strong interest in current consumption.[8] Such lender side concerns over default risk can boost marginal borrowing costs or lead to credit rationing. If so, a family with a high loan to value ratio may be unable to refinance even if they wanted to access home equity.

In this paper, we abstract from the lender side of the market. We focus on borrower incentives to access home equity. We refer to the access of home equity as refinancing – even though refinancing is only one means of liquidating equity. The general outline of the theoretical model applies to any method of accessing home equity - such as home equity lines of credit or to second mortgages – as long as accessing the home equity imposes some non-trivial fixed cost on the borrower. For the empirical work, we focus on refinancing because it was the prevalent method of adjusting home equity during the period we are studying – the early to mid 1990s.

III. THE REFINANCING DECISION IN A PERMANENT INCOME MODEL

This section sets out a model in which households are allowed to use their home equity as a buffer stock. Each household is endowed with a fixed housing stock. Each household optimally chooses consumption, savings, and mortgage borrowing. The key features to this model are that the agent faces different borrowing and lending rates. The agent may not borrow more than his endowed value of housing stock. Finally, the agent must pay a fixed cost in order to change the total quantitiy borrowed. We choose to interpret the borrowing in this model as a secured loan on the housing stock. We will refer to changes in the borrowing levels as refinancing. For simplicity, households are not allowed to alter their housing stock and the utility generated by consuming the flow of housing services is ignored.[9] The house is simply treated as another asset in which the household can choose to add or remove savings after paying a fixed cost.

---

[8] Additionally, the continued deductibility of mortgage interest after the U.S. tax code was changed to eliminate the deduction of other consumer interest payments in the early 1990's encouraged lenders to offer increased borrowing options to households wishing to transfer debt into housing for tax purposes.

[9] This assumption is qualitatively similar to assuming that the consumption flow from housing and the consumption of other goods is separable. Recent papers that more formally model the decision to rent versus buy or model the decision to alter the housing stock include Dunn (1998) and Flavin and Ymashita (1998).

A. The Model

Households i chooses consumption, C_{it}, whether to refinance, R_{it}, and the change in housing equity conditional on refinancing (the amount of equity liquidated), L_{it}, so as to maximize:

$$E_t[\sum_{s=0}^{\infty} \beta^s U(C_{it})],\tag{1}$$

subject to the following constraints:

$$X_{i,t+1} = X_{it}(1+r) + Y_{i,t+1} - C_{i,t+1} + (L_{i,t+1} - F_{i,t+1})R_{i,t+1} - M_{i,t+1}\tag{2}$$

$$B_{it} = B_{i,t-1} - L_{it}\tag{3}$$

$$M_{it} = r_t^m B_{it}\tag{4}$$

R_{it} = 1 if the household refinances, 0 otherwise

$M_0 = r^m{}_0 B_0$

C_{it} and $X_{it} \geq 0$ for all t

$0 \leq B_{it} \leq H$

$B_{i0}, X_{i0,}$ and H are given ,

where C_{it} is household i's consumption in period t, β is the household's intertemporal time discount factor, and $U(C_{it})$ is a constant elasticity of substitution utility function of the form $C_{it}^{1-\rho}/(1-\rho)$, where ρ is the coefficient of relative risk aversion. Households hold two assets; a risk free asset that is perfectly liquid, X_{it} and a less liquid asset, H (for simplicity, we will refer to H as a home). We explicitly build binding liquidity constraints into our model; households cannot be a net debtor in either X or H.

Households are endowed with a 'mortgage' on H in period 0, B_0. As a result, households start with equity in their home equal to $H - B_0$. If the household has outstanding mortgage debt ($B_{it} > 0$), they must make a mortgage payment equal to the interest on the mortgage balance at a mortgage interest rate of $r^m{}_0$ - the mortgage interest rate. The liquid asset, X, earns a rate of return equal to r. We also assume that H, r and r^m are exogenous and believed to be constant over the infinite horizon by all households.[10]

In each period, households choose their consumption, whether to refinance, R_{it}, and the amount of equity to add _or_ remove from the home, conditional on refinancing. If a household chooses to refinance, the new mortgage payments are computed at the new outstanding mortgage balance multiplied by the

---

[10] To compute comparative statics, we will allow for one time permanent shocks to these variables.

outstanding mortgage interest rates that prevailed in the period in which the household refinanced. The optimal amount of equity removed from or added to the illiquid asset when the household refinances is denoted as L_{it}. After the equity is removed from or added to the home, the mortgage balance on that asset adjusts by the corresponding amount. If the household refinances in period t, it must pay a cost in period t equal to F. If the household does not refinance, both L_{it} and F_{it} are set to zero. Additionally, in this model, households face income uncertainty. Household income in period t, Y_{it}, follows a Markov process with three states of the world - low income, medium income and high income.

For computational convenience this problem can be rewritten as a Bellman Equation:

$$V(X,B,Y) = \max_{\{C,R,L\}} u(C) + \beta EV(X^{'},B^{'},Y^{'}) \tag{5}$$

Proof of the equivalence between the Bellman Equation and the above sequence problem is straightforward. For a proof of this equivalence in a similar problem and for a description of the numerical techniques employed to solve this model see Martin (2000). To illustrate comparative dynamics, we solve the model with different parameters. The value of the housing stock is constant. Prospective yearly income is drawn from three states - low, medium and high - with the transition over time represented by the following Markov process:[11]

		Income t		
		Low Income	Medium Income	High Income
	Low Income	0.5	0.3	0.2
Income t-1	Medium Income	0.25	0.5	0.25
	High Income	0.2	0.3	0.5

Normalize the medium income state to 1, the low income state to 0.5 and the high income state to 1.3 and set the coefficient of relative risk aversion equal to 1.5 and the fixed cost to refinancing to be 3% of the house value. The return on the risk free liquid asset is set to 0.03 and the initial mortgage rate was set to 0.07. The time discount factor is initially set as either 0.85 or 0.95.[12]

---

[11] The transition matrix is not calibrated to actual data. The purpose of this section is to establish qualitative results that will help guide our empirical work. This model is for a representative consumer. To match the aggregate data on refinancing and consumption, we would have to add in more heterogeneity into this model. Our numerical solutions are qualitatively robust to all income specifications and preference parameters that we have chosen.

[12] Lawrence (1991) and Samwick (1997) find large time discount rate using micro data implying that a time discount factor of 0.85 is not excessively small. We also report the results with $\beta = 0.95$.

The purpose of the theoretical exploration is to identify important dimensions of the consumer optimization problem and the refinancing decision when the household has the choice to access housing equity, but at a cost. These qualitative results provide guidelines for the empirical work that follows.

B.   Results

Numerical solution of the above model illustrates two different motives for the household to refinance. When mortgage rates fall, households will refinance as long as the gain in lifetime wealth associated with making smaller mortgage payments is enough to offset the cost of refinancing. Households who refinance to take advantage of this present value wealth gain from locking in a lower mortgage rate are those households who had a 'financial' motivation to refinance. Some households also had a 'consumption smoothing' motivation to refinance. Households can boost utility by removing equity from the house and increasing current consumption at the expense of lowering total lifetime consumption.   We outline the salient features of the financial and consumption motivations to refinance below.

B1.   Even with no movement in mortgage rates, households may choose to refinance so as to access home equity.

Panels a1, b1 and c1 of figure 1 shows the refinancing decision for the three potential income states (low, medium and high, respectively) derived from the model and parameter specifications above, using a time discount factor of 0.85. The refinancing decision rules outlined in figure 1 are drawn in B, X space, where B and X are defined as above.   Panels a2, b2 and c2 of figure 1, also drawn in B, X space, show the amount of equity, if any, removed from or added to the household's mortgage balance conditional on the household having refinancing in response to the income shocks.

In response to a poor income shock (panel a1), two groups of households refinance: those with little liquid assets and a large amount of home equity (low X and low B) and those with large amounts of liquid assets and large amounts of mortgage debt (high X and high B). The first group removed substantial equity from their home during the refinancing process (panel a2), while the second group actually reduced their mortgage debt (added equity to their house) when refinancing.

Motivated by consumption smoothing, this first group of refinancing households found it in their best interest to pay the refinancing cost and access home equity when faced with a negative income shock. It should be noted, that not all home owners who received a poor income shock, who had low liquid assets and who had some equity in their home refinanced.   Households with low assets (X close to 0) and little home equity (B above about 0.75) did not refinance – even though they had some

accumulated home equity to draw down. For them, the loss in lifetime utility that resulted from paying the refinancing costs were larger than the utility gains from accessing the home equity and increasing current consumption. As a result, these households were truly liquidity constrained. They would have liked to have drawn down their savings to increase current consumption but the cost of accessing their home equity prevented them from doing so. As further evidence that these households are liquidity constrained, we find that such households had a much larger jump in consumption if in future periods they received the medium or high income draw when compared to the other households who had low liquid assets and who did choose to refinance.

To summarize, households who had low liquid assets and large amounts of home equity refinanced when faced with a poor income shock. As liquid assets grew (move along the X axis in panel a1), the propensity to refinance for consumption smoothing reasons fell. Additionally, as noted above, the propensity to refinance also declined as home equity diminished. Finally, as indicated in panels b1 and c1, as the household received better income draws the propensity to refinance for consumption smoothing reasons diminished. There was less need to smooth consumption when the medium and high income draws were realized. In the following empirical section, we will test if those households who received a poor income draw _and_ who had low liquid assets _and_ who had large amounts of housing equity were more likely to refinance, all else equal.

Another interesting result arises from an analysis of figure 1. Households with a large amount of liquid assets (large *X*) and relatively little home equity (large outstanding mortgage balance - *B* close to 1) also refinanced in the face of a poor income shock. These households wanted to convert some of their liquid assets into home equity (a negative *L* in figure a2). By doing so, these households could reduce their per period mortgage payment, freeing up more resources to spend on current consumption (generating a present value wealth gain by reducing their mortgage payments). These households did not refinance to access home equity; they did so to accumulate home equity so as to avoid paying interest payments on the debt. Although it is hard to tell simply by reading panel a2 of figure 1, these households reduced their mortgage balance to zero as they refinanced. Similarly to refinancing in the face of lower interest rates, these refinancing households were motivated by financial reasons – ie, to get a present value wealth gain from converting some of their accumulated liquid assets into home equity.[13]

---

[13] The households with the largest amounts of mortgage debt (little home equity) and high amounts of liquid assets did not refinance. These households with large mortgage debt optimally choose to wait to a future period to refinance. Such households with large mortgage balances could not pay their mortgage all the way down to zero and still hold their desired amount of liquid assets. These households are waiting to they accumulate more liquid assets so they can refinance and take the mortgage balance all the way down to zero. Refinancing now means they would likely have to refinance twice (and pay the refinancing costs twice) to take their mortgage balance down to zero.

Households with high liquid assets and large amounts of home equity did not refinance. These households are already paying low mortgage payments given their small mortgage balance. It is not worthwhile for these households to pay the refinancing cost to further reduce their mortgage payments. Additionally, households with a moderate amount of liquid assets also chose not to refinance. They do not need the home equity to smooth current or near term consumption, nor do they wish to convert their liquid assets into home equity. With a large positive probability that in the next period they will receive another negative income shock, they prefer to keep their savings in more liquid forms.

In panels 1b and 1c of figure 1, when there is a moderate or high income draw, more households refinance to reduce their mortgage payments and fewer households refinance to remove equity to smooth their consumption (no households refinance for consumption smoothing reasons when faced with the high income shock under this parameter specification). Again, it is the households with little liquid assets choosing not to refinance for financial reasons in periods of moderate or high income draws. These households prefer to keep their savings in more liquid forms to protect themselves against the possibility of future bad income draws. With positive income shocks, the only households who refinanced were households doing so for financial reasons, converting liquid assets to home equity so as to reduce their per period mortgage payments.

