Residential Mortgage Selection, Inflation Uncertainty and Real Payment Tilt

Abstract

This study addresses prime and subprime residential mortgage selection in an inflationary environment. Using data from the *Mortgage Bankers Association* on the proportion of variable rate mortgages closed for the 1994 through 2007 period, we find that higher anticipated inflation held with certainty increases the proportion of ARM originations, while greater inflation uncertainty in the sense of a Diamond-Stiglitz mean preserving spread decreases it. Further, the percentage of subprime ARM originations is significantly decreased with greater inflation uncertainty while the impact on prime ARM originations is statistically insignificant. These results are consistent with the hypothesis that prime borrowers hold a valuable exchange option that subprime borrowers do not, i.e. the opportunity to refinance into an alternative mortgage product, if necessary.

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I. Introduction

Many have argued that low interest rates and alternative mortgage instruments were motivating factors in the surge in demand for housing over the past decade. Financing homeownership was cheap by historic standards, fueled by low, long-term rates on fixed rate mortgages. Low rates increased the supply of funds to the mortgage markets yet incremental increases in household income failed to keep pace with the increase in property value making it difficult for some borrowers to qualify for a fixed rate mortgage. Variable rate lending with extraordinarily low teaser rates became a popular method of combating the disconnect between income and value and helped to inflate the housing bubble. Income-to-debt ratios were maximized and homes were often financed with 100 percent loan-to-value ratios in anticipation of continued property appreciation that would, within a short time, decline to 80%. Households could then refinance into a conventional, fixed-rate loan with more favorable terms (Baily, Litan and Johnson, 2008). This culminated with housing starts and the rate of homeownership reaching all-time highs by 2006 (Taylor, 2007). Not long thereafter, the market began its precipitous collapse.

This paper is an extension of research conducted by Taube and MacDonald (1989) analyzing mortgage selection in the inflationary period between 1981 and 1987. Here we address borrower behavior, specifically the mortgage-choice decision, focusing on the choice between fixed- and adjustable-rate financing in both inflationary and deflationary environments. The impact of anticipated inflation held with certainty and inflation uncertainty is examined on the choice between fixed and variable rate residential mortgage instruments. Using data from the *Mortgage Bankers Association* on the proportion of variable rate mortgages closed for the 1994 through 2007 period, we find that higher levels of anticipated inflation held with certainty increase this proportion, while higher levels of inflation uncertainty in the sense of a Diamond-Stiglitz mean preserving spread decrease this proportion. That is, the higher expected inflation and real housing prices are, the more difficult it is for borrowers to qualify for loans and therefore borrowers prefer the variable rate mortgage. Conversely, when confronted with increased inflation uncertainty, risk adverse borrowers prefer a more present tilt to the real payment path and a more random real consumption path.

The impact of inflation on the mortgage choice decision is further explored in the prime and subprime markets. Findings show that, when anticipated inflation is held constant, inflation uncertainty significantly decreases the number of subprime variable rate originations while no significant impacts are evident in the pool of prime variable rate originations. This is primarily a function of credit quality; prime borrowers have credit quality sufficient to refinance into an alternative mortgage instrument if necessary. Subprime borrowers, alternatively, do not generally possess the same valuable exchange option and may be subject to rate increases that make monthly mortgage payments unaffordable.

The remainder of this paper is divided as follows. The following section provides background information on the impact of inflation on mortgage choice. Section 3 discusses the development of the residential mortgage choice problem and provides a brief literature review. Section 4 introduces the model and the determinants of the residential mortgage selection problem. Section 5 describes the data and presents the empirical results. The final section summarizes the paper and draws implications from the results.

