Home is Where the Equity Is:

Mortgage Refinancing and Household Consumption

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January 2003

We thank members of the Public Finance and Macroeconomics seminars at the University of Michigan and seminar participants at the Federal Reserve Bank of New York, the Inter-American Development Bank, and Indiana University for helpful comments on earlier drafts of this paper. We thank seminar participants at the Federal Reserve Bank of Chicago, the University of Chicago and NBER's 2001 Summer Institute for Real Estate and Public Policy for comments on this draft. Special thanks go to Axel Anderson, Mark Aguiar, Bob Barsky, Susanto Basu, Paul Bennett, Olivier Blanchard, Dennis Capozza, Kerwin Charles, Paul Courant, Scott Fay, Eric French, Ned Gramlich, Ricardo Hausmann, Michael Hanson, John Laitner, Cara Lown, Jonathan Parker, Matthew Shapiro, Nick Souleles and two anonymous referees. The authors would also like to thank Rob Martin for his excellent research assistance. Support for this research from Citicorp Credit Services and the University of Chicago's Graduate School of Business is gratefully acknowledged. Hurst would also like to thank the financial support given by the William Ladany Faculty Research Fund at the Graduate School of Business, University of Chicago for work on this project. Opinions expressed are those of the authors. Comments may be mailed to erik.hurst@gsb.uchicago.edu.

Journal of Money, Credit and Banking, December 2004

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Abstract: Applying a permanent income model with exogenous liquidity constraints and mortgage behavior, household refinancing when mortgage interest rates are historically high and rising, a persistent empirical puzzle, is explained. Using data from the Panel Study of Income Dynamics, households experiencing an unemployment shock and having limited initial liquid assets to draw upon are shown to have been 25% more likely to refinance, 1991-1994. On average, such liquidity constrained households converted over two-thirds of every dollar of equity they removed into current consumption as mortgage rates plummeted, 1991-1994, producing an estimated expenditure stimulus of *at least* $28 billion.

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I. INTRODUCTION

The extent to which refinancing activity by homeowners provides a net economic stimulus during times of falling mortgage interest rates has been a topic of discussion by policy makers during the recent economic slowdown of 2001-2002.[1] Housing is by far the largest single non-pension asset in a household's portfolio, comprising over 35% of the median household's wealth (Hurst, Luoh and Stafford 1998), about two-thirds of families are homeowners. However, unlike drawing down other non-pension 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 to 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.

In this paper, we explore the use of home equity as a mechanism by which households smooth their consumption over time. When confronted with a negative income shock, a household can sustain their consumption by either drawing down their "more-liquid" assets or, alternatively, tapping into their home equity. If the household has sufficient amounts of more-liquid assets (checking account balances, stocks, etc.) it is relatively easy for them to costlessly smooth their consumption. However, it becomes increasingly difficult for a household to buffer income shocks when these liquid asset balances are low, especially if non-collateralized borrowing rates are high. Households who have accumulated equity in their home may choose to pay the fixed cost to refinance and draw down their home equity. But, for a subset of homeowners, their housing equity is essentially trapped in the home; the gain in lifetime utility from refinancing and increasing current consumption 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.[2] While there 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.

In the first part of this paper, a model of optimal refinancing incorporating the household's desire to access home equity is developed. This model 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 - referred to as the "financial motivation", and 2) households may refinance so as to access accumulated home equity - referred to as the "consumption smoothing motivation". Households who received a negative income shock and who have little liquid assets to buffer the shock are shown to be more likely to refinance and access home equity, all else equal. This consumption smoothing motivation can explain the fact that some households will refinance even in a world of stable or rising interest rates, which has been characterized as an empirical anomaly in the housing literature (Stanton 1995 and Agarwal, Driscoll, and Laibson 2002).

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 reductions in the cost of refinancing alleviates otherwise binding liquidity constraints. We regressed whether a household refinanced anytime between 1991 and 1996 on the household's permanent income, demographics, the present value financial gain to refinancing, and controls for the consumption smoothing motivation to refinance. Households who experienced a spell of unemployment between 1991 and 1996, and who had zero liquid assets going into 1991, were 8 percentage points, or 25%, more likely to refinance than otherwise similar households. These same households were also more likely to remove equity during the refinancing process. Furthermore, the propensity to refinance and remove equity for households who experienced a negative income shock declined as the amount of liquid assets that they held increased.

Using a broader definition of liquidity constraints, we distinguished empirically those who refinanced primarily to improve their balance sheets from those who refinanced in part to access their home equity. The latter group exhibits what can be termed as a high average propensity to convert home equity into current consumption. Households who removed so much equity while refinancing so as to pay private mortgage insurance converted over 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, we discuss how declining mortgage rates can lead to an aggregate net spending stimulus as otherwise liquidity constrained households are now able to access their home equity at a lower net cost. We estimate that between 1991-1994, when mortgage rates fell substantially, previously liquidity constrained households increased aggregate consumption, via refinancing, by *a minimum* of $28 billion.

II. SUMMARY OF PREVIOUS RESEARCH

There is growing evidence that the home is used as a buffer against adverse shocks. Carroll, Dynan and Krane (1999) study whether households with a greater risk of unemployment are more likely to hold assets to buffer the potential shocks. 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.

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.

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)). 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, thereby reducing their monthly mortgage payments. The benefit to the household is a present value wealth gain. This benefit only need exceed the time and money costs of acquiring the new mortgage - which, as discussed above, can be quite large. Chen and Ling (1989) and Kau and Keehan (1995) extended this approach by developing contingent claims frameworks embodying a dynamic model of the decision to refinance.

While current and expected future interest rate movements can forecast a great deal of refinancing behavior, both Stanton (1995) and Agarwal, Driscoll and Laibson (2002) note that these financially motivated models of refinancing fail 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. Such refinancing behavior is often classified as "suboptimal" (Stanton 1995) or "anomalous" (Agarwal et al 2002). 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.

In this paper, we abstract from the lender side of the market.[3] We develop a utility based model where households optimally choose to refinance even in periods when interest rates are constant or rising. Such households refinance to access their accumulated home equity so as to smooth their consumption as their income fluctuates. We refer to the access of home equity as refinancing even though refinancing is only one means of liquidating the equity.[4] 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 financial buffer. Each household is endowed with a fixed housing stock. In each period, households optimally choose consumption, savings, and mortgage borrowing. A key feature to this model is that the agents face different borrowing and lending rates. Additionally, the agents may not borrow more than their endowed value of housing stock. Finally, the agents must pay a fixed cost in order to change the total quantity 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.[5] The house is treated as an asset in which the household can choose to add or remove savings after paying a fixed cost. The difference between mortgage interest rates and the interest rate earned on liquid assets implies the house would be the dominant asset in the absence of transaction costs. Only in the presence of costs to access home equity will we observe households simultaneously holding both liquid assets and mortgage debt.