With low, moderate or high income draws, this model can generate refinancing behavior in a world of no interest rate movements. Furthermore, our model predicts that some households would choose to refinance even in a world of rising interest rates. Households with little liquid wealth may wish to pay slightly higher monthly mortgage payments (as well as the fixed costs) so as to access home equity. If low liquid asset households did not have a bad income draw, households would only refinance to exercise the financial option (ie, get a pure present value wealth gain by reducing mortgage payments). But, if households have low liquid assets and equity in their home, households may also refinance to access home equity to smooth consumption shocks. Finally, it should be noted that the liquidity constraints on the liquid assets are driving the consumption smoothing motivation to refinance. If households were allowed to be net borrowers in the liquid asset, the consumption smoothing results would not carry through - households would simply borrow from a non-collateralized source assuming that cost of borrowing on that source was lower than accessing home equity. Empirical evidence, however, seems to provide strong support for the existence of binding liquidity constraints (Zeldes, 1989 and Gross and Souleles, 2000).

B2.   In a world with no interest rate movements, households who are more impatient are more likely to refinance for a given income shock.

To this point, there is no heterogeneity in the model. To get a sense of how our results would differ across different type of households we recomputed the solution for different preference parameter values. Figure 2 is analogous to figure 1 - except that it is drawn for more patient households. Panels a1, b1 and c1 of figure 1 shows the refinancing decision for the three potential income states derived from the model and parameter specifications above, using a time discount factor of 0.95 instead of 0.85. Comparing panels a1, b1 and c1 of figure 2 with panels a1, b1 and c1 of figure 1, we see that as households become *more* patient (a higher time discount factor), they are less likely to refinance for consumption smoothing reasons in the face of any income shock. This result is intuitive. As shown in much of the existing consumption literature (Deaton, 1991), households with a lower time discount factor are more likely to be liquidity constrained or 'impatient', wishing to transfer more consumption from the future to the present.

Taking income and the time discount factor (β) as given, one can define R*(X^*,B^*) as the plane describing the refinancing decision for households motivated solely to smooth consumption, where X^* and B^* represent the maximum amount of liquid assets and mortgage debt that a household would hold and still be willing to refinance to access home equity.   As can be seen from figure 2, the change in the plane describing the refinancing decisions for households seeking to smooth their consumption in response to changes in the time discount factor are given by $\partial X^*/\partial\beta \leq 0$ and $\partial B^*/\partial\beta \leq 0$. In other words, as households become more patient, they are less willing to refinance so as to access home equity for a given level of liquid assets and mortgage equity.[14] Looking at figure 2, X^* and B^* are zero for all income realizations – for relatively more patient households, they would not choose to pay the costs to refinance even if they received a bad income draw, had little assets to buffer the shock and had a low mortgage balance.[15]

Conversely, households with a higher time discount factor are more likely to refinance for financial motivations.   Comparing panel c1 of figure 2 with panel c1 of figure 1, it can be seen that households with a higher time discount factor (figure 2), with relatively low levels of liquid assets (X = 2) and with large mortgage debt (B greater than 0.5) always refinanced and added equity to their home (reduced monthly mortgage payments) when faced with a positive income shock. Differences in individual levels of impatience, along with differences in shocks to income, may explain some of the heterogeneity

---

[14]   By extension as households become more impatient or as the households becomes mores constrained, they would be more likely to refinance for consumption smoothing reasons even in the face of rising interest rates.

observed in the aggregate refinancing data and may further explain why some households would want to access home equity even when they do not experience an income shock or when they have a flat income profile.

B3.   For a given reduction in mortgage rates, households are more likely to refinance to access home equity.

As predicted by the pure financial option, a majority of households will refinance when mortgage rates unexpectedly fall, as long as the present value gain in reduced mortgage payments is enough to offset the fixed cost of refinancing. Figure 3 is set up similarly to figure1 except that mortgage rates unexpectedly fell. As seen in panels a1, a2 and a3 of figure 3, when interest rates unexpectedly fall from 7% to 6% (with households expecting the 6% rate to persist indefinitely into the future), far more households refinanced relative to amount of refinancing that occurred when interest rates did not fall (figure 1) - although the pattern of refinancing was similar.[16]   The decrease in interest rates increased the net benefits for households wishing to refinance for consumption smoothing reasons. This resulted from the fact that all households who refinanced were able to lock in a lower mortgage rate on their existing mortgage balance. This benefit offset some of the cost associated with paying the fixed refinancing cost. As a result, we see more households refinancing for consumption smoothing reasons. The reduction in interest rates relaxed the liquidity constraints for households who had equity trapped in their home.

Panels b1, b2 and b3 of figure 3 illustrate whether the households who refinanced removed, added to or left unchanged the equity in their home, for different income shocks, for a given fall in mortgage rates. This is the same pattern in the desire to consumption smooth as shown in figure 1. Households with low liquid assets and who experienced a negative income shock were likely to remove large amounts of equity during the refinancing process. This is seen from the positive change in equity in panel a2 of figure three for those who refinanced with low liquid assets and large amounts of home equity. Comparing panels a1 and a2 of figure 1 and figure 3, more households can be seen refinancing and removing equity when there is an unexpected interest rate decline. Also, there was a larger consumption increase associated with refinancing as interest rates fell as more households were able to tap into their home equity at a lower net cost (results not shown). The results were similar for all income shocks (panels a2 and a3 of figure 3).

---

[15]   It should be noted that even households who are relatively patient may choose to refinance and access home equity if the shock to income is sufficiently large.

[16]   Figure 3 is computed using the original time discount factor of 0.85. It should be noted that not all households refinanced. The present value wealth gain, by itself, from locking in a lower mortgage rate was not enough to induce people to refinance. Households needed an additional incentive to reoptimize their portfolio or remove equity to increase current consumption.

Households also refinanced for financial reasons. Regardless of the income shock, almost all households with large mortgage balances refinanced when interest rates fell. These households received the additional gain of locking in lower mortgage rates. Some households (figure 1) also refinanced to convert some of their liquid assets into housing equity. A reduction in mortgage rates further increased the benefit of using liquid assets to pay off mortgage debt. It should be noted that under different parameter values (a larger reduction in mortgage rates or a smaller fixed cost), all households would choose to refinance as interest rates fell.

This simple theory is consistent with the aggregate time series presented in table 1. Column 1 of table 1 lists the average annual 30-year fixed mortgage rate between 1986 and 1998 and column 2 presents the share of all mortgage originations which were for the purpose of refinancing. During 1988, when mortgage rates were high, the overall refinancing share was low, but those who did refinance were very likely to 'refinance up', increasing overall mortgage debt as part of the refinance process. In terms of the theory, those who refinance in periods of relatively high interest rates are more likely to do so because they were motivated by consumption smoothing; they refinance so as to access 'pent-up' home equity and used the funds to smooth their marginal utility of consumption over time.

As mortgage rates fell in 1993 and 1994, the overall refinance rate rose strongly, but the share of those 'refinancing up' fell, meaning that most refinancers were motivated by wealth gains (solely for financial motivations). On the other hand, the absolute number of households who 'refinanced up' was greater than in other years, and these households are more interesting for understanding the potential spending stimulus arising from lower mortgage rates. Note that in 1993, 20 percent of refinancers *added* equity ('refinanced down') during the refinancing process. This is not unexpected (and consistent with the theory above) given that many households are likely to reallocate their portfolio between housing equity and other assets as they refinance. As implied by the above theory, if market mortgage rates rise, households with a prior fixed-rate mortgage contract will be much less likely to remove any intervening equity increases from their homes. However, those who do choose to refinance in the face of rising mortgage rates must have a strong need to access home equity.

Recent work by Brady, Canner and Maki (2000) is also consistent with this theory. These authors summarized the March – May 1999 University of Michigan's Surveys of Consumers' questions asking households if they refinanced, whether they removed equity when they refinanced last and what they did with the equity that they removed. Although their results apply to the late 1990s (not the early 1990s that examined in the empirical section), they shed light on the refinancing process. They found that about 35% of households removed equity while refinancing during the low mortgage rate period of 1998. Of those who removed equity, 43% took out less than $10,000 and 26% took out more than $25,000. The

mean amount liquefied was more than $18,000 and the median amount was over $10,000. Of the total amount of equity removed during the refinancing process, 20% of that amount was used for current consumption while the remaining 80% was shifted to other portfolio components including a portion which was reinvested back into the home via home improvements.[17] This is predicted by our theory. In periods of low mortgage rates, households will refinance to lock in lower interest rates. Many of these households will remove equity. Some will simply use these funds to reallocate their portfolio. But others will use the opportunity of low interest rates to access their home equity so as to fund current consumption.

In the next sections, micro data are used to test for some of the more salient results outlined above on how the household uses the home as a financial buffer. Specifically, two of the above hypotheses are tested: 1) For a given wealth gain from refinancing during a period of low interest rates, were households who experienced a negative income shocks *and* who had low initial levels of wealth more likely to refinance? and 2) Were liquidity constrained households (defined as those who received a bad income shock or those who are simply more impatient) more likely to remove equity when they refinanced so as to fund current consumption? After answering these questions, we assess the extent to which Federal Reserve Policy can stimulate spending by increasing the benefits to refinancing (lowering mortgage rates), allowing liquidity constrained households to access their home equity at a lower net cost.

IV. ESTIMATION OF THE REFINANCING DECISION USING MICRODATA

A. Data

Observations from the Panel Study of Income Dynamics (*PSID*), a large-scale longitudinal study of U.S. households starting in 1968, were used for the research. Since 1980, the *PSID* has tracked housing decisions with detailed mortgage information.[18] In each year of the survey, households are asked to report their own estimated value of their house and, if applicable, to report the outstanding balance on their mortgage. In 1996, a special supplement to the *PSID* core survey focused on mortgage shopping. In this supplement, households were asked whether they refinanced their mortgage during the 1990s and

---

[17]   They found 28% of the equity removed was to repay debts, 33% was used for home improvements, 2% was invested in the stock market and 19% was invested in other real estate properties or in a business.

[18]   Data on market house value, annual mortgage payments net of taxes and insurance, the remaining mortgage balance and the number of years remaining on the mortgage were collected throughout the sample. Starting in 1993, information on second mortgages and the year the household acquired the mortgage were collected. Some mortgage variables were omitted from the survey in 1988 and 1989. The *PSID* is sponsored by the National Science Foundation, the Department of Housing and Urban Development, the National Institute on Aging, and other Federal agencies.

if so, in what years. Additionally, households were asked to provide the rate they are paying on their current mortgage and the effort they put forth in searching for their current mortgage lender.

The core *PSID* survey asks detailed questions on the respondent's earnings, family structure and demographics. The *PSID Wealth Supplements*, in 1984, 1989 and 1994, asked respondents questions about their current financial position.[19] In 1996, the *PSID* conducted a supplement focused on gauging households' financial distress during the 1991 – 1996 period: whether they have had trouble paying bills, had creditors call and demand payment, had their wages garnished, had liens placed against their property and whether they went bankrupt.

Our sample included all households in the *PSID* owning their main home continuously between 1989 and 1996, who had a mortgage, who did not move any time during the period and who had positive average labor income between 1991 and 1996. In total, the sample included 1,497 households. For 1994 – 1996, *PSID* data were only available in early release form, meaning some of the outliers in the data had not been hand edited, some coding errors not yet corrected or missing values imputed. As a result, some observations with unprocessed data or obvious coding errors were dropped with the sample size thereby reduced to 1,392 observations. Of the 1392 households, 467 refinanced between 1991 and 1996. Corresponding to aggregate data, approximately 32% of mortgage holders in our sample (weighted average, using *PSID* weights) refinanced during the early 1990s with the majority of refinancing taking place between 1993 and 1994 - again, matching the aggregate time series data.