II. Background

A broad category of mortgage instruments have been developed to address the 'real payment tilt' and housing affordability problems associated with anticipated inflation.[1] With fully anticipated inflation, the nominal interest rate rises on fixed rate mortgages to incorporate expectations of higher levels of inflation. Higher nominal yields and higher initial real mortgage payments create a present value tilt in the stream of real mortgage payments. For borrowers unconstrained by capital market imperfections, the real payment tilt of the fixed rate mortgage (FRM) is not a problem. However, for borrowers who are unable to acquire loans based on expected future income or are constrained to maximum originating loan to value ratios, a mismatch exists between the time sequence of mortgage payments and income growth. Adjustable rate mortgages (ARM) and graduated payment mortgage instruments have been developed to address the problems associated with the real payment tilt of fixed rate mortgages (FRM).

Inflation affects the real capital value of mortgages, increasing the riskiness of FRMs and stabilizing ARMs, an important element in household risk management. Campbell and Cocco (2003) highlight risk differences between fixed and adjustable rate mortgages, finding that a FRM with a prepayment option is expensive in a stable or deflationary environment. ARMs, conversely, limit potential risks associated with inflation uncertainty, yet are subject to income risk due to the short-term variability in monthly payments that may force a reduction in future consumption. The authors find that income risk is particularly acute in households with large mortgages relative to income, volatile labor income, or high risk aversion. These findings are consistent with those of Shilling, Dhillon and Sirmans (1987) who found that households with low or stable income are more likely to borrow using an ARM.

Although inflation uncertainty is a well recognized economic variable, the causes of its variation are not well understood.[2] Initial work by Friedman and Schwartz (1963) and Friedman (1977) suggests a dual hypothesis exists or that (i) a positive relationship exists between inflation uncertainty and inflationary shocks and (ii) a negative relationship exists between inflation uncertainty and real economic output growth. Interestingly, while the evidence strongly (but not universally) supports the first hypothesis, relatively mixed evidence exists on the second hypothesis.[3]

In the case of residential mortgage selection, Brueckner (1984) demonstrated theoretically that with a constant inflation rate and rising real income, borrowers will prefer the graduated payment mortgage to the fixed payment mortgage. Barney and White (1986) find that with constant real income and price level uncertainty, borrowers prefer a less graduated or more present tilted payment path. Research by Tucker (1989) shows borrowers are willing to assume the additional interest rate risk associated with variable rate loans in markets where house values are appreciating rapidly, implying the expectation of greater returns for the assumption of greater risk. Taube and MacDonald (1989) examine a model similar to that proposed here and find that both anticipated inflation held with certainty and inflation uncertainty are important determinants of the residential mortgage selection decision during the inflationary period of the 1980s.

The differential response of borrowers to expected inflation and inflation uncertainty should be of concern to lenders concerned with forecasting the demand for various mortgage debt instruments. If borrowers prefer a more present tilt or fixed rate payment path in the face of inflationary uncertainty, then lenders must increase the effective fixed to variable rate spread to induce borrowers to accept the transferred interest rate risk. The more risk averse borrowers are, the greater the spread necessary to induce the transfer. Conversely, the lower the level of borrower risk aversion, the narrower will be the spread necessary to induce the transfer of interest rate risk.