A. The Model

Household i will choose 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:

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

$$B_{it} = B_{i,t-1} - \mathrm{L}_{\mathrm{it}} \tag{3}$$

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

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). The value of the home is

constant in all periods.[6] We explicitly build binding liquidity constraints into our model; households cannot be a net debtor in either X or H.

Households are endowed with an interest only "mortgage" tied to 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 an after tax mortgage interest rate of r^m_0 , the mortgage interest rate. The liquid asset, X, earns an after tax rate of return equal to r in all periods. We also assume that H, r and r^m are exogenous and believed to be constant over the infinite horizon by all households.

In each period, households choose 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 the new outstanding mortgage balance multiplied by the 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}. If the household refinances in period t, it must pay fixed cost F.

Households face income uncertainty. Household income in period t, Y_{it}, follows a Markov process with three independent states of the world - low income, medium income and high income:[7]

		Income t		
		Low Income	Medium Income	High Income
	Low Income	.2	.4	.4
Income t-1	Medium Income	.2	.4	.4
	High Income	.2	.4	.4

The low income state corresponds to 'unemployment'. We set the probability of being unemployed equal to 0.2, which is about the probability of being unemployed anytime between 1991 and 1996 for households in our data (see Table 2, discussed below). The probability of being in either the medium or

the high income states is 0.4. We set the low income value to 0.3 and the median income value equal to 0.6. The 0.3 corresponds to the median ratio of labor income plus transfers relative to house value for unemployed households in our sample. This 0.6 corresponds to the median ratio of labor income plus transfers relative to house value for all employed households in our sample. We set the high income value equal to the value of the housing stock, 1. Finally, we set the return on the risk free liquid asset to 0.03, the mortgage rate to 0.065, the time discount factor to 0.85, and the fixed cost to refinancing to be 2% of the house value.[8]

The timing of the household's decision in period t is as follows: 1) The household enters the period with outstanding mortgage balance (B_{t-1}) and an existing stock of liquid assets (X_{t-1}). 2) The household receives an income realization in the current period (Y_t). 3) The household decides whether to refinance (R_t) and the amount of equity to remove (L_t). This decision determines the mortgage balance to be carried into the following period (B_t). 4) Lastly, the household chooses consumption today (C_t) and the savings to be carried over to next period (X_t). It should be noted that 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.

Using numerical solution techniques, there are several interesting results that come from our theoretical example. Figure 1 shows household refinancing behavior in a world with no interest rate movements as a function of the liquid assets held by the household at the beginning of the period (X_{t-1}), the outstanding mortgage balance of the household at the beginning of the period (B_{t-1}) *and* the current income realization of the household (Y_t). Figure 1 has three panels labeled a, b and c, corresponding to the three income realizations (low, medium and high). The shaded area in each of the panels indicates which households will refinance in the current period as a function of B_{t-1} and X_{t-1}, for each Y_t realization. Comparing across panels, it is seen that households with low income realizations are much more likely to refinance than households who receive medium or high income draws. In fact, a household who receives

a high income realization does not refinance at all under this parameterization. Panel a) further illustrates that not all households who receive low income realizations will refinance; only those households with equity in their home and with little initial liquid assets to buffer the shock. Our model generates what has previously been described as an empirical anomaly; utility maximizing households will optimally choose to refinance in a world with stable interest rates.

These results are quite intuitively appealing. If a household received a high income realization and that household had low liquid wealth, there is no need for them to tap into their home equity to sustain their consumption. To the contrary, such a household would likely save a portion of their income realization (in liquid assets) so as to fund consumption in future periods. Additionally, households with high beginning of period liquid assets who receive a low income shock do not refinance. Such a household could buffer the low income realization using their liquid assets, which they can access without cost. It is the combination of low initial liquid assets *and* a low income realization that predicts refinancing. Figure 1 generates the first prediction which we will test empirically: households who receive a low income realization (relative to their expected permanent income), who have low liquid assets, and who have equity in their home will be willing to pay the associated costs to refinance.

Although the results are not shown, the households refinancing in figure 1 removed substantial amounts of equity when refinancing. This is not surprising given that the household is refinancing to access the home equity. Lastly, it can be easily shown that the equity removed was used to fund current consumption. In other words, if the household did not to refinance (i.e., the cost of refinancing was prohibitively large), their consumption would be much less than their post-refinancing consumption.

Two further comments about our model are noteworthy. First, it is worth discussing the implication of different income 'shocks'. The income process we specified in our numerical example has both permanent and transitory components. However, if the income process was either a pure random walk or pure i.i.d. with a constant mean, the results would be intuitively the same. The decision rule of the household is to compare the benefits of refinancing (in terms of the increase in lifetime utility from

smoothing consumption) to the costs of refinancing (the loss in utility associated with paying the refinancing fees). In our empirical work below, we will focus on unemployment shocks. While unemployment shocks have both a permanent and a transitory component, they are thought to be much more temporary than permanent (Huff-Stevens 1997). Given that permanent shocks would be likely to induce many households to alter their housing stock, empirically focusing on large transitory shocks is more in the spirit of our model. For completeness, we do account for the possibility of moving in our some of our empirical specifications.

Second, our model adds to the existing literature by isolating two separate motives to refinance. The models of financially motivated refinancing studied by other authors conclude that households only refinance when current mortgage rates are lower than the mortgage rate on the existing mortgage contract. As interest rates fall, households will refinance if the present value gain in wealth from reducing mortgage payments exceeds the cost of refinancing. However, as shown above, households will also refinance to tap into their home equity. These two motives to refinance are not independent. For households who have low initial liquid assets and who received a low income realization, the refinancing rule when interest rates fall differs from the rule followed by other households. These households who received a negative income shock and who have low liquid wealth will refinance when the lifetime utility gain from lower mortgage payments *plus* the lifetime utility gain from accessing home equity exceed the utility loss from paying the refinancing costs. All else equal, these households will be induced to refinance at smaller interest rate differentials.

Given this, our model shows that there is a role for monetary policy in alleviating liquidity constraints faced by homeowners with equity remaining in their home. By lowering interest rates, the Fed reduces the effective cost of accessing home equity. Prior to the declining interest rates, homeowners would only receive a consumption smoothing benefit if they choose to refinance. If this benefit is smaller than the utility loss from paying the refinancing costs, such households would not refinance. In essence, their housing equity would be trapped. But, if mortgage rates fall, the household would have two benefits

to refinance; the financial benefit and the consumption smoothing benefit. Such households would be more likely to refinance and access their pent-up home equity (because the benefits increased). Reducing mortgage rates could stimulate refinancing, allowing otherwise liquidity constrained households with equity trapped in their home to access that equity and fund current consumption.