B. Factors Affecting Household Refinancing Probabilities

In this section, we are interested in testing the first propositions from Section II: For a given fall in interest rates (a given present value wealth gain from lower mortgage payments), is a household that experienced a negative income or consumption shock more likely to refinance to access home equity than other homeowners? Not only does a fall in interest rates provide a rationale for non-liquidity constrained households to refinance, but the decline in interest rates will reduce the net costs of accessing home equity for those households trying to increase consumption.

To test this proposition, we run a cross section regression predicting whether the household refinanced any time between 1991 and 1996 as a function of the financial gain from locking in lower interest rates during this period, demographics and controls for the consumption smoothing benefits to

---

[19] Household wealth is defined to include real estate – main home, second home, real estate investments, land contract holdings – cars, trucks, motor homes, boats, farm or business, stocks, bonds, mutual funds, saving and checking accounts, money market funds, certificates of deposit, government savings bonds, Treasury bills, IRAs, bond funds, cash value of life insurance policies, valuable collections for investment purposes, and rights in a trust or estate, less mortgage, credit card, and other outstanding collateralized and non-collateralized debt. The *PSID* does not ask questions concerning the wealth in private pensions or about expected social security retirement benefits. For a full discussion of *PSID* wealth data, and for the calculation of a measure of active savings from the *PSID*, see Hurst, Luoh and Stafford (1998).

refinance. For our dependent variable, we used the households' self-reported refinancing behavior between 1991 and 1996 as given in the 1996 mortgage shopping supplement. The reduced form refinancing decision for households over this period can be formalized as:

$$Y_i = \beta_0 + \beta_1 PV_{Wealth,i} + \beta_2 X_i + \beta_3 Z_i + \varepsilon_i; \qquad\qquad (6)$$

where Y_i becomes the unobservable gain from refinancing, $PV_{Wealth,i}$ - defined below - is the present value wealth gain of locking in lower mortgage rates, X_i represents a vector of variables reflecting the household's desire to access interim home equity – variables representing the value of the consumption smoothing motivation to refinance, Z_i is a vector of demographics, and ε_i is a normally distributed white noise error term. The observed variable is $Refi_i$, which equals one if household i refinanced during the early 1990s (1991-1996) and zero otherwise. If a household refinances when $Y_i > 0$, then the probability that household i refinances can be expressed as:

$$Prob(Refi_i = 1) = \Phi(\varepsilon_i > -\beta_0 - \beta_1 PV_{Wealth,i} - \beta_2 X_i - \beta_3 Z_i). \qquad\qquad (7)$$

Assuming that $\Phi(.)$ is the cumulative normal distribution with mean zero and variance σ_ε^2, we can estimate (6) using standard probit techniques. Because the household only reported refinancing behavior retrospectively in 1996 and only is asked about their most recent refinancing experience, we cannot take advantage of the panel aspect of our data. As a result, all our regressions are cross sectional regressions predicting refinancing behavior anytime between 1991 and 1996, with the present value wealth gain computed as of 1993-1994 - when mortgage rates were at a minimum.

Consistent with the existing literature, we constructed a measure of the present value wealth gain (the value of the financial option) that households would receive if they refinanced during the 1993-1994 period.[20] The present value of pure wealth gains from an interest rate change can be expressed as the difference between households' mortgage payments under the new rate and the mortgage payments under their original mortgage rate, discounted over the remaining length under the old mortgage.[21] Assuming that the mortgage balance or the term of the mortgage is not altered during the refinancing process, we can represent, in continuous time, the present value wealth gain from refinancing as:

---

[20] The reader should note that this option value is calculated using discreet interest rate changes assuming that the change in interest rates will remain constant into future periods. We do not model a world in which interest rate movements are uncertain. Given we are only able to take advantage of the cross section and predict refinancing behavior during the 1993-1994 period, there is no variation in expected future interest rate movements across households.

[21] For the household's new rate, we used the lowest average monthly mortgage over this time period - October 1993. For the household's old mortgage rate, we used the average prevailing mortgage rate in the year in which the household acquired their mortgage.

17

$$PV_{Wealth,it} = \text{Max}\left[B_{it} \int_0^{T_i} (\omega_{i0} - \omega_{it})/(1 + r_{it})^t \, dt, \, 0\right]; \quad \text{where} \tag{8}$$

$$\omega_{i0} = \frac{r_{i0}^m}{(1 - e^{-r_{i0}^m T_i})} \quad \text{and} \quad \omega_{it} = \frac{r_{it}^m}{(1 - e^{-r_{it}^m T_i})} \, ,$$

and where $PV_{Wealth,it}$ is the present value of wealth gains for household i refinancing in year t truncated at zero, T_i represents the number of periods remaining on household i's original mortgage, r_{it} is the rate at which the household discounts future income (assumed to be 3 percent), r_{i0}^m is the original mortgage rate on household i's mortgage, r_{it}^m is the mortgage rate had the household refinanced in October of 1993, and B_{it} is the outstanding balance on household i's mortgage in year t. The higher $PV_{Wealth,it}$ for the household, the greater the likelihood that the household will refinance in a given period.[22] Almost all studies of refinancing use this (potentially adjusted for future interest rate movements) as the sole measure of demand for refinancing.

In periods where interest rates are falling, households who had large house appreciations during the period are predicted to be more likely to refinance so as to liquidate and consume some of their home equity. We capture this by including a variable, $\Delta House_i$, which measures the percentage change in the individual's house value between 1990 and 1995. Additionally, according to comparative statics from our model above, households who received an adverse income or consumption shock would also be more likely to refinance for a given change in interest rates. This effect should be most pronounced for households who have limited initial liquid financial assets. To control for such factors we included measures of household income shocks, changes in desired consumption and the extent to which the household experienced financial distress.

The variable $Unemp_i$ is a dummy variable taking the value of 1 if either the household head or the spouse experienced an unemployment spell (income shock) between 1991 and 1996. We also interact $Unemp_i$ with the amount of 'more-liquid' assets that the household had in 1989.[23] Households with enough liquid assets need not access home equity to buffer the shock. As seen in the theoretical section above, unemployment spells should matter most in the refinancing decision for households with little financial buffer. We predict the sign on $Unemp_i$ to be positive and the sign on the unemployment - liquid asset interaction to be negative. We also directly include the level of liquid assets in 1989 as a control. Additionally, as evident in figure 1, households would only want to refinance in the face of

---

[22] Although we assume that each household would face the same new mortgage rate had they refinanced, $PV_{Wealth,it}$ differs across households to the extent that the year that the mortgage was taken out differs, the size of the mortgage balance differs and the extent to which the remaining length of the existing mortgage differs.

negative income shocks if they had equity in their home. To test this prediction, we include measures of the amount of equity in the home and interact these measures with whether the household experienced an unemployment spell and the amount of liquid assets held by the household. As our measure of equity in the house, we include two dummy variables: whether the household had a loan to value ratio between 0.8 and 0.9 in 1990 and whether the household had a loan to value ratio greater than 0.9 in 1990. We predict that households with the least amount of equity in their home – as measured by the household having at a greater than 0.8 loan to value ratio in 1990 – will be less likely to refinance for consumption smoothing reasons.

To control for shocks in desired consumption, we included whether the number of children in the household changed between 1991 and 1996, $\Delta Child_i$, and whether the household head became divorced between 1991 and 1996, $Divor_i$. Finally, to further proxy for an unexpected need to use housing equity to smooth the marginal utility of consumption, we include a measure of household financial distress. If the household responded that they had trouble paying bills between 1991 and 1996, had creditors call their home to demand payment between the 1991 and 1996 periods, had their wages garnished or had liens placed on their property during the sample period, $FinDis_i$ took a value of 1.[24] If the consumption smoothing motivation is important in the refinancing decision, we would expect households with more variable income, who experienced spells of unemployment or periods of financial distress, who became divorced or who increased the number of children in their household to be more likely to refinance for a given change in interest rates.

A series of demographic variables were included to control for additional differences among households. We also included dummy variables to control for the household's level of educational attainment: less than a high school education, some college education or a college degree or more. We treat these educational variables as a proxy for the household's financial sophistication. We expect that more educated households would be more likely to refinance during periods of falling interest rates. Additionally, the *PSID* reports the household's expectations about the possibility of moving in the next several years. The more likely the household is to move in the near future, the less likely they would be to bear the fixed costs of refinancing. Finally, we included the age and age squared of the household head (to account life cycle differences among the heads), a measure of the household's permanent income, a dummy variable for whether the household head was black, family size, a dummy variable for

[23] Liquid assets are defined as the amount of assets held in checking, savings, IRAs, stocks, bonds, and t-bills. Liquid assets were measured in 1989 – the most recent period in which the PSID measured assets prior to the refinancing period.

[24] It should be noted that factors such as job loss and financial distress may cause a lender to ration credit to borrowers. We abstract from the supply decisions in our model. But, lenders need not ration quantity to such higher risk borrowers - they could charge a higher price. There is a growing literature on non-traditional, higher risk lending in mortgage markets. As we will see

whether the household head planned to move in the next several years, and a dummy variable for marital status.[25]   The means of relevant variables used in our empirical work for those households who refinanced and those households who did not refinance are shown in table 2.

C.   The Importance of the Consumption Option in Refinancing Probabilities

Table 3 presents the results of our estimation of equation (10).[26]   As anticipated, regression (I) shows that households with a higher present value wealth gain from refinancing and locking in the lower mortgage interest rate were more likely to refinance and this variable was highly significant (*p-value* = 0.000). This is consistent with much of the existing literature on financial, or asset managing motivations to refinance. This variable measures this direct gain from refinancing and proxies for the reduction in marginal borrowing costs for those wishing to access their home equity. Lower interest rates in the early 1990s both reduced marginal borrowing costs and increased the present value gain from refinancing for both households who were and who were not looking to access home equity, inducing more households to refinance.   The marginal effect (reported in column I) is large. For every $1,000 increase in the present value wealth gain the probability that a household refinances is predicted to increase by 0.045 percentage points, or 14.2%.[27]

Demographic variables enter with the predicted signs although they are only marginally significant. Households planning to move in the near future were 25.3% less likely to refinance. Households with at least some college experience were 13.8% more likely to refinance than their counterparts who received only a high school diploma. Neither the probability of moving, nor the household's education level were statistically significant at the 10 percent level. As a household aged, the probability that they refinanced fell by 1 percentage point per year.   Black households were over 37% less likely to refinance.[28]   Also, households with higher permanent income measures were also more likely to refinance. For every $10,000 increase in permanent income, the household was 1.1 percentage points more likely to refinance.

---

in the next section, lenders do seem to be acting rationally - borrowers who experienced job loss or financial distress did, in fact, pay higher mortgage rates then other households.

[25]   All dollar amounts are reported in constant 1996 dollars. Permanent income is a five year average of the household's labor income between 1990 and 1994. For the remainder of the paper time subscipts have been suppressed.

[26] We realize that a household may be able to remove equity from their house by taking out a second mortgage or by establishing a home equity credit line. In our sample, approximately 4% of the sample had either a second mortgage or a home equity credit line. The sample was too small to run our reduced form estimation on just those acquiring second mortgages. Although we did include as the dependent variable those who added a second mortgage or home equity credit line along with those who refinanced, our results were not significantly altered.

[27]   The effect of an increase of $1,000 will increase the probability of refinancing by 0.045 percent. With a base probability of refinancing of 0.316 for our sample, this reflects a 14.2% increase in the probability of refinancing.

[28] This number is consistent with existing research. See Charles and Hurst (2000) for a discussion of racial differences in access to housing markets.