III. Residential Mortgage Choice

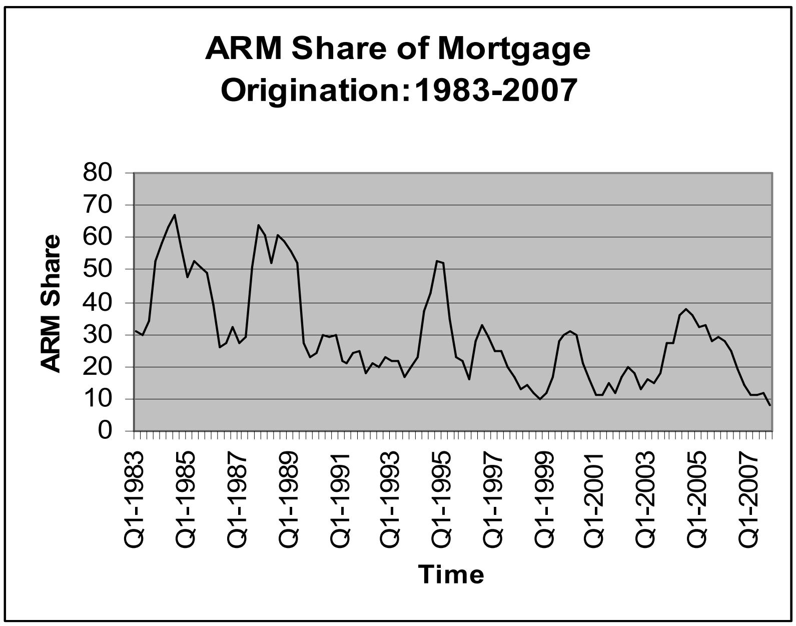
Prior to the early 1980s, there was one basic mortgage type: the standard fixed rate mortgage.[4] Residential borrowers selected either a conventional or FHA/VA loan and the payment reflected the cost of intermediate term funds as well as the cost of the call (prepayment) and put (default) option premiums. The singular existence of the FRM causes a cross subsidization between borrowers. That is, all residential borrowers pay the same implicit call premium even though the value of the option is more valuable to less mobile households (longer lived call options are at least as valuable as shorter lived options). The call option is more valuable to households who expect rates to decline and anticipate refinancing at a lower rate than to those who expect just the reverse (McConnell and Singh, 1994; Ambrose and LaCour-Little, 2001). The put (default) option also varies in value, decreasing the larger the down payment on the home and increasing with greater house price volatility (Harrison, Noordewier, and Ramagopal, 2002).

Adjustable rate mortgages were introduced in 1981 to combat high interest rates and facilitate borrowing among consumers during periods of high inflation. The initial payment on an ARM is generally less than that on a FRM, but the payment on an ARM can easily rise over the life of the loan relative to the original payment on a comparable FRM. Thus, the residential borrower is faced with a trade off between lower initial payments and greater uncertainty about the payment in later loan repayment periods. Obviously, borrowers prefer lower initial mortgage payments because they can qualify for larger loan to value mortgages and reduce the affordability problem. Lenders prefer ARMs because they transfer some of the interest rate risk associated with FRMs to borrowers. Low teaser rates and margins are used to attract borrowers, while higher, predetermined rate caps limit lenders' interest rate exposure (Chiang, Gosnell, and Hueson, 1997; Phillips and VanderHoff, 1991).

Which mortgage a specific borrower will choose depends ultimately on the mortgage possibilities available and their preference structure (assuming they possess a reasonable understanding of the various instruments). Arsham, Ford, Morse, and Pitta (2007) address the mortgage selection issue, recognizing that borrowers are often ill-prepared to understand the costs and benefits associated with different types of mortgages. Research by Chomsisengphet, Murphy and Pennington-Cross (2008) evaluates consumer selection for a number of different mortgage products created to help borrowers who would not traditionally qualify, obtain a mortgage. The authors show that the origination of different types of loans (ARM, hybrid, interest-only, non-amortizing, balloons) is each affected differently by a variety of demographic characteristics. ARMs, in particular, are likely originated in areas displaying substantial wealth, increasing income, low credit scores, and/or small down payments. Additional studies show that the number of ARM originations may be partially the result of institutional, political, and regulatory changes (Coleman, LaCour-Little, and Vandell, 2008), and that pricing can mitigate risk factors resulting in a greater share of ARM originations (Mori, Diaz III, and Ziobrowski, 2009).

The relative share of ARM originations for the period 1983 through 2007 is given in Figure 1. It is important to note that a portion of the sample period coincides with the rapid growth of the subprime market. The subprime market originated in the mid-90s to expand credit opportunities for those who were generally considered to be poor credit risks by traditional lenders, primarily in low-income communities, and were guaranteed by the FHA. Wheaton and Nechayev (2008) identify the increase in subprime mortgage originations and other risk-based credit as one of the factors contributing to the housing market boom. Prior to 2003 the majority of mortgage originations were "prime conforming" loans that were purchased by Fannie Mae and Freddie Mac, but by 2006 about 46% of all mortgage originations were Alt-A (near prime but lacking documented income – 25%) or subprime (21%). Fifteen percent were jumbo mortgages that exceeded conforming limits and 36% were conforming (Kiff and Mills, 2007).