Before we get to our empirical work, we show that our simple theory is consistent with the aggregate time series of refinancing behavior. Table 1 summarizes data compiled by Freddie Mac Corporation. Column 1 of Table 1 lists the average annual 30-year fixed mortgage rate between 1986 and 1998, Column 2 presents the share of all mortgage originations that were refinancing, while Columns 3 and 4, respectively, show the percentage of refinancers who removed equity from their home and the percentage of refinancers who added equity to their home. During the late 1980s, 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 refinanced in periods of relatively high interest rates were more likely to remove housing equity; this is consistent with these refinancing households being motivated by consumption smoothing.

As mortgage rates fell in 1993 and 1994, the overall refinancing rate rose strongly, but the share of those removing equity fell, meaning that most refinancers were motivated solely by wealth gains. 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.

Recent work by Brady, Canner and Maki (2000) is also consistent with the model of refinancing discussed above. These authors summarized the March through May 1999 University of Michigan's Surveys of Consumers' questions asking households if they refinanced, whether they removed equity when they refinanced and what they did with the equity that they removed. 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.[9] 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 home equity, which was otherwise trapped in their home when interest rates were high, so as to fund current consumption.

IV. 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 by asking detailed mortgage questions. In each year of the survey, households are asked to report their own estimated value of their house and, if applicable, to report the terms of their mortgage (mortgage balance, monthly payment net of taxes and insurance, and the years remaining on the loan). 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 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.[10]

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 1,606 households. Some observations with obvious data entry errors or missing values were dropped, reducing the sample size to

1,448 households. Of the 1,448 households, 434 refinanced between 1991 and 1996. Corresponding to aggregate data, approximately 31% 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.

V. Consumption Smoothing and Household Refinancing Probabilities

In this section, using our sample of *PSID* homeowners discussed above, we empirically test one of the key results from our theoretical model. If households use their home equity to smooth consumption, we would predict that those who received *both* a negative income shock and who had low levels of pre-existing liquid assets would be more likely to refinance, all else equal. This would be especially true in periods of lower mortgage rates, such as the early 1990s, where the net-cost of accessing home equity was reduced.

Three caveats are of note when trying to test our theory empirically. First, as discussed above, not all households who receive a negative income shock will refinance to access home equity, only those households who do not have other lower cost options to smooth the shock. A series of successive bad shocks could cause historically high saving households to be left with little liquid assets, forcing them to tap into their home equity to smooth additional shocks. Second, also discussed above, both permanent and transitory income shocks could cause households with little liquid assets to refinance. The household will refinance any time the gain in lifetime utility from increasing consumption is greater than the cost of refinancing. The benefits of refinancing increase if a given size shock in the current period is permanent, but in such cases, it is likely that the household would also want to change the size of their housing stock. Given that we restrict our sample to non-moving households, our empirical work will focus on the impact of unemployment shocks which are more temporary in nature.

Third, households will respond to both expected and unexpected shocks, particularly in periods of low interest rates. Suppose in 1990 a household with very little liquid assets, but a large amount of housing equity, knew for certain that she would become unemployed in 1993. Given the relatively high

interest rates in 1990, 1991 and 1992, a perfect foresight household would wait until 1993 before refinancing. The refinancing would take place in the year of the income shock, even though the shock was perfectly anticipated. Conversely, if the household head in 1993 found out that she would lose her job in 1994, a perfect foresight household would respond to the predictable shock in the low interest period of 1993. In this case, the refinancing would occur prior to the arrival of the income shock. Such timing issues need to be accounted for empirically. Unemployment spells in 1994, if predicted, could have resulted in refinancing in 1993. Below, we discuss how we address each of these caveats empirically.

To test the proposition that households use their home to buffer income shocks, 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 refinance. The reduced form refinancing decision for households over this period can be formalized as:

$$Y_i = \beta_0 + \beta_1 PV_{Wealth,i} + \beta_2 ConSmooth_i + \beta_3 Dem_i + \beta_4 Income_i + \varepsilon_i; \quad (5)$$

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, $ConSmooth_i$ represents a vector of variables reflecting the household's desire to access interim home equity, Dem_i and $Income_i$ are vectors of demographic and income controls, respectively, that could affect the refinancing decision, and ε_i is a normally distributed white noise error term. The observed variable is $Refi_i$, which equals one if household i refinanced between 1991 and 1996, and zero otherwise. We estimated the probability that $Refi_i = 1$ using standard probit techniques.

Because the household only reported refinancing behavior retrospectively in 1996 and is only asked about their most recent refinancing experience (back through 1991), 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. Averaging over the years will also likely mitigate

measurement error in all the variables we used in our regression. More importantly, treating our data as a cross section allows us to better address the timing of predictable and unpredictable shocks, discussed above. If households have perfect foresight, they may wait until the period of low interest rates to respond to past or expected future shocks. To address these timing concerns, we test whether income shocks received anytime between 1991 and 1996 affect refinancing anytime between 1991 and 1996. For robustness, we estimated a stacked regression predicting refinancing in year *t*, as a function of only year *t-1* characteristics, where *t* equals all years between 1991 and 1996. The results (not reported) were quantitatively similar in point estimates to the results we report below, although, as expected given the potential measurement error and the neglect in dealing with timing issues, the standard errors were slightly larger.

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 and locked in the low interest rates that prevailed during those years. 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.[11] Assuming that the mortgage balance or the term of the mortgage is not altered during the refinancing process, we can represent the present value wealth gain from refinancing in continuous time as:

$$PV_{Wealth,it} = \text{Max}\left[B_{it} \int_0^{T_i} (\omega_{i0} - \omega_{it})/(1+r_{it})^s \, ds \, , 0\right]; \quad \text{where} \tag{6}$$

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

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^m_{i0} is the original mortgage rate

(after tax) on household i's mortgage, r^m_{it} is the after tax 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.[12] The higher $PV_{Wealth,it}$ for the household, the greater the likelihood that the household will refinance in a given period. Almost all studies of refinancing use this measure (potentially adjusted for future interest rate movements) as the sole measure of demand for refinancing.

We use unemployment spells as our measure of income shocks. In relation to our theory, unemployment spells tend to be more temporary than permanent. Formally, 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 between 1991 and 1996. Just as almost all of the households in our sample who refinanced did so between 1993 and 1994, almost all of the unemployment spells in our sample occurred prior to the end of 1993. This is not surprising given the macroeconomic conditions that prevailed in the United States prior to and after 1993.

As seen in Section III, unemployment, per se, does not predict refinancing for consumption smoothing reasons. If a household has sufficient liquid assets, it can buffer the income shock by drawing down these assets. However, households who have little liquid assets prior to the receipt of the shock will have to pay the fixed costs of refinancing so as to access their accumulated home equity. To test the theory, the unemployment shock was interacted with the liquid assets that the household had in 1989 (the last time liquid assets were measured in the *PSID* prior to our sample period).[13] Additionally, we include a triple interaction between the unemployment shock, the liquid assets, and the amount of equity the household had in their home in 1990 (the period directly prior to the start of our sample period). We measure home equity by the household's loan to value ratio (LTV), defined as the households remaining mortgage balance in year t relative to their self reported house value in year t. The regressions also separately include controls for the household's LTV in 1990 and the value of liquid assets in 1989. Given that lenders require households with a LTV above 0.8 to purchase costly private mortgage insurance and may exclude borrowers completely with a LTV above 0.9, we also include a dummy variable for whether

the household had a LTV in 1990 between 0.8 and 0.9 and a dummy variable for whether they had a LTV in 1990 above 0.9.