There is evidence that households not only refinance to receive a present value wealth gain, but also do so for consumption smoothing reasons during periods of declining interest rates. The coefficient on the house price appreciation variable indicates that households with rising house values were more likely to refinance, potentially to liquidate the gains in home equity. A 10 percentage point increase in house prices is predicted to increase the probability of refinancing by 1.1 percentage points, or just under 3.5% (*p-value* = 0.021). This result is consistent with the results found in Skinner (1996). Skinner found that young households were likely to tap into their home equity when they received large house price appreciations.

Households with small amounts of equity in their home were less likely to refinance than were otherwise comparable households. If the household's loan to value ratio was between 0.8 and 0.9 or greater than 0.9 in 1990, the household was, respectively, 4.5 percentage points or 11.0 percentage points less likely to refinance (*p-values* of 0.409 and 0.095, respectively).

The results in column (I) provide little additional support for the consumption smoothing hypothesis. Neither the unemployment measure, nor the liquid asset measure was statistically significant, although each entered with the expected sign. But, given this specification, the results should not be surprising. The results of our model did not say that all unemployed households should be more likely to refinance, only the unemployed households with low levels of more-liquid assets. In regression (II) of table 3, we also include an unemployed-liquid wealth interaction. Here, the results become stronger. Households who experienced an unemployment spell in the early 1990s with no liquid assets in 1989 were far more likely (6.0 percentage points or 19% more likely) to refinance their home during the 1991-1996 period (*p-value* = 0.093). For each additional $10,000 in liquid assets that the household had in 1989, the probability of refinancing decreased by 1 percentage point or 3.2% (*p-value* = 0.111). Including the interaction term matches the empirical results with the theoretical predictions. It is not all households who received a negative income shock that were more likely to refinance - just those who had little assets to buffer the shock. It should be noted that even in this specification liquid assets are not statistically significant - only the liquid assets interacted with the unemployment shock.

The theoretical results above also predict that not all households who had low liquid assets and who experienced a consumption shock would refinance - only those households who had sufficient home equity to do so. In regression (III) of table 3, we also included a triple interaction of whether the household experienced an unemployment shock, whether they had an initial loan to value ratio in 1990 less than 0.8 and the amount of liquid assets they had in 1989. This interaction came in with the expected sign. Households who experienced an unemployment shock, had low liquid wealth and had

large amounts of home equity where more likely to refinance than similar households with small amounts of home equity.

These households who experienced unemployment spells and who had low levels of liquid assets were also more likely to remove equity during the refinancing process. Table 4 shows the results of a regression predicting the proportion of equity removed relative to the initial mortgage balance as a function of demographics, income, unemployment spells and unemployment spells interacted with liquid assets.[29] Because the proportion of equity that a household would have removed is not observed for those households who did not refinance, OLS estimation would produce biased coefficient if there is a correlation between the choice to refinance and the dependent variable in the regression of table 4. To address this problem, we ran the Heckman selection procedure with the decision to refinance modeled as in table 3. We were able to get identification from the fact that the present value gain from refinancing effects the refinancing decision, but should be independent of the proportion of equity that the household would want to remove during refinancing. The estimated correlation between the error terms of the refinance and equity removed equations was large and statistically different from zero ($\rho = 0.788$, *p-value* 0.083). We suppressed the first stage results for the probability of refinancing when reporting the results of the Heckman selection model in table 4.

As predicted, households who experienced an unemployment spell and had zero liquid assets in 1989 removed 114% more equity than other comparable households when refinancing (p-value = 0.047). The amount diminished rapidly for households who experienced unemployment spells as the amount of liquid assets they held grew. Surprisingly, households who experienced a large house price appreciation were not more likely to remove a greater proportion of their initial equity during the refinancing process.

The predictions of the consumption smoothing theory of refinancing are mostly borne out in the data: controlling for the present value wealth gain to refinancing and demographics, households who experienced a negative income shock, who had low levels of liquid assets and who had equity in their home were more likely to refinance and were more likely to remove equity from their home during the process of refinancing. Households who had large increases in house value were also more likely to refinance, but they were not more likely to remove a greater *proportion* of that equity during the refinancing process. The next section provides additional evidence for the consumption smoothing motivation to accessing home equity by specifically looking at the behavior of liquidity constrained households.

---

[29] The average on the amount of equity removed as a fraction of the total outstanding mortgage balance at the beginning of the 1990 was 0.084. The median equity removed, for those households who removed equity was 0.143.

V.   HOME EQUITY AND LIQUIDITY CONSTRAINTS

According to the theory from Section III, households in pursuit of current consumption would sometimes refinance even in the face of high borrowing costs to access accumulated home equity. These households could want to borrow either because they are impatient (have a taste for current consumption), because they expected a high growth rate of income, or because they experienced an unexpected income or consumption shock and have exhausted their other savings. As noted earlier, some households will wish to draw down the equity in their home but are unwilling to do so because of the associated costs. In this instance, these households will be liquidity constrained - they wish to increase their consumption, but are confronted by an unfavorable cost structure. But, in periods when interest rates decline, the liquidity constraint can be partially alleviated as the net benefits to accessing the accumulated home equity are now larger.

In order to compare the refinancing and consumption behaviors of liquidity constrained households, we first have to isolate households who we plausibly believe would be liquidity constrained. The fact that households have low assets is not sufficient for a household to be liquidity constrained. Many households with a flat income profile will optimally choose to have low assets throughout their life cycle and yet they could never be liquidity constrained. We decided to identify liquidity constrained households by looking at observable differences in behavior across refinancing households.

To do this, we posit that households who had loan to value ratios below 0.8 and who in the process of refinancing, chose to remove equity to the extent that their post-refinancing loan-to-value ratio was in excess of 0.8 would only do so if they were liquidity constrained. As noted above, crossing the 0.8 loan to value ratio requires that the household get private mortgage insurance - which dramatically increases the marginal borrowing costs on any additional dollar removed beyond 0.8. Why else would a household choose to pay the premium associated with having a loan-to-value ratio in excess of 0.8 unless they were liquidity constrained? For the following empirical work, these households need not be liquidity constrained - we will empirically test for differences in behavior. But subsetting the sample in this way, we are just arguing that this group, ex ante - by not buying down their mortgage to a 0.8 loan to value ratio, is a likely candidate for being liquidity constrained. Again, we wish to stress that this group could be liquidity constrained because they received a negative income shock, because they expect a high future growth rate of income or *simply* because they are more impatient than other households (Deaton, 1991).

It should be noted that this group need not be the only liquidity constrained households who refinanced - we are just arguing that if you are choosing not to buy down your mortgage so that you have a post refinancing loan to value ratio below 0.8 that the reason you are not doing so is because you are

liquidity constrained. Other households could still have equity trapped in the home - they could have low levels of liquid assets, would like to increase current consumption, but choose not to access home equity because the costs are too prohibitive. By focusing on households who paid the private mortgage insurance when refinancing, our empirical work will *underestimate* the amount of liquidity constrained households who refinanced.[30] This section sets out to verify empirically two points: 1) households who crossed the 0.8 loan to value ratio while in the process of refinancing have behavior consistent with being liquidity constrained - they paid a premium to access home equity, they held low levels of liquid wealth, they potentially tapped out their non-collaterallized borrowing sources by running up large credit card debt, etc. *and* 2) that these liquidity constrained households converted the home equity they removed while refinancing into current consumption (while those who had a loan to value ratio below 0.8 and who removed equity did not convert the equity into current consumption).

A.   Liquidity Constraints and Mortgage Rates

Do the households we designated as being potentially liquidity constrained pay higher rates in their search for current consumption? We estimated a model of the mortgage rates paid on the sample of 467 households who refinanced during 1992-1996.[31]   Table 5 presents the results of this estimation. Those households with loan-to-value ratios between 0.8 and 0.9 had to pay an additional 33 basis points (on average) while those above 0.9 had to pay an additional 70 basis points (on average). These numbers are similar to industry standards where households with loan to value ratios between 0.8 and 0.9 are required to secure private mortgage insurance which usually costs and addition quarter to a third of a basis point. This supports our theory that those below a 0.8 loan-to-value ratio initially and who refinanced to above 0.8 loan-to-value ratio were willing to do so at an additional cost.

As expected, borrower credit worthiness also affected the rate that households paid.   If the household had a greater risk of default, measured by recent spells of financial distress, recent spells of unemployment or recently declaring bankruptcy, they paid a statistically higher mortgage rate: 26 basis points (*p-value* = 0.091), 21 basis points (*p-value* = 0.191) and 100 basis points (*p-value* = 0.023), respectively. The three measures were jointly significant at the 5% level. If the household had a debt to

---

[30]   Just because a household removed equity need not imply that they were liquidity constrained. Many households remove equity when refinancing to adjust their housing stock (build additions, etc) or to re-adjust their portfolio by placing some of their housing equity into other diverse saving instruments. See Dickson and Hueson (1993) for examples.

[31]   Because the mortgage rate that a household would have received is not observed for those households who did not refinance, OLS estimation would produce biased coefficient if there is a correlation between the choice to refinance and the interest rate that the household would have received conditional on refinancing.   To address this problem, we ran the Heckman selection procedure with the decision to refinance modeled as in table 3.   The estimated correlation between the error terms of the refinance and rate equations was small and not statistically different from zero (ρ = 0.096, *p-value* 0.6488).   Under an OLS model and the Heckman selection model, the coefficients and standard errors were nearly identical. We did, however, report the results from the Heckman selection model in table 5.

income ratio in 1989 greater than 0.32 (a common cutoff used in the mortgage underwriting process), the household paid an interest rate 32 basis points higher than households with a debt to income ratio below 0.32 (*p-vlaue* = 0.287).

Age, educational attainment and income had no predictive power on the rate that the household paid.   The year dummies are highly significant and match the pattern of mortgage rate movements observed in the early 1990s.   In the next section, we are going to show that these households who were willing to refinance from a loan to value ratio below 0.8 to a loan to value ratio exceeding 0.8, even though they paid a premium to remove the extra cash, had behavior consistent with standard definitions of being liquidity constrained.

B.   Refinancers Remove Equity at a Premium based on Pre-Refinancing Wealth Holdings

Of all refinancers, 11.1% refinanced from a loan to value position below 0.8 to a loan to value position above 0.8 (3.5% of all households with mortgages).   Table 6 shows the means of demographic, income and wealth variables for homeowners with mortgages who refinanced and removed equity so as to have an ex-post loan to value ratio greater than 0.8 and homeowners with mortgages who refinanced and had an ex-post loan to value ratio less than 0.8.   One of the major differences between the two refinancing groups was that those who ended up with a loan to value ratio of 0.8 were, on average, 4 years younger.   Given the way the sample is subsetted, this should not be surprising.   Only the households who removed substantial equity so as to trigger the rate premium when they refinanced were included in this refinancing group.   It is possible that some refinancers removed substantial equity for current consumption without triggering the penalty associated with crossing the 0.8 ex-post loan-to-value ratio threshold.   These omitted households would tend to be older, on average, having had the opportunity to pay down their mortgage over time.   However, given the shape of the income profile, younger households are more likely than older households to be liquidity constrained, all else equal, if there exists hard borrowing constraints (see Japelli, 1990; Attanasio and Browning, 1995).