We predict the sign on $Unemp_i$ to be positive, the sign on the unemployment/liquid-asset interaction to be negative, and the sign on the unemployment/liquid-asset/loan-to-value-ratio triple interaction to be negative. Households will be more likely to want to tap into their home equity when they receive a negative income shock, but their desire will diminish as the amount of liquid assets they have increases or the amount of equity they have in their home falls. Why would a household pay the cost to refinance to access home equity to smooth their income shock when they have sufficient assets in their checking account to do so?

To control for additional factors that affect the decision to refinance, we include the following series of demographics: the change in house value between 1990 and 1995, marital status in 1990, the change in marital status between 1990 and 1995, the number of children in 1990, the change in the number of children between 1990 and 1995, a permanent income measure (average household labor income between 1990 and 1995), the age of the household head, a series of education dummies measuring the educational attainment of the household head, the race of the household head, a series of region dummies for where the household lived in 1990, and whether the household experienced any financial distress between 1991 and 1996. 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. All dollar amounts reported in this paper are in 1996 dollars. Refinancers tended to be younger, more educated, more likely to be married, have higher incomes, and have a higher financial gain from refinancing than other non-refinancing homeowners.

Columns I-IV of Table 3 presents the results of our estimation of equation (10), where each of the columns includes different controls for the consumption smoothing motivation to refinance. For space, we suppressed the coefficients on all the income and demographic controls. Column I reports the results of a probit regression predicting refinancing as a function of the present value gain to refinancing, all the

income and demographic controls and *none* of the consumption smoothing controls. As anticipated, households with a higher present value wealth gain from refinancing and locking in the lower mortgage interest rate were more likely to refinance (*p-value* < 0.01). This is consistent with much of the existing literature on the financial motivations 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 4.6 percentage points, or 14.4% (0.046/0.32, where 0.32 is the base probability of refinancing for our sample).

Column II reports the results of a probit regression predicting refinancing that includes all the controls from regression I, plus some controls for the household's desire to refinance so as to smooth consumption. The first thing to note is that the coefficient on the present value wealth gain fell. This is not surprising. The regression in column II includes controls for the household's LTV. Households with a higher LTV, have lower outstanding mortgage debt and as a result, have less of a benefit from locking in the lower mortgage interest rate. By controlling for the household's LTV, we are partially controlling for their present value wealth gain. As is shown in Table 3, refinancing is an increasing function in LTV. However, households with an LTV above 0.8 are much less likely to refinance than other households. Lenders will require such households to secure private mortgage insurance, reducing their financial option to refinance. Additionally, there is little equity to remove from their home, thereby reducing their consumption smoothing option to refinance.

The results in column (II) provide little direct support for the consumption smoothing hypothesis. Neither the unemployment measure, nor the liquid asset measure, is statistically significant, although each entered with the expected sign. But, given this specification, these results are not surprising. Our model did not predict that all unemployed households will be more likely to refinance, only the unemployed households with low levels of more-liquid assets. In column (III) of Table 3, we also include an unemployed/liquid-asset interaction. Here, the results become much stronger. Households who experienced an unemployment spell in the early 1990s with no liquid assets in 1989 were 8.0 percentage

points, or 25% (0.08 divided by the base probability of refinancing for the sample, 0.32), more likely to refinance their home during the 1991-1996 period (*p-value* = 0.05). 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* = 0.10). 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 (IV) of Table 3, we also included a triple interaction of whether the household experienced an unemployment shock, their initial LTV in 1990 and their liquid assets in 1989. This interaction came in with the expected sign, although it was not statistically significant. The unemployment variable by itself increased from 0.08 to 0.16 and it still remained statistically different from zero (*p-value* = 0.08).[14]

As predicted by our theory of the consumption motivation to refinance, 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 fraction of equity removed relative to the initial mortgage balance as a function of demographics, income, unemployment spells and unemployment spells interacted with liquid assets. The demographic and income controls used in this regression were the same as used in the regressions reported in Table 3. Because the amount of equity, relative to the initial mortgage balance, 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 is independent of the fraction of equity that the household would want to remove during refinancing scaled by the initial mortgage balance. The identification is driven by the fact that the present value wealth gain is a function of the year when the initial mortgage was originated. It is not unreasonable to assume that the year in which the initial mortgage was originated is independent of the desire to remove equity from the home conditional on refinancing during the mid-1990s.[15] The estimated correlation between the error terms of the refinancing and equity removed equations was large, but not statistically different from zero ($\rho = 0.67$, *p-value* 0.46). Although we cannot reject that the error terms between the equity removal equation and the selection equation were correlated, we still report the results from the Heckman selection model. We suppressed the first stage results for the probability of refinancing when reporting the results of the Heckman selection model in Table 4. It should be noted that the results reported in Table 4 were nearly identical to the results from the OLS estimation.

The average amount of equity removed for the sample was 9% of their initial mortgage balance. As predicted, households who experienced an unemployment spell and had zero liquid assets in 1989 removed 12 percentage points more equity, relative to their initial mortgage balance, than other comparable households when refinancing (*p-value* = 0.09). As the amount of liquid assets held by the refinancing households who received an unemployment shock increased, the amount of equity they removed diminished rapidly.

The predictions of the consumption smoothing theory of refinancing are borne out in the data: controlling for the present value wealth gain to refinancing and demographics, households who experienced an unemployment shock, who had low levels of liquid assets and who had equity in their home *both* were more likely to refinance and were more likely to remove equity from their home during the process of refinancing. Was the equity removed used to fund current consumption? We address this question in the next section.

VI. Mortgage Refinancing, Liquidity Constraints and Consumption

It is quite conceivable that forward looking households would have equity trapped in their home. A series of negative income shocks could easily have depleted a household's liquid saving. Given the large fixed costs associated with accessing their home equity, some households may prefer to alter their consumption away from their optimal path instead of refinancing. We saw such behavior predicted from the model in Section III. In these instances, households will be essentially liquidity constrained; they wish to increase their consumption, but are confronted by an unfavorable cost structure. However, the liquidity constraint can be partially alleviated in periods of declining interest rates as the net benefits to accessing the accumulated home equity are now larger.

In order to compare the consumption behavior of liquidity constrained refinancing households, we first have to isolate households who we plausibly believe would be liquidity constrained. In this section, we are going to analyze a *broader* group of potentially liquidity constrained refinancers than we did in the previous section when we focused on households who became unemployed and who had low levels of liquid assets to buffer the shock. A household could be liquidity constrained for reasons other than having received a negative income shock. For example, a household could have received positive news about their income growth prospects, they could have experienced a negative consumption or health shock, or, simply, they could have a high intertemporal time discount rate.

Existing mortgage regulations allow households who are potentially liquidity constrained, for whatever reason, to reveal themselves. In order for conventional mortgages to be sold on the secondary market, all mortgages with an originating loan to value ratio greater than 0.8 must secure private mortgage insurance. Thus, conventional mortgages have a kink in the mortgage borrowing schedule at a 0.8 loan to value ratio. The effective borrowing rate on the equity removed for households who refinanced with an initial LTV just below 0.80 to an ex-post refinancing LTV of just above 0.80 can easily exceed twenty percent (see Caplin et al 1997). The reason for this is that the higher borrowing rate

resulting from the private mortgage insurance is applied to the whole outstanding mortgage balance, not just the incremental equity removed. We posit that households who had a pre-refinancing LTV below 0.8 and who subsequently had a post refinancing LTV above 0.80 were otherwise liquidity constrained.[16] For the following empirical work, these households need not be liquidity constrained - we will empirically test for differences in behavior. But by sub-setting 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.

This section sets out to verify empirically two points: 1) households who crossed the 0.8 LTV threshold 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, and they removed large amounts of equity while refinancing *and* 2) that these liquidity constrained refinancing households used the equity they removed while to fund current consumption (while those who had ex-post refinancing LTVs below 0.8 and who removed equity did not convert the equity into current consumption).

Did the households we designated as being potentially liquidity constrained pay higher rates in order to refinance? We estimated the loan supply curve offered by lending institutions. Table 5 reports the results of a regression of the mortgage rates paid by households who refinanced between 1991 and 1996 as a function of household income and demographics, characteristics of the loan and controls for the default risk of the refinancing household, estimated using a Heckman selection model.[17] Demographic controls used to estimate the loan supply curve include the household head's 1990 age, marital status in 1990, level of educational attainment, race, average five year labor income between 1991 and 1995 and household family composition in 1990. The characteristics of the loan include whether the 1996 interest rate is fixed or variable, whether the loan in 1996 was guaranteed by the Veterans Administration, whether the loan was insured by the Federal Housing Administration, the term of the mortgage in 1996 and the year the mortgage was originated. The coefficients on all the other additional variables, except the year the mortgage was originated, were suppressed. The time dummies portray a pattern consistent

with Table 1. Interest rates in 1993, 1994 and 1996 were lower than in 1992 and 1995. All the rates were lower than they were in 1991.

Of note in Table 5 are the controls for the default risk of the household. Not surprising, riskier borrowers paid higher interest rates. If the household was unemployed in the year that they refinanced, they paid, on average, 40 basis points higher. Households who reported experiencing some financial distress during the period (had trouble paying bills, had creditors call to demand payments, were late on payments) were also more likely to pay a higher interest rate. In this section of the paper, we designated households who are likely liquidity constrained as those households who had a pre-refinancing loan to value ratio below 0.8 and then had a post-refinancing loan to value ratio above 0.8. As evidenced in Table 5, such households, in fact, paid a higher mortgage rate in order to refinance. Those households with post refinancing loan-to-value ratios between 0.8 and 0.9 had to pay an additional 22 basis points on average (*p*-value 0.09) while those above 0.9 had to pay an additional 48 basis points on average (*p*-value 0.02). 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 an additional quarter of a basis point.

Households that are liquidity constrained likely would have lower levels of liquid assets than other comparable households. 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, having had the opportunity to pay down their mortgage over time.

Liquidity constrained refinancers tended to be different from other refinancers (and homeowners in general) along many other dimensions. The identified liquidity constrained group of refinancers had less mean and median net worth in 1989 ($101,600 and $41,900, respectively, for the liquidity constrained group and $171,300 and $106,300, respectively, for the other refinancers). Not only did the identified liquidity constrained refinancers have lower current total wealth, they also had lower liquid wealth in 1989. The median liquid wealth was $6,200 for the liquidity constrained group and $12,000 for the other refinancers (*p-value* of the difference 0.08). The difference persisted at both the mean and the 75th percentile. The liquidity constrained refinancers were also much more likely to remove equity during refinancing. 92% of liquidity constrained household removed equity while refinance versus only 57% for the other refinancers. The average equity removed, conditional on refinancing, was over two and a half times greater for liquidity constrained households ($43,400 vs $17,200).

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 lower levels of total and liquid wealth and were more likely to remove large amounts of equity during refinancing. All of these characteristics are consistent with this group being potentially liquidity constrained.

The question to which we now turn is whether this liquidity constrained group did, in fact, use the equity they removed to increase their current consumption. As interest rates fell in the early 1990s, it reduced the cost of accessing home equity for liquidity constrained households. In the *PSID*, aside from food consumption, there are no direct measures of consumption. However, one can back out consumption changes for *PSID* homeowners using the detailed wealth and income measures. Conditional on income, if household saving falls, household consumption must have increased. To test if there are differential consumption responses between liquidity constrained refinancers who removed equity and non-liquidity

constrained refinancers who removed equity, we estimated the following cross sectional equation on a sample of *PSID* homeowners:[18]

$$\begin{aligned}\Delta Wealth_{89,94} = {} & \alpha_0 + \alpha_1 Dem_{89} + \alpha_2 \Delta Dem_{89,94} + \alpha_3 Income_{89\text{-}94} + \alpha_4 \Delta Income_{89,94} + \alpha_5 Wealth_{89} \\ & + \alpha_6 Refi_{91\text{-}94} + \alpha_7 Refi_{91\text{-}94} * LiqCon + \gamma_1 Refi_{91\text{-}94} * LiqCon * \Delta Equity \\ & + \gamma_2 Refi_{91\text{-}94} * NonLiqCon * \Delta Equity + \eta \end{aligned} \quad (7)$$

where each variable is index by household *i*, although the *i* subscripts are suppressed. $\Delta Wealth_{89,94}$ is the change in household *i*'s total measured wealth, including housing, between 1989 and 1994, Dem_{89} is a vector of demographics of household *i* in year 1989, and $\Delta Dem_{89,94}$ is the change in demographic variables between 1989 and 1994. The demographic variables included are the household head's age, education, race, marital status, number of children, census region and sex. The change in demographic variables included whether the head became married, whether the head became divorced and the change in the number of children living in the home. $Income_{89\text{-}94}$ is a vector of income controls including household *i*'s average family labor income between 1989 and 1994 and the square of this measure. $\Delta Income_{89,94}$ is the change in household *i*'s family labor income between 1989 and 1994. $Wealth_{89}$ is a vector of initial wealth controls for household *i* including the household's initial 1989 wealth if it was positive, a separate variable for the household's 1989 wealth if it was negative, whether the household had any non-collateralized debt in 1989 and whether the household owned any stocks in 1989. The inclusion of these variables is designed to capture differences in returns faced by different homeowners. $Refi_{91\text{-}94}$ is a dummy variable taking the value of 1 if the household refinanced between 1991 and 1994. All refinancers can be classified as being either liquidity constrained (*LiqCon* = 1) or non-liquidity constrained (*NonLiqCon* = 1). Our identification of who is liquidity constrained is the same as above; a refinancing household is designated as being liquidity constrained if they refinanced from a LTV less than 0.8 to a LTV above 0.8.