Our liquidity constrained refinancers tended to be similar to other refinancers (and homeowners in general) along many other demographic lines. On average, these refinancers with an pre-refinancing loan to value ratio below 0.8 and who had an ex-post loan to value ratio above 0.8 achieved the same level of educational attainment as other refinancing households, had the same probability of being married in 1994 and had similar numbers of children.   The income processes of the two refinancing groups differ slightly. The liquidity constrained refinancing group had lower average family income during the late 1980s (1986-1990), $48,900 versus $52,500 and had higher income in the early 1990s (1991-1995), $61,400 versus $55,500. That is, our identified liquidity constrained refinancing group had a *steeper*

income profile from mid 1985 to 1994. Again, this is consistent with these households being liquidity constrained - households with steeper income profiles are more likely to be liquidity constrained. It should be noted that shocks to the income process were similar across the two groups over the early 1990s were similar.[32]

Additionally, our identified group of liquidity constrained households held more non-collateralized debt in 1989, had lower net worth in 1989 and held lower amounts of liquid assets in 1989. The amount of debt held by the liquidity constrained refinancers was almost 4.5 times higher than the amount of debt held by the non-liquidity constrained refinancers ($9500 versus $2100 at the mean and $4800 versus $1300 at the median). The fact that these households hold debt does not preclude them from being liquidity constrained. As shown in Gross and Souleles (2000), hard borrowing constraints need not exist at zero. Liquidity constraints can bind even for households with positive debt. Gross and Souleles show that over 15% of households with credit card debt are at or near their credit limits. The median net worth for the liquidity constrained refinancing group was almost 50% lower than the amount of net worth held by the non-liquidity constrained refinancing group ($61,600 versus $111,500). Finally, the amount of liquid assets held by our identified liquidity constrained group was lower than the amount of liquid assets held by the other group of refinancers. Almost 10% of the liquidity constrained held zero assets (versus 2% for the other refinancing group). Compared to other refinancers, the median amount of liquid assets in 1989 was almost 50% lower for the group of households who refinanced to a loan to value ratio above 0.8 ($16,100 versus $34,000). While $16,100 is relatively large for liquid assets, this is the amount of liquid assets held in 1989 - the amount of liquid assets held by the household in 1993 (after the 1990-1991 recession) could be much lower.[33] Also, there are sizeable and statistically significant differences in total wealth, liquid wealth and non-collateralized debt persist between the two groups of refinancers - especially at the medians - in a multivariate analysis controlling for household income and demographics.

We are relatively confident that we isolated a group of households which were liquidity constrained before they refinanced. This group was willing to pay a large premium to access home equity, they persistently held low levels of wealth, they held more non-collateralized debt and they had a slightly steeper income profile when compared to other refinancers. All of these characteristics are consistent with this group being potentially liquidity constrained, refinancing, in part, to remove equity from their

---

[32] Approximately 18% of both refinancing groups experienced an unemployment spell between 1991 and 1996. Hurst (1999) show that the variance of family income between the two groups and the year to year deviations from average income over the period were also similar between the two groups in a multivariate regression controlling for a full set of demographics.

[33] The fact that many households simultaneously hold non-collateralized debt and liquid assets has been pointed recently by a few authors (see, for example, Laibson, Repetto and Tobacman, 1999). This fact cannot be explained by a standard permanent income model, but, under certain specifications, can result from a model where households have time inconsistent preferences (Angeletos, Laibson, Repetto, Tobacman, and Weinberg, 2001). If households have hyperbolic preferences, refinancing and removing equity, even at a high marginal borrowing cost, would be one means of increasing current consumption.

home so as to fund current consumption. As noted above, just because these households held some small amounts of liquid assets in 1989 does not mean that they had these assets to draw upon in the early to mid 1990s.

It may be possible that households who removed equity at the premium when refinancing were not liquidity constrained; they may have had an another investment opportunity. If this outside investment option yielded a higher return (ie, stock market, business) than the additional cost of paying the private mortgage insurance, these households may optimally want to reallocate their portfolio away from home equity towards the outside option - even at an additional cost. We can test for the existence of such households empirically. We predict that the liquidity constrained households will dramatically increase consumption after refinancing. This same prediction would not hold true for households who reallocated their portfolio toward higher yielding assets. In the next section, we test whether there are differences between our identified group of potentially liquidity constrained households and other refinancing households in the extent that they removed equity while refinancing and in the extent to which they converted that equity into current consumption.

C. The Average Propensity to Convert Mortgage Equity into Consumption

The proximate cause of the 1990-1991 recession has been argued to be cumulative, negative consumption shocks (Blanchard, 1993). To what extent does refinancing provide an aggregate economic stimulus by restoring consumption? In the theoretical section outlined in Section III, we saw that the existence of large fixed costs could result in some households having equity trapped in their home. When mortgage rates fell, it reduced the net cost of accessing home equity - these households would have refinanced for financial motivations regardless of their desire to access home equity. The theory showed that liquidity constrained households were likely to use the opportunity of falling interest rates to refinance *and* simultaneously access home equity to fund current consumption. In this section, we empirically test whether our identified group of liquidity constrained households were more likely to convert home equity into spending during the period of falling interest rates of the early 1990s.

Which families used refinancing as a way to increase current consumption and which used refinancing primarily to augment their financial wealth? To study this, we regressed the change in wealth holdings between 1989 and 1994 on a series of household specific variables, including whether the household refinanced and the amount of equity they removed conditional on refinancing. From our theory, we expect liquidity constrained household choosing to refinance to remove equity from their home during the process using the proceeds to fund current consumption. We would not necessarily expect to observe this behavior for households who refinanced solely to exercise the financial option.

These households may have also removed equity during the refinancing process, but would have likely done so to tidy up their balance sheet (put the money back in the home by building an addition or transfer the equity to the stock market) as opposed to using the proceeds to fund current consumption. As documented by Brady, Canner and Maki (2000), conditional on removing equity, 82 percent of the equity was reallocated to other portfolio components.

Of the identified liquidity constrained households, over 79% of them removed equity while refinancing (as compared to only 45% of the other refinancing households). Conditional on removing equity, the median amount of equity removed by the liquidity constrained refinancing households was $16,000 - compared to $11,000 for the other refinancers.[34] As outlined in the above paragraph, there are a variety of portfolio reallocation reasons why a non-liquidity constrained household may choose to remove equity while refinancing. Empirically, we predict that the equity removed while refinancing by the liquidity constrained households would be used to fund current consumption and that the equity removed by the non-liquidity constrained households would show up else where in the household's portfolio.

In the *PSID* - aside from food consumption - there are no direct consumption measures. However, one can back out consumption changes using the detailed wealth and income measures in the *PSID*. The change in household wealth between 1989 and 1994 was regressed on a series of income and demographic variables, a dummy variable for whether the household refinanced between 1991 and 1994 and a dummy variable for whether the household was a liquidity-constrained refinancer. The amount of equity removed during refinancing was included, separately, for both the liquidity constrained and non-liquidity constrained refinancers.[35] The household wealth measure includes the value of housing equity. If a household removed equity from their home while refinancing between 1991 and 1994 and their overall wealth position fell, we infer that consumption expenditures must have increased (it would not have shown up elsewhere in the household's balance sheet). If, however, a household removed equity from their home while refinancing and their overall wealth position remained unchanged, we infer that that the household simply transferred the home equity to some other portfolio component. The model from section III predicts that the coefficient on equity removed for the liquidity-constrained households will be between 0 and -1 and will be significantly different from zero. Additionally, the predicted

---

[34] Not all of our identified liquidity constrained group removed equity. Some of these households went from a loan to value ratio below 0.8 to a loan to value ratio above 0.8 because they suffered a fall in house prices. In this instance, these households may still be liquidity constrained - because they did not choose to reduce their loan to value ratio below 0.8. We will focus our attention on only those households which moved to a loan to value ratio greater than 0.8 and who removed equity during the refinancing process.

[35] We only looked at households who removed equity during the refinancing process. Some households added to their housing equity while refinancing. For these households, we set the amount of equity removed while refinancing equal to zero.

coefficient on equity removed for the non-liquidity constrained households will not be significantly different from zero.

The results of quantile regression analysis predicting the change in household wealth between 1989 and 1994 are show in table 7.[36] As to be expected, older, more educated and higher permanent income families had experienced higher wealth gains over the period (age and age squared were jointly significant at the 10% level). Wealth accumulation slowed as a household aged and with higher levels of household income. Additionally, households who became divorced during the period and households with a large number of children at the beginning of the period experienced slower wealth growth.

The household's initial portfolio of wealth was a strong predictor of wealth accumulation. If the household had positive wealth in 1989, wealth grew at about 2% per year (in real terms) between 1989 and 1994. Given the other controls in the regression plus the fact that our measure of wealth includes durables such as vehicle wealth, this number seems plausible. Households with negative wealth in 1989 had large wealth gains during the following five-year period. For every dollar of negative wealth in 1989, household wealth in 1994 grew by $2 (or $0.40 per year). Households who held non-collateralized debt in 1989 had wealth their wealth grow by $6,900 less than households with no non-collateralized debt (*p-value* = 0.012). Whether the household owned stocks in 1989 did not have predictive power in the wealth accumulation equation. However, households who owned a business in 1989 were significantly more likely to accumulate wealth between 1989 and 1994.

Overall, refinancers had similar wealth growth when compared to other homeowners who had a mortgage and who did not refinance. Liquidity constrained refinancing households, as a group, also did not accumulate wealth at rate statistically different from other homeowners. However, for these liquidity-constrained households, *wealth was drawn down* during the refinancing process. This is consistent with the predictions set out above: Other than high yielding alternate investments, why else would a household acquire a loan with a loan to value ratio above 0.8 during the refinancing process and be willing pay the higher marginal borrowing cost? Table 7 gives us an estimate a household's average propensity to convert housing equity (*APCE*) into consumption expenditures. For liquidity constrained households, the *APCE* was 0.599 (*p-value* = 0.000). In other words, for every $1 of equity removed by the liquidity-constrained household, consumption increased during that time period by $0.60. The fact that the households did not spend all of it could be an issue of timing. The households primarily refinanced during 1993 and 1994 and the latest wealth measure we observed was in 1994. It is possible

---

[36] Given that the distribution for the dependent variable, the change in wealth between 1989 and 1994, is skewed to the right and has large outliers in both directions, OLS estimation could lead to biased coefficients. To address this problem, we ran quantile regressions at the median. This approach is common when dealing with wealth data. See Hurst, Luoh and Stafford (1998) for a discussion of the use of quantile regressions with wealth data.

that households who refinanced and removed equity simply did not have a chance to spend it by the time the *PSID* survey was conducted (mostly in February through July of 1994). For the other group of refinancers who removed equity, every $1 of equity removed from the house ended up in another component of the household's portfolio. The APCE for these households was -0.082 and was not statistically different from zero (*p-value* = 0.578).

Here, there is a bifurcation in behavior of our two refinancing groups. It appears that some households used the period of low interest rates to refinance and access home equity so as to alleviate liquidity constraints. Empirically, households were observed to be liquidity constrained in the sense they were willing to pay a premium by refinancing to an ex-post loan to value ratio above 0.8. These households removed equity while refinancing and converted that equity into current consumption while the other control group of refinancers did not convert the equity they removed into current consumption.

Using the results from table 7, we can predict the total net spending stimulus that resulted to the economy when mortgage rates fell and the cost of accessing home equity for liquidity constrained households was reduced. Although only a small percentage of the sample is termed liquidity constrained by our definition, these households removed large amounts of equity when refinancing. 11% of refinancing households increased their loan to value ratio above 0.8 when refinancing, borrowing an additional $16,000, at the median, during the process. Using aggregate statistics on the number of households and the number of homeowners, and using our results on the percentage of homeowners who refinanced during the early 1990s, we predict that the amount of spending stimulus that resulted when liquidity constrained households refinanced with low mortgage rates during 1993 was approximately $18 billion, or 0.2% of GDP.[37] Given that we only pick up liquidity constrained households who crossed the 0.8 threshold and the fact that our sample period stops before the households would have had a chance to spend all the equity removed, the $18 billion is likely an underestimate of the total stimulus associated with the large amount of refinancing during the early 1990s.[38]

VI. CONCLUSION AND POLICY IMPLICATIONS

Recent research on household net worth has highlighted the precarious financial condition of many families. With about two-thirds of American families now homeowners, much of their limited saving is

---

[37] (100 million households)*(2/3 homeowners)*(31.6 % refinancing during 1993)*(11% liquidity constrained)*(79% of the liquidity constrained households removed equity while refinancing)*($16,000 - median amount of equity removed by liquidity constrained households who removed equity)*(0.60 - APCE for liquidity constrained households) = $17.57 billion.