As we saw in Table 6, both liquidity constrained and non-liquidity constrained refinancers removed equity while refinancing. From our theory, we expect the liquidity constrained refinancers to use the equity they removed to fund current consumption. We would not necessarily expect to observe this behavior for households who refinanced solely to exercise the financial option.[19] To test these predictions, we separately included controls for the amount of equity removed (*ΔEquity*) for both liquidity constrained refinancers and non-liquidity constrained refinancers. The coefficients on these variables, γ_1 and γ_2, provide an estimate of the average propensity to convert housing equity into consumption expenditures (APCE) for both liquidity constrained and non-liquidity constrained households, respectively. Households who removed equity from their home while refinancing between 1991 and 1994 could either spend it or reallocate that equity to another portfolio component. If the household spends it, it would no longer show up in any measure of their wealth. However, reallocating the wealth to another portfolio component would leave total wealth unchanged. We predict that the APCE for liquidity constrained refinancers (γ_1) will be close to negative 1 and the APCE for non-liquidity constrained refinancers will be zero (γ_2). The interpretation is that liquidity constrained refinancers will spend the equity they remove on current consumption and hence, that equity will disappear from their portfolio causing their total wealth to fall. The non-liquidity constrained refinancers will remove equity and use this equity to rebalance their portfolio. Their total wealth, as a result, will not fall when equity is removed during refinancing.

Table 7 presents the results of estimating (11) via OLS (Row 1) and via a quantile regression at the median regression (Row 2). We only present the estimates of γ_1 (Column I), γ_2 (Column II) and the *p*-value from a Wald test that $\gamma_1 \leq \gamma_2$ (Column III) in this table. The OLS and median regressions estimate γ_1 to be -0.66 and -0.67, respectively (*p*-values = 0.02 and < 0.01). In other words, for every $1 of equity removed by the liquidity-constrained household, consumption increased (wealth declined) during that time period by two-thirds of a dollar. The results are dramatically different for the non-liquidity constrained households where the APCE is estimated to be 0.20 (OLS) and -0.03 (median), with p-values,

respectively, equaling 0.65 and 0.84). We can reject that $\gamma_1 \leq \gamma_2$ for both the OLS and median regressions (p-value = 0.05 and < 0.01, one tailed test, respectively). The data conclude that liquidity constrained refinancers spend much more of the equity they remove on current consumption. It should be noted that the OLS estimate of γ_1 for liquidity constrained households is not statistically different from -1, although we can reject that the estimate from the median regression is equal to 1. The fact that the household did not spend all of the removed equity could be an issue of time. The households primarily refinanced during 1993 and 1994 and the latest wealth measure was observed in early 1994. It is possible that households who refinanced and removed equity simply did not have a chance to spend it by the time their wealth was measured. Given this, our estimates of the APCE for liquidity constrained households are likely biased towards zero.

The fact that a fall in interest rates can alleviate liquidity constraints by allowing households to access their home equity at a lower cost has implications for aggregate spending. When the mortgage rates fell during the early 1990s, liquidity constrained households suddenly were able to access their trapped home equity at a lower cost. Using the results from Table 7, we can predict the total net spending stimulus that resulted to the economy when mortgage rates fell during the early 1990s. Although only a small percentage of the sample is termed liquidity constrained by our definition, these households removed large amounts of equity when refinancing. 14% 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 in 1993, 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 $28 billion (in 1996 dollars), or 0.4% of 1993 GDP.[20] 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 $28 billion is likely an underestimate of the total stimulus associated with the large amount of refinancing during the early 1990s.[21]

VI. CONCLUSION AND POLICY IMPLICATIONS

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, 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. While the first motivation has been studied in detail in the literature, we are the first to model and test for the consumption smoothing motivation to refinance. If households receive a negative income shock 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 beginning period liquid assets and who subsequently experienced an unemployment shock were 25 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 and who had greater amounts of liquid assets to buffer the shock. Additionally, households who experienced a spell of unemployment and who had low levels of liquid assets were far more likely to remove equity during their refinancing process. 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.

Using a kink in the mortgage borrowing schedule, we identify a broader group of refinancing households who were liquidity constrained. If a household was willing to pay for private mortgage insurance when refinancing, we inferred that such a household was likely liquidity constrained. These liquidity constrained households converted, on average, at least two-thirds 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 $28 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 1.5% of the mortgage balance (Bennett et. al, 1998). Reductions in the cost of refinancing will make it easier for households who want to access home equity to do so. 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.

Endnotes

[1] Alan Greenspan, in his testimony before the Committee on Financial Services, U.S. House of Representatives on February 27, 2002, stated that "Low (mortgage) rates have also encouraged households to take on larger mortgages when refinancing their homes. Drawing on home equity in this manner is a significant source of funding for consumption and home modernization."

[2] 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)."

[3] 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 why households are observed not to refinance even in periods of low interest rates.

[4] A similar story can be told for second mortgages or home equity lines of credit. 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).

[5] 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 Carroll and Dunn (1997), Dunn (1998), Flavin and Ymashita (1998), and Martin (2002). Allowing the agent to alter their housing stock would add an additional dimension to the problem. However, controlling for the decision to move or "add on" to the house would not alter the solution to the refinancing model as long as the costs to altering the housing stock are large or the shocks to income are temporary. For a recent analysis of a model where households are allowed to alter their housing stock in the face of different realizations of income shocks, see Martin (2002).

[6] Our framework can be easily extended to include variability in house prices. In such instances, households who receive an unexpected capital gain on their housing stock may wish to refinance to access their home equity, even in periods of constant or rising interest rates.

[7] The purpose of this section is to establish qualitative results that will help guide our empirical work. Our intention is to simply use the model in order to identify the important dimensions of the agents' problem. In particular, we wish to identify the combination of states which lead to refinancing. 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.

[8] Lawrence (1991) and Samwick (1997) find large time discount rates using micro data implying a time discount factor of 0.85. All results are qualitatively similar using $\beta = 0.95$.

[9] 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.

[10] 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 see Hurst, Luoh and Stafford (1998).

[11] 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.

[12] One aspect of the mortgage decision that we have to this point ignored was the tax benefits of borrowing on one's home. Given the current U.S. tax code, mortgage interest payments on primary residences can be deducted from adjusted gross income when calculating personal tax liabilities. To address this empirically, all interest rates used to compute $PV_{Wealth,it}$ are after tax. We adjust the nominal mortgage rates by multiplying them by one minus the household's 1991 marginal tax rate, reported in the *PSID*. This method only approximates the U.S. tax code because it does not account for the fact that households receive a standard deduction if they choose not to itemize. We believe these effects will likely be second order.

[13] Liquid assets are defined as the sum of two questions in the *PSID*. The first asks households to report "the value of checking and saving accounts, money market funds, certificate of deposits, saving bonds, Treasury bills and IRAs", while the second asks household "the value of shares of stock in publicly held corporations, mutual funds, or investment trusts, including stocks in IRAs." Although IRAs are considered by many to be illiquid, there is no way to remove IRAs from our measure of liquid assets given the way the *PSID* collected wealth data in 1994. This should not affect our results in any substantive ways as long as the ratio of IRAs to liquid wealth is relatively constant as liquid wealth increases.

[14] Given that we focus on homeowners who did not move between 1989 and 1996, our sample has the potential to be non-representative. As discussed above, households who experience a negative income shock may be able to free up equity by moving to a smaller home. Although, moving is much more costly than refinancing, households may choose this option if they are simultaneously looking to alter their desired housing stock. To control for this potential bias, we ran a Heckman selection model of whether the household refinanced between 1991 and 1996 with the first stage being whether the household moved during 1989 to 1996. The second stage was exactly the same as specified in Column III of Table 3. We were able to identify the moving equation using the self reported likelihood of moving 'in the next few years' as asked of *PSID* respondents in 1990. There was little evidence that such selection is biasing our results. The correlation in errors between the first and second stage was small ($\rho = 0.27$) and not statistically different from zero (*p-value* = 0.48). The coefficient on the unemployment variable in the second stage (comparable to Column III of Table III) was 0.066 with a standard error of 0.037. We conclude that restricting our sample to non-moving households is not biasing our results in any appreciable way.

[15] Even if the present value wealth gain is not independent of the amount of equity that a household would like to remove, we are still able to identify the Heckman Selection model off of non-linearities in the specification.

[16] Just because a household removed equity need not necessarily 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. But, the incremental cost of doing so is often very large for households with a pre-refinancing LTV of just under 0.8.

[17] 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 large and statistically different from zero ($\rho = 0.96$, *p-value* < 0.01). As before, identification results from the fact that present value wealth gain (driven by the year the mortgage was initially originated) is independent of the mortgage rate menu that the household faced in the mid 1990s.

[18] Sample includes all homeowners in the *PSID* who where in the sample continuously from 1989 to 1994, who were less than 60 years of age in 1989, who had a mortgage in 1989 and who did not move between 1989 and 1994. Additionally, the top/bottom 1% of the change in wealth distribution was truncated (1,626 observations).

[19] It is possible that those who refinance solely to lock in lower interest rates may experience a consumption increase as their mortgage payments decreased. This wealth effect, however, will likely be small. Assuming that the present value wealth gain from refinancing was as large as $6,000 and assuming a marginal propensity to consume out of wealth shocks of about 4% per year, we predict the effect on spending should be about $240 per year.

[20] (100 million households)*(2/3 homeowners)*(31% refinancing during 1993)*(14% liquidity constrained)*(92% of the liquidity constrained households removed equity while refinancing)*($16,000 - median amount of equity removed by liquidity constrained households who removed equity)*(0.66 - APCE for liquidity constrained households) = $28.1 billion. All numbers were in 1996 dollars.

[21] This $28 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), $28 billion represents about 13% 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.

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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

Note: Source for the data is Freddie Mac's *Secondary Mortgage Markets*, 2000.

[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.

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

Variable	*Refinancers*	*Non-Refinanacers*	*p-value of difference*
Financial Motivation			
Average Present Value Wealth Gain (in dollars)	1,800	890	< 0.01
Median Present Value Wealth Gain (in dollars)	1,300	350	< 0.01
Demographics and Income			
Age of Head in 1989	45	52	< 0.01
Education Dummy (Head): Less than High School	0.05	0.14	< 0.01
Education Dummy (Head): Some College	0.23	0.20	0.17
Education Dummy (Head): College or More	0.42	0.32	< 0.01
Dummy: African American Head	0.04	0.10	< 0.01
Dummy: Head Married in 1991	0.85	0.78	< 0.01
Dummy: Become Married 1991 – 1996	0.01	0.02	0.07
Dummy: Become Divorced 1991 – 1996	0.02	0.03	0.30
Average Family Labor Income 1991-1995	54,700	41,600	< 0.01
Median Family Labor Income 1991-1995	48,000	37,400	< 0.01
Percentage Increase in House Value 1991-1996	0.12	0.09	0.04
Initial Housing Equity and Liquid Assets			
Average Loan to Value Ratio in 1990	0.54	0.41	< 0.01
Median Loan to Value Ratio in 1990	0.55	0.39	< 0.01
Average Liquid Assets in 1989	37,000	42,600	0.29
Median Liquid Assets in 1989	10,000	10,000	1.00
Consumption Smoothing Motivation			
Dummy: Household Experience Unemployment 1991-1996	0.18	0.15	0.168
Number of Households	434	967	

Notes: Sample consists of all homeowners in the PSID, who owned the same home continuously between 1989 and 1996, who were in the sample continuously between 1989 and 1996, who had an outstanding mortgage on their home in 1990 and who had liquid assets in 1989 less than $1 million dollars (1,401 observations). The weighted percentage of refinancing households for this sample was 32%. All results reported in the paper are weighted using PSID core weights. All dollar amounts reported in the paper are in 1996 dollars.

Table 3: Probit Estimating the Probability of Refinancing 1991-1996

	I	II	III	IV
Variable	*Marginal Effect*	*Marginal Effect*	*Marginal Effect*	*Marginal Effect*
Financial Motivation				
Present Value of Wealth Gain (in $10,000s)	0.46	0.29	0.29	0.29
	(0.10)	(0.11)	(0.11)	(0.11)
Controls for Initial Housing Equity and Liquid Assets				
Loan to Value Ratio in 1990 ($LTV90_i$)		0.38	0.38	0.41
		(0.09)	(0.09)	(0.09)
Loan to Value Ratio in 1990 between 0.8 and 0.9		-0.16	-0.16	-0.16
		(0.04)	(0.04)	(0.04)
Loan to Value Ratio in 1990 > 0.9		-0.22	-0.22	-0.22
		(0.04)	(0.04)	(0.04)
Liquid Assets in 1989 (in $100,000s)		-0.02	-0.01	-0.01
		(0.02)	(0.02)	(0.02)
Controls for Consumption Smoothing Motivation				
Unemployed Between 1991 and 1996 ($Unemp_i$)		0.05	0.08	0.16
		(0.04)	(0.04)	(0.09)
$Unemp_i$ * Liquid Assets in 1989 (in $100,000s)			-0.10	-0.06
			(0.06)	(0.06)
$Unemp_i$ * $LTV90_i$				-0.13
				(0.16)
$Unemp_i$ * Liquid Assets in 1989 * $LTV90_i$ *(in $100,000s)*				-0.11
				(0.19)
Include Demographic and Income Controls?	Yes	Yes	Yes	Yes

Notes: Sample used in this table is the same as in Table 1 (1,401 observations). The dependant variable in regressions I-IV takes the value of 1 if the household refinanced anytime between 1991 and 1996. Standard errors, in parenthesis, are robust to heteroskadasticity across households. Only marginal effects from the probits are reported. The weighted percentage of refinancing households for this sample was 32%. All coefficients on demographic and income controls were suppressed. See text for a discussion.