[38] This $18 billion is a sizeable component of an expansionary stimulus package by the Federal Reserve. Under ideal conditions, a stimulus package by the Fed could total 3% of real GDP. Given that real GDP in 1993 was about $7 trillion (1996 dollars), $18 billion represents about 9% of the expected stimulus projected from a monetary expansion. As noted above, this number is likely a lower bound. Additionally, this number does not capture any of the spending generated by households using home equity to fund durable purchases such as home improvements.

in the form of home equity. This paper explores the extent and some of the policy ramifications of families using housing equity as a financial buffer. In times of adverse income or expenditure shocks or anticipated higher future income prospects, families may wish to transfer resources from the future to finance current consumption by removing equity from their home. But, unlike the drawing down of other assets, liquidating home equity comes at a relatively large cost. Households with limited amounts of more-liquid assets and who are restricted from borrowing against future income may wish to increase current consumption by drawing down their accumulated home equity, but are unwilling to pay the costs to do so. As a result, their home equity essentially remains trapped in their home. An implication of this paper is that in periods of higher interest rates, falling house prices or when household balance sheets are illiquid, households will only be able to liquidate a portion of their home equity and at rising marginal borrowing costs.

This paper sets out a model of how households use home equity to buffer consumption shocks in a world with exogenous liquidity constraints. There are two reasons why a household may choose to refinance. 1) In periods of relatively low interest rates, the household would refinance to receive a lower stream of mortgage payments and consequently receive an increase in lifetime wealth - we refer to this as the 'financial' motivation to refinance, and 2) households may refinance so as to access accumulated home equity - we refer to this as the 'consumption smoothing' motivation to refinance. The model predicts that if households receive a negative consumption or income shock or if they are impatient and have accumulated a large amount of equity in their home, they are more likely to choose to refinance if their reserves of more-liquid assets are limited, all else equal.

Empirically, households are found to use their home as a financial buffer. Homeowners who had low levels of liquid assets and who experienced an unemployment shock were 19 percent more likely to refinance than other households – although they had to pay a higher rate to do so. The probability of refinancing diminished for households who experienced an unemployment shock but had greater amounts of liquid assets to buffer the shock. Additionally, households who experienced a spell of unemployment were far more likely to remove equity during their refinancing process. Households experiencing a house price increase had a greater probability of refinancing, all else equal. These findings reconcile what have been termed as an empirical anomaly in the housing literature. If the consumption smoothing motive is large, some households will optimally choose to refinance in periods where mortgage rates are stable or rising.

We identify a group of refinancing households who were liquidity constrained - either because they expect a higher future income growth or perhaps, simply, because they have a taste for consumption (they are 'impatient' as defined by Deaton (1991)). If a household was willing to pay for private

mortgage insurance when refinancing, we inferred that such a household must have been liquidity constrained (if they were not, they would have reduced their loan to value ratio below 0.8 and avoided paying the higher marginal borrowing costs). The amount of liquid assets held was much lower, the amount debt accumulated was much higher, and the slope of their income profile was slightly steeper than other refinancers. All these conditions are consistent with this group being liquidity constrained. These liquidity constrained households converted, on average, at least 60 percent of the equity they removed while refinancing into current consumption. Non-liquidity constrained households, however, were not likely to convert any of the equity they removed into current consumption – these households simply reallocated the equity they removed into other portfolio components.

Monetary policy can partially alleviate household liquidity constraints and lead to a net spending stimulus. By reducing mortgage rates, the Federal Reserve can increase the net benefits to accessing home equity making it easier for liquidity constrained households to borrow against their home. The period of low interest rates gives liquidity constrained homeowners another reason to refinance - they can receive a present value wealth gain by servicing their existing mortgage balance at the lower interest rate. This additional gain can help to offset the high costs of accessing home equity for consumption smoothing reasons. Given that we find liquidity constrained households, at the median, removed close to $16,000 when refinancing during the low interest rate period of the early 1990s and that they comprised 11 percent of all refinancers, the resulting spending stimulus associated with lower mortgage rates is estimated to have been over $18 billion in 1993-1994.

This spending stimulus may not be without limits. Unlike public debt where repayment obligations have only diffuse and uncertain limits on private decision makers, the accumulation of private debt comes home to roost quickly in the form of higher repayment risk and the exhaustion of collateralized, marketable assets as security. Borrowers are then forced to resort to higher-cost, non-collateralized sources, such as 100 percent plus equity mortgages to fund any other future consumption shocks. These borrowers then have the added cash flow burden of 'debt service costs'. The exhaustion of home equity may limit the monetary stimulus of successive reductions in home mortgage rates over a limited time horizon.

Additionally, throughout the 1990s, the cost of accessing home equity has been dramatically decreased. The automation of many of the steps in the lending process and competition in mortgage markets have cut the cost of originating a mortgage from 2.5% to 1% of the mortgage balance (Bennett et. al, 1998). Reductions in the cost of accessing home equity will make it easier for households who want to access home equity to do so. Like a reduction in mortgage rates, a reduction in the fixed cost of refinancing will help to alleviate liquidity constraints for borrowers with low liquid assets and pent up

home equity. If the home did not serve a special purpose in the household's portfolio, a reduction in liquidity constraints would be socially optimal. But, if the relative illiquidity of the home serves as a commitment device for some households, a reduction in costs to accessing home equity could actually be welfare reducing. If households have dynamically time inconsistent preferences and wish to save for the future, but are unable to commit themselves to do so, large costs associated with accessing home equity may be socially optimal. In future research, to compute accurately the welfare gains from making home equity more liquid, it would be valuable to explore the extent to which the home serves as a savings commitment.

REFERENCES

Angeletos, G.M., D. Laibson, A. Repetto, J. Tobacman, and S. Weinberg (2001). "The Hyperbolic Buffer Stock Model: Calibration, Simulation, and Empirical Evaluation," Harvard University, Journal of Economic Perspectives, forthcoming.

Archer W., D. Ling, and G. McGill (1995). "The Effect of Income and Collateral Constraints on Residential Mortgage Terminations." *Regional Science and Urban Economics*; 26(3), pg 235-61.

Attanasio, O. (1994). "The Intertemporal Allocation of Consumption: Theory and Evidence." *NBER Working Paper* #4811, July.

Attanasio, O. and M. Browning (1995). "Consumption over the Life Cycle and over the Business Cycle", *American Economic Review*, 85(5), 1118-37.

Bennett, P., R. Peach and S. Peristiani (1998). "Structural Change in the Mortgage Market and the Propensity to Refinance." *Federal Reserve Bank of New York Staff Reports*; 45, September.

Blanchard, O. (1993). "Consumption and the Recession of 1990-1991." *American Economic Review*; 83(2), pgs 270-74.

Brady, P, G. Canner and D. Maki (2000). "The Effects of Recent Mortgage Refinancing." *Federal Reserve Bulletin*. 86(7), July, pgs 441-50.

Browning, M. and A. Lusardi (1996). "Household Saving: Micro Theories and Micro Facts." *Journal of Economic Literature*, v34, December, pgs 1797 - 1855.

Caplin, A., C. Freeman, and J. Tracey (1997). "Collateral Damage: How Refinancing Constraints Exacerbate Regional Recessions." *Journal of Money, Credit and Banking*; 29(4), 499-519.

Carroll, C., K. Dynan and S. Krane (1999). ``Unemployment Risk and Precautionary Wealth: Evidence from Households' Balance Sheets." *Finance and Economics Discussion Series Number 1999-15*, Federal Reserve Board.

Charles, K and E. Hurst (2001). "The Transition to Homeownership and the Black/White Wealth Gap". *Review of Economics and Statistics,* forthcoming.

Chen, A., and D. Ling (1989). "Optimal Mortgage Refinancing with Stochastic Interest Rates." *American Real Estate and Urban Economics Association Journal*; 17(3), pgs 278-99.

Curley, A. and J. Guttentag (1974). "The Yield on Insured Residential Mortgages." *Explorations in Economic Research*; pgs. 114-61.

Deaton, A. (1991). "Saving and Liquidity Constraints." *Econometrica;* 59(2), pgs 1221-48.

Dickinson, A. and A. Heuson (1994). "Mortgage Prepayments: Past and Present." *Journal of Real Estate Literature*; 2(1), pgs 11-33.

Dunn, W. (1998). "Unemployment Risk, Precautionary Saving, and Durable Goods Purchase Decisions".

Engelhardt, G. (1996). "House Prices and Home Owner Saving Behavior." *Regional Science and Urban Economics*; 26(3-4), June, pgs 313-36.

Flavin, M. and T. Yamashita (1998). "Owner Occupied Housing and the Composition of Household Portfolio over the Life Cycle". *University of California at San Diego Department of Economic's Working Paper 98/02.*

Gilberto, S. M., and T. G. Thibodeau (1989). "Modeling Conventional Residential Mortgage Refinancings." *Journal of Real Estate Finance and Economics*; 2(1), pgs 285-299.

Green, J. and J. Shoven (1986). "The Effects of Interest Rates on Mortgage Prepayment." *Journal of Money, Credit and Banking*; 18(1). pgs 41-59.

Gross, D. and N. Souleles (2000). "Do Liquidity Constraints and Interest Rates Matter? Evidence from Credit Card Data." *Quarterly Journal of Economics*, forthcoming.

Hall, R. (1988). "Intertemporal Substitution in Consumption." *Journal of Political Economy*; 96. pgs 339-57.

Hayashi, F. (1987). "Test for Liquidity Constraints: A Critical Survey and Some New Observations," in Advances in Econometrics, Truman Bewley, ed, Cambridge: Cambridge University Press.

Hurst, E. (1999). "Household Financial Behavior: Bankruptcy, Mortgage Refinancing and Wealth Accumulation." Dissertation, University of Michigan.

Hurst, E., M.C. Luoh and F. P. Stafford (1998), "Wealth Dynamics of American Families, 1984-1994." *Brooking Papers on Economic Activity;* 98(1), pgs 267-338.

Jappelli, T. (1990). "Who is Credit Constrained in the U.S. Economy?" *Quarterly Journal of Economics*, 105(1), 219-234.

Laibson, D., A. Repetto and J. Tobacman (1999). "A Debt Puzzle." mimeo, Harvard University.

Kau, J. and D. Keehan (1995). "An Overview of the Option-Theoretic Pricing of Mortgages." *Journal of Housing Research*; 6(2), pgs 217 - 44.

Manchester, J. and J. Poterba (1989). "Second Mortgages and Household Saving." *Regional Science and Urban Economics*; 19(2), May, pgs 325-46.

Martin, R. (2000). "Consumption and Transaction Costs." University of Chicago Working Paper.

Quigley, J. (1987). "Interest Rate Variations, Mortgage Prepayments and Household Mobility." *Review of Economics and Statistics*; 69(3), pgs 636-43.

Salandro, D. and W. Harrison (1997). "Determinants of the Demand for Home Equity Credit Lines." *Journal of Consumer Affairs*. 31(2), Winter, pgs. 326-45.

Samwick, A. (1997). "Discount Rate Heterogeneity and Social Security Reform." *NBER Working Paper #6219.*

Skinner, J. (1996). "Is Housing Wealth a Side Show?" <u>Advances in the Economics of Aging</u>, Wise, D. ed. Chicago: University of Chicago Press; pgs 241-68.

Skinner, J. (1994). "Housing and Saving in the United States", <u>Housing Markets in the United States and Japan</u>, Noguchi, Y. and J. Poterba, eds, Chicago: University of Chicago Press.