Table 4: The Removal of Equity During Refinancing

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*
Controls for Initial Housing Equity and Liquid Assets	
Loan to Value Ratio in 1990 ($LTV90_i$)	-0.18
	(0.24)
Loan to Value Ratio in 1990 between 0.8 and 0.9	-0.06
	(0.10)
Loan to Value Ratio in 1990 > 0.9	-0.02
	(0.13)
Liquid Assets in 1989 (in $100,000s)	0.002
	(0.02)
Controls for Consumption Smoothing Motivation	
Unemployed Between 1991 and 1996 ($Unemp_i$)	0.09
	(0.05)
$Unemp_i$ * Liquid Assets in 1989 (in $100,000s)	-0.20
	(0.11)
Include Demographic and Income Controls?	Yes

Notes: The sample used for the results in this table is the same as that reported in the notes to Table 2 except with the additional restriction that the refinancing households had to have non-missing data needed to compute the equity removed during refinancing (1,345 households, of which 378 refinanced). Standard errors, in parenthesis, are robust to heteroskadasticity across households. The weighted percentage of refinancing households for this sample was 29%. The average percentage equity removed relative to initial mortgage balance was 9%. See text for details of the additional income and demographic variables included in this regression.

Table 5: Interest Rates Paid By Refinancing Households

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

Dependent Variable: Interest Paid By Refinancing Households, Reported by Household in 1996	*Coefficient*
Dummy: Year Household Refinanced	
1992	-0.42
	(0.19)
1993	-0.55
	(0.16)
1994	-0.79
	(0.16)
1995	-0.47
	(0.19)
1996	-0.54
	(0.28)
Controls for Default Risk of the Refinancing Household	
Unemployed Between 1991 and 1996	0.41
	(0.17)
Experience Financial Distress Between 1991 and 1996	0.37
	(0.16)
Have an *Ex-Post* Refinancing Loan to Value Ratio Between 0.8 and 0.9	0.22
	(0.15)
Have an *Ex-Post* Refinancing Loan to Value Ratio Above 0.9	0.50
	(0.20)
Include Household Income and Demographic Controls?	Yes
Include Additional Loan Characteristics?	Yes

Notes: The sample used in this table is the same as that reported in the footnote to Tables 2 except with the additional restriction that the refinancing households had to report a positive, non-missing value for their interest rate (1,364 households, of which 420 refinanced). Standard errors, in parenthesis, are robust to heteroskadasticity across households. The weighted percentage of refinancing households for this sample was 32%. The average interest rate paid by refinancing households was 7.8%. See the text for details of the additional income and demographic variables and the additional loan characteristics included in this regression.

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

Variable	*Liquidity Constrained Refinancers*	*All Other Refinancers*	*p-value of difference*
Demographics			
Age of Head in 1989	34	40	<0.01
Education Dummy (Head): Less than High School	0.08	0.03	0.15
Education Dummy (Head): Some College	0.24	0.23	0.86
Education Dummy (Head): College or More	0.35	0.45	0.20
Dummy: African American Head	0.07	0.02	0.05
Dummy: Head Married in 1991	0.95	0.86	0.09
Dummy: Become Married 1991 - 1996	0.01	0.01	0.57
Dummy: Become Divorced 1991 - 1996	0.06	0.01	0.02
Income			
Average Family Labor Income 1991-1995	58,800	57,700	0.85
Unemployment and Financial Distress			
Dummy: Unemployment Spell 1991-1996	0.17	0.12	0.33
Dummy: Household Experience Financial Distress 1991-1996	0.32	0.19	0.04
Liquid Wealth			
Median Liquid Wealth in 1989	6,200	12,000	0.08
Mean Liquid Wealth in 1989	21,900	37,300	0.13
75^{th} Percentile of Liquid Wealth in 1989	18,900	37,700	0.09
Total Wealth			
Median Total Net Worth in 1989	41,900	106,300	<0.01
Mean Total Net Worth	101,600	171,300	0.03
Equity Removed			
Percent Removing Equity During Refinancing	0.92	0.57	<0.01
Median Equity Removed (Conditional on Removing Equity)	16,000	11,000	0.22
Mean Equity Removed (Conditional on Removing Equity)	43,400	17,200	<0.01
75^{th} Percentile of Equity Removed (Conditional on Removing)	39,000	20,800	0.05

Notes: The sample for this regression includes all homeowners in the *PSID* who refinanced between 1991 and 1994, who where in the sample continuously from 1989 to 1994, who were less than 60 years of age in 1989, who had a mortgage in 1989 and who did not move between 1989 and 1994. Additionally, the top/bottom 1% of the change in wealth distribution was truncated (305 observations). 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. The weighted percentage of liquidity constrained households was 14.4%. 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: Average Propensity to Convert Home Equity (APCE) into Consumption

	I	***II***	***III***
Dependent Variable: Change in Household Wealth (including home equity) between 1989 and 1994	APCE for Liquidity Constrained Households Who Remove Equity While Refinancing Between 1991 and 1994	APCE for Non-Liquidity Constrained Households Who Removed Equity While Refinancing Between 1991 and 1994	*p*-value of difference
1. OLS Regression	-0.66 (0.29)	0.20 (0.44)	0.05
2. Quantile Regression at Median	-0.67 (0.09)	-0.03 (0.13)	< 0.01

Notes: The sample includes all homeowners in the *PSID* who where in the sample continuously from 1989 to 1994, who were less than 60 years of age in 1989, who had a mortgage in 1989 and who did not move between 1989 and 1994. Additionally, the top/bottom 1% of the change in wealth distribution was truncated (1,626 observations). The dependent variable for the mean and the median regression is the change in wealth (including housing equity) between 1989 and 1994. The coefficients in columns I and II provide estimates of γ_1 and γ_2, respectively, from equation (11) in the text and measure the change in wealth that occurs after a household removes $1 of equity from their home during refinancing. See the text for the additional income and demographic controls included as regressors. Heteroskadastic robust standard errors are reported in parenthesis for the OLS regressions. The mean and median change in wealth between 1989 and 1994 was, respectively, $96,018 and $39,629. Column III reports he *p*-value of a one tail test for whether the APCE for liquidity constrained households (column I) is strictly greater than the APCE for non-liquidity constrained households (column II).