Skinner, J. (1989). "Housing Wealth and Aggregate Saving." *Regional Science and Urban Economics*, 19, pgs 305-24.

Stanton, R. (1995). "Rational Prepayment and the Valuation of Mortgage Backed Securities." *Review of Financial Studies*; 8(3). pgs 676-708.

VanderHoff, J. (1996). "Adjustable and Fixed Rate Mortgage Terminations, Option Values and Local Market Conditions: An Empirical Analysis." *Real Estate Economics*; 24(3), pgs 379-406.

Zeldes, S. (1989). "Consumption and Liquidity Constraints: An Empirical Investigation." *Journal of Political Economy*; 97(2), pgs 305-46.

Table 1: Aggregate Time Series Statistics
Mortgage Rates, Refinance Activity and the Removal of Equity

Year	Average 30 Year Fixed Mortgage Rate	Refinance Share [a]	Refinance up [b]	Refinance down [c]
1986	10.3	NA	0.50	0.13
1987	10.2	0.29	0.60	0.09
1988	10.3	0.21	0.82	0.06
1989	10.3	0.24	0.86	0.05
1990	10.1	0.26	0.86	0.05
1991	9.3	0.45	0.62	0.14
1992	8.4	0.52	0.47	0.16
1993	7.3	0.57	0.34	0.20
1994	8.4	0.27	0.47	0.12
1995	9.6	0.18	0.50	0.14
1996	7.8	0.27	0.54	0.12
1997	7.6	0.31	0.59	0.14
1998	6.9	0.52	0.51	0.14

[a] Refinance Share refers to the fraction of total mortgage originations that were refinancings.
[b] Refinance up refers to the fraction of households who removed more than 5% of the outstanding mortgage balance while refinancing.
[c] Refinance down refers to the fraction of households who decreased their mortgage balance while refinancing.

Source: Freddie Mac's *Secondary Mortgage Markets*, 2000.

Table 2: Means of Income, Demographic and Wealth Variables for Those Households Who Did and Did Not Refinance During the Early to Mid 1990s

(1396 Observations: All Homeowners With Mortgages Who Did Not Move 1989-1996)

Variable	Refinancers	Non-Refinanacers
Age of Head in 1989	39.8	45.0
Education Dummy (Head): Less than High School	0.045	0.115
Education Dummy (Head): Some College	0.234	0.209
Education Dummy (Head): College or More	0.423	0.326
Dummy: African American Head	0.037	0.089
Present Value of Wealth Gain (Financial Option) - in dollars	1,813	962
Dummy: Likelihood of Moving in Near Future	0.067	0.084
Number of Children in 1991	0.828	0.808
Change in the Number of Children Between 1991 and 1996	-0.140	-0.237
Dummy: Head Married in 1991	0.861	0.804
Dummy: Become Married 1991 - 1996	0.006	0.022
Dummy: Become Divorced 1991 - 1996	0.022	0.033
Average Family Labor Income 1991-1995	57,700	44,700
Percentage Increase in House Value 1991-1996	0.124	0.086
Dummy: Household Experience an Unemployment Spell 1991-1996	0.173	0.153
Dummy: Household Experience Financial Distress 1991-1996	0.227	0.194
Dummy: Household Declare Bankruptcy 1985 - 1996	0.022	0.027
1989 Liquid Wealth (sum of stocks, bonds and cash)	36,989	39,700
Number of Households	429	967

Weighted percentage of refinancing households (using PSID weights): 31.6%.
All reported means are weighted using PSID core weights.
All dollar amounts reported in the paper are in 1996 dollars.

Table 3: Probability of Refinancing 1991-1996
(1392 Observations: All Homeowners With Mortgages Who Did Not Move 1989-1996)

Variable	I Marginal Effect	II Marginal Effect	III Marginal Effect
Present Value of Wealth Gain (Financial Option)	**4.50 E-5**	**4.51 E-5**	**4.50 E-5**
	(1.05 E-5)	**(1.03 E-5)**	**(1.03 E-5)**
Dummy: Likelihood of Moving in Near Future	-0.080	-0.080	-0.081
	(0.046)	(0.046)	(0.045)
Age of Head	**-0.010**	**-0.009**	**-0.009**
	(0.002)	**(0.002)**	**(0.002)**
Education Dummy (Head): Less than High School	-0.068	-0.066	-0.065
	(0.059)	(0.059)	(0.059)
Education Dummy (Head): Some College	0.044	0.044	0.046
	(0.040)	(0.041)	(0.041)
Education Dummy (Head): College or More	0.029	0.031	0.034
	(0.039)	(0.039)	(0.039)
Dummy: African American Head	**-0.120**	**-0.120**	**-0.119**
	(0.042)	**(0.042)**	**(0.042)**
Change in the Number of Children Between 1991 and 1996	0.022	0.023	0.024
	(0.018)	(0.018)	(0.018)
Dummy: Head Married in 1991	0.015	0.015	0.013
	(0.047)	(0.047)	(0.047)
Dummy: Become Married 1991 - 1996	**-0.201**	**-0.201**	**-0.201**
	(0.074)	**(0.073)**	**(0.071)**
Dummy: Become Divorced 1991 - 1996	0.009	0.009	0.009
	(0.096)	(0.096)	(0.096)
Average Family Labor Income 1991-1996	**1.11 E-6**	**1.14 E-6**	**1.11 E-6**
	(4.92 E-7)	**(4.96 E-7)**	**(4.94 E-7)**
Percentage Increase in House Value 1991-1996	**0.112**	**0.114**	**0.112**
	(0.048)	**(0.048)**	**(0.048)**
Dummy: Household Loan to Value Ratio between 0.8 and 0.9	-0.045	-0.045	-0.028
	(0.052)	(0.052)	(0.053)
Dummy: Household Loan to Value Ratio > 0.9	**-0.110**	**-0.110**	**-0.087**
	(0.047)	**(0.047)**	**(0.047)**
Dummy: Experience an Unemployment Spell 1991-1996	0.032	**0.060**	**0.076**
	(0.042)	**(0.036)**	**(0.041)**
Liquid Assets in 1989	-1.89 E-7	-1.19 E-7	-1.10 E-7
	(2.02 E-7)	(2.00 E-7)	(1.98 E-7)
Unemployment Spell Interacted with Liquid Assets in 1989		-9.80 E-7	**-2.26 E-5**
		(6.11 E-7)	**(1.26 E-5)**
Unemployment Spell, Liquid Assets and LTV > 0.8 Interaction			**2.17 E-5**
			(1.29 E-5)
Dummy: Household Experience Financial Distress 1991-1996	0.030	0.030	0.030
	(0.038)	(0.038)	(0.038)
Dummy: Household Declare Bankruptcy 1985 - 1996	-0.021	-0.021	-0.025
	(0.087)	(0.087)	(0.086)

White Standard Errors in parenthesis; Only Marginal Effects are Reported; 1996 PSID weights were used
Average Probability of Refinancing for this sample: 31.6% :
Variables Significant at 10% level in bold.

Table 4: The Liquidity Option and The Removal of Equity During Refinancing
(1392 Observations: All Homeowners With Mortgages Who Did Not Move 1989-1996)

Heckman Selection Model on Whether the Household Refinanced
Selection Regression Results Suppressed
Present Value of Wealth Gain Driving Identification

Dependent Variable: Change in Equity During the Refinancing Process Relative to Initial Mortgage Balance	*Coefficient*	
Age of Head	**-0.005**	**
	(0.002)	
Education Dummy (Head): Less than High School	**-0.069**	
	(0.074)	
Education Dummy (Head): Some College	**0.088**	**
	(0.044)	
Education Dummy (Head): College or More	**0.099**	**
	(0.040)	
Dummy: African American Head	**-0.050**	
	(0.082)	
Change in the Number of Children Between 1991 and 1996	**-0.005**	
	(0.020)	
Dummy: Head Married in 1991	**0.101**	**
	(0.046)	
Dummy: Become Married 1991 - 1996	**-0.004**	
	(0.191)	
Dummy: Become Divorced 1991 - 1996	**0.019**	
	(0.118)	
Average Family Labor Income 1991-1996	**-5.31 E-7**	
	(4.13 E-7)	
Percentage Increase in House Value 1991-1996	**-0.017**	
	(0.049)	
Dummy: Household Loan to Value Ratio between 0.8 and 0.9	**-0.115**	**
	(0.058)	
Dummy: Household Loan to Value Ratio > 0.9	**-0.088**	
	(0.064)	
Dummy: Household Experience an Unemployment Spell 1991-1996	**0.096**	**
	(0.047)	
Unemployment Spell Interacted with Liquid Assets in 1989	**-2.50 E-6**	**
	(1.61 E-6)	
Constant	**-0.065**	
	(0.101)	

Standard Errors in parenthesis
*   Significant at 10% Level
**   Significant at 5% Level
*** Significant at 1% Level
Average Change in Equity Relative to Initial Mortgage: 0.084
Note: A few houses added equity and many households neither added to nor removed equity during the refinancing process.

Table 5: Interest Rates Paid By Refinancing Households
(467 Observations: All Homeowners With Mortgages Who Did Not Move 1989-1996 and Who Refinanced Between 1991 and 1996)

Heckman Selection Model on Whether the Household Refinanced
Selection Regression Results Suppressed

Dependent Variable: Interest Paid By Refinancing Households	Coefficient	
Age of Head	**-0.005**	
	(0.009)	
Education Dummy (Head): Less than High School	**-0.433**	
	(0.293)	
Education Dummy (Head): Some College	**-0.047**	
	(0.170)	
Education Dummy (Head): College or More	**-0.237**	
	(0.156)	
Dummy: African American Head	**-0.134**	
	(0.319)	
Dummy: Did the Household Secure a VA Loan	**0.062**	
	(0.367)	
Dummy: Did the Household Secure a FHA Loan	**-0.271**	
	(0.211)	
Year Dummy: 1992	**-0.459**	*
	(0.242)	
Year Dummy: 1993	**-0.567**	***
	(0.211)	
Year Dummy: 1994	**-0.750**	***
	(0.212)	
Year Dummy: 1995	**-0.399**	
	(0.250)	
Year Dummy: 1996	**-0.571**	
	(0.391)	
Average Household Labor Income 1991-1996	**-5.50 E-7**	
	(1.64 E-6)	
Dummy: Household Experience Financial Distress 1991-1996	**0.259**	*
	(0.153)	
Dummy: Household Experience an Unemployment Spell 1991-1996	**0.212**	
	(0.162)	
Dummy: Did the Household Declare Bankruptcy 1985-1995	**0.999**	**
	(0.440)	
Dummy: Household Ex-Post Loan to Value Ratio Between 0.8 and 0.9	**0.334**	*
	(0.187)	
Dummy: Household Ex-Post Loan to Value Ratio Greater than 0.9	**0.695**	***
	(0.269)	
Dummy: Debt to Income Ratio (1989) Greater than 0.32	**0.327**	
	(0.308)	
Dummy: Household Have a Variable Rate Mortgage	**0.326**	
	(0.201)	
Constant	**8.67**	***
	(0.505)	

T-stats in parenthesis   *   Significant at 10% Level   **   Significant at 5% Level   *** Significant at 1% Level
Average Mortgage Rate for Refinancing Households: 7.5%
Region Dummies Were Included in this Specification. None of the regions were statistically different from any of the other regions.

Table 6: Means of Income, Demographic and Wealth Variables for Liquidity Constrained Refinancers and all other Refinancers

(436 Observations: All Homeowners With Mortgages Who Did Not Move 1989-1996 and Refinanced between 1991 and 1994)

Variable	Liquidity Constrained Refinancers	All Other Refinancers
Age of Head in 1989	36.9	40.8
Education Dummy (Head): Less than High School	0.035	0.050
Education Dummy (Head): Some College	0.271	0.242
Education Dummy (Head): College or More	0.402	0.430
Dummy: African American Head	0.066	0.036
Number of Children in 1991	0.828	0.827
Change in the Number of Children Between 1991 and 1996	0.079	-0.188
Dummy: Head Married in 1991	0.877	0.857
Dummy: Become Married 1991 - 1996	0.015	0.003
Dummy: Become Divorced 1991 - 1996	0.041	0.017
Average Family Labor Income 1991-1995	61,400	55,500
Average Family Labor Income 1986-1990	48,916	52,535
Dummy: Household Experience an Unemployment Spell 1991-1996	0.182	0.176
Dummy: Household Experience Financial Distress 1991-1996	0.227	0.194
Dummy: Household Declare Bankruptcy 1985 - 1996	0.012	0.025
Percent with Zero Liquid Wealth in 1989	10%	2%
Median Liquid Wealth in 1989	7,500	11,000
Mean Liquid Wealth in 1989	27,200	37,200
75th Percentile of Liquid Wealth in 1989	16,100	34,400
Median Non-Collateralized Debt in 1989	9,500	2,100
Mean Non-Collateralized Debt in 1989	4,800	1,300
Median Total Net Worth in 1989	61,600	111,000

We define liquidity constrained refinancers as households who started with an ex-ante loan to value ratio less than 0.8 and ended up with an ex-post loan to value ratio in excess of 0.8.

Weighted percentage of liquidity constrained households: 11.1%

Liquid Wealth is defined as the sum of stocks, bonds and cash held by the household. See the text for the full definition.

Table 7: Marginal Propensity to Convert Home Equity (MPCE) into Consumption
(1396 Observations: All Homeowners With Mortgages Who Did Not Move 1989-1996)

Dependent Variable: Change in Household Wealth (including home equity) between 1989 and 1994	Coefficient	
Age of Head in 1989	**1,138**	
	(1,297)	
Age Squared	**-12.6**	
	(15.8)	
Education Dummy (Head): Less than High School	**-3,446**	
	(4,834)	
Education Dummy (Head): Some College	**1,737**	
	(3,446)	
Education Dummy (Head): College or More	**8,399**	**
	(3,470)	
Dummy: African American Head	**2,735**	
	(4,907)	
Number of Children in 1989	**-3,219**	**
	(1,348)	
Change in the Number of Children Between 1991 and 1996	**1,894**	
	(1,628)	
Dummy: Head Married in 1989	**-5,294**	
	(5,617)	
Dummy: Become Married 1989 - 1994	**-10,072**	
	(8,788)	
Dummy: Become Divorced 1989 - 1994	**-16,553**	***
	(6,427)	
Average Family Labor Income 1989-1994	**1.14**	***
	(0.113)	
Average Family Labor Income Squared	**-1.17 E-6**	**
	(5.23 E-7)	
Dummy: Have Positive Non-Collateralized Debt in 1989	**-6,866**	***
	(2,728)	
Dummy: Own Stocks in 1989	**-3,354**	
	(2,914)	
Dummy: Own Business in 1989	**20,793**	***
	(4,276)	
Net Worth, if net worth was positive, in 1989	**0.097**	***
	(0.010)	
Net Worth, if net worth was negative, in 1989	**-2.38**	***
	(0.401)	
Dummy: Household Refinanced 1991-1994	**-1,596**	
	(3,538)	
Dummy: Household Refinanced 1991-1994 and Liquidity Constrained	**-1,593**	
	(7,223)	
Equity Removed for Liquidity Constrained Refinancers	**-0.599**	***
	(0.106)	
Equity Removed for Non-Liquidity Constrained Refinancers	**0.082**	
	(0.147)	
Constant	**-27,257**	
	(25,848)	

T-stats in parenthesis   *   Significant at 10% Level   **   Significant at 5% Level   *** Significant at 1% Level
Median Change in Wealth Between 1989 and 1994: $39,629   Region Dummies Were Included in this Specification.

Figure 1: Refinance Decion With Stochastic Income and No Interest Rate Movements (beta = 0.85)
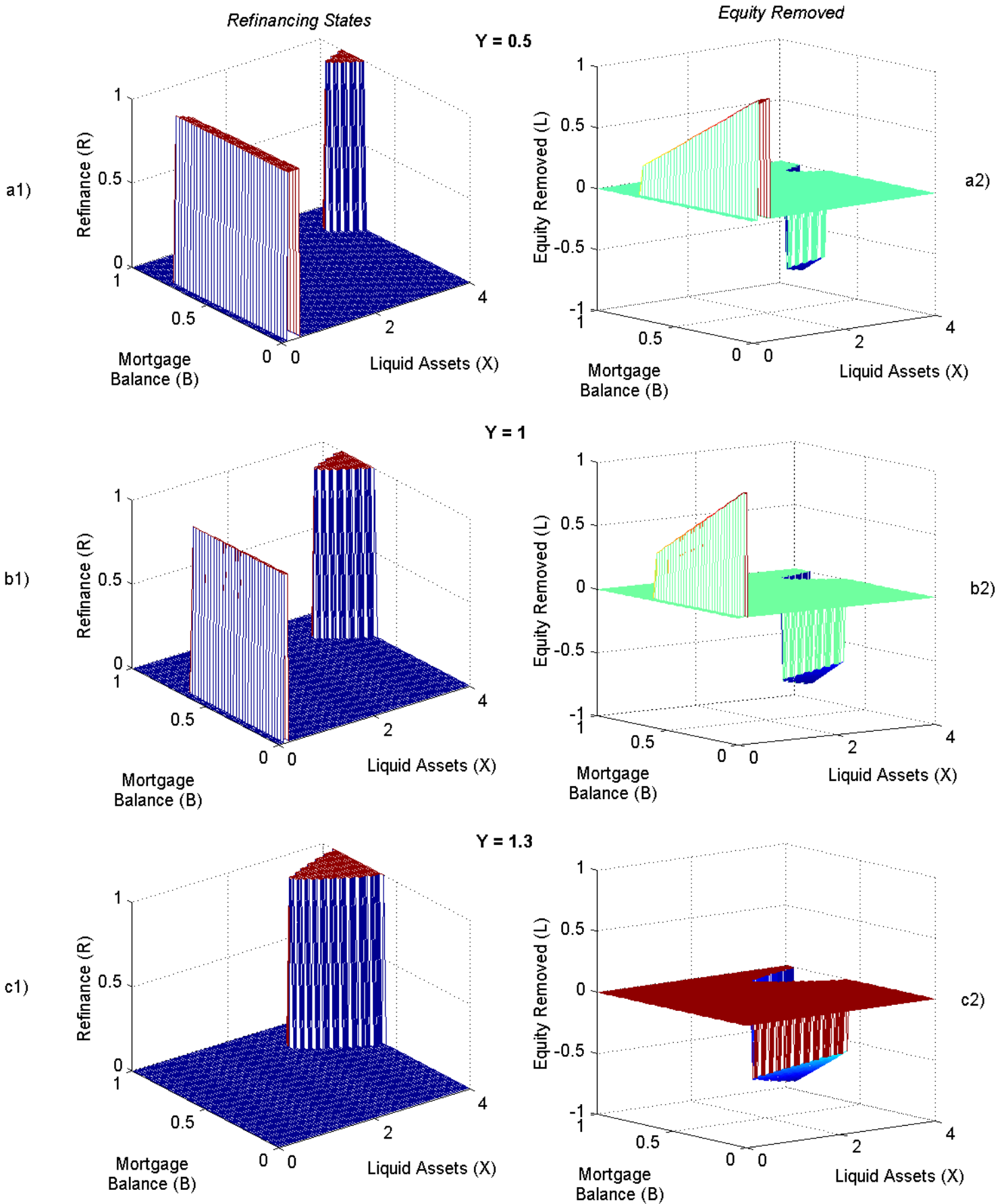
Figure 2: Refinace Decision With Stochastic Income and No Interest Rate Movements (beta = 0.95)
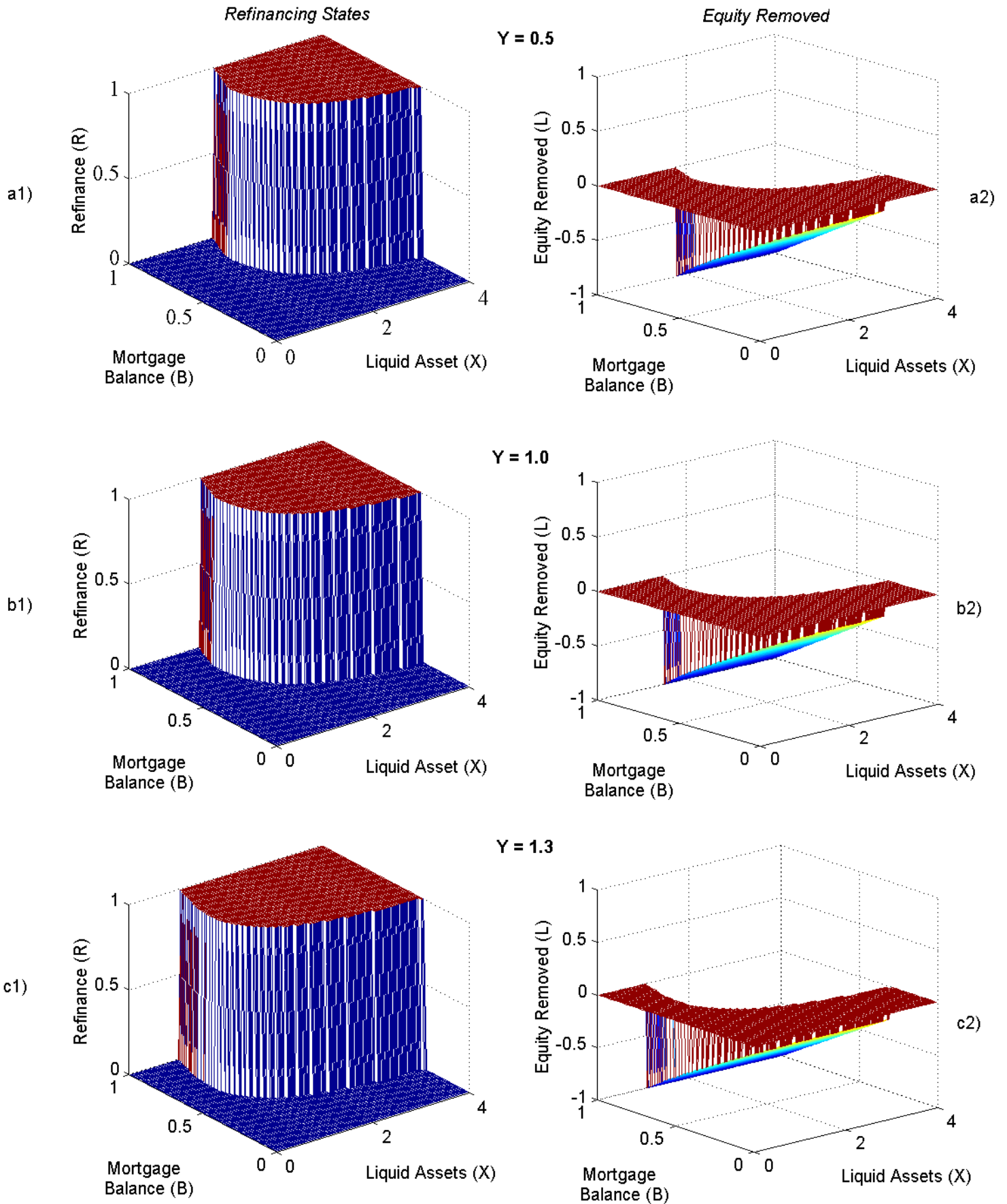
Figure 3: Refinancing Decisions With Interest Rates Unexpectedly Falling from 0.07 to 0.06 (beta = 0.85)