Figure 1: ARM share of total mortgage originations: 1983-2007



Source: Mortgage Bankers Association

Chomsisengphet and Pennington-Cross (2006) report that subprime rates were generally issued at about a 2% premium over prime lending rates from 1995 through 2004. They further show that the number of FRM subprime originations (based on LoanPerformance ABS securities database) outpaced ARM originations through 2001. After that, more subprime ARMs were originated than FRMs, though each made up a substantial portion of mortgages. The number of FRM subprime originations peaked at 780,000 in 2004 with ARM originations somewhat higher at 866,000. Data collected from the third quarter of 2005 through the second quarter of 2007 by the Mortgage Bankers Association shows that approximately one-third of all FRM issues and roughly half of all ARMs were considered subprime (Table 1).

Insert Table 1 here

As shown in figure 1, the proportion of ARMs to total originations has varied widely and fallen dramatically in recent years. Theoretical studies by, Statman (1982), Alm and Follian (1987), Basel and Biger (1980), and Breuckner (1984), and empirical studies by Dhillon, Shiling and Statman (1987) and Breuckner and Follain (1988), Phillips and Vander Hoff (1991), Posey and Yavas (2000), and Campbell and Cocco (2003) have all examined various aspects of the mortgage selection decision. In general, these studies suggest that the ARM proportion of total mortgage originations rises when (i) the ratio of the effective rate of fixed rate to variable rate debt increases, (ii) the growth in permanent income increases, (iii) the real interest rate rises and (iv) relative borrower risk aversion decreases.

With relatively high current interest rates or with lower rates and a steeply inclined (upwardly) term structure, residential mortgage selection favors the ARM. That is, high initial interest rates induce borrowers to select the ARM due to the affordability problem. With lower rates and a flat or downwardly inclined term structure, the lower affordability problem and lack of relatively low short term rates induces selection of the FRM. Therefore, two key components of the ARM share total of home mortgage originations exist: the level and term structure of interest rates. When anticipated inflation is at low levels and short term rates are at sufficiently low levels, yields will matter little because most borrowers will have already selected the FRM.

Brueckner and Follain (1989) and Sa-Aadu and Sirmans (1995) empirically support these hypotheses concerning the ARM and FRM share of total mortgage originations.

Residential borrowers who live in relatively low cost housing areas and with relatively high real income and wealth will tend to prefer the FRM. Those borrowers with rapid expected income growth or who expect interest rates to decline fear payment path uncertainty less and are more likely to choose an ARM. Basel and Biger (1980) examine a single period mean-variance model in which risk adverse borrowers maximize the end of period terminal wealth. Statman (1982) and Smith (1987) extend the Basel/Biger model and find that variable rate financing is preferred when real income and the value of housing are positively correlated with both the real interest rate and anticipated inflation.

In the absence of new mortgage instruments and governmental intervention, the relative ARM share of total originations is ultimately dependent on the interaction of lender and borrower behavior.[5] On the side of lenders, their liability structure is largely endogenous since they can fund mortgages through a variety of debt instruments and alter the relative liability mix through interest rate swaps and other related instruments. Lenders can also use derivative instruments to convert short term to long term debt and cap adverse interest rate movements while profiting from favorable movements. Residential borrower behavior does impact the yields on alternative mortgage instruments so their behavior ultimately explains the relative distribution of mortgage originations across mortgage types.

V. Mortgage Origination and Inflation Uncertainty

To formalize the concept of inflationary uncertainty, we assume that if borrowers expect future inflation to deviate from the current inflationary path, then borrowers will be more uncertain about the future inflation process. Inflation uncertainty can therefore increase or decrease as the probability that future inflation is expected to deviate from the present level of inflation or some perception of normal inflation. Therefore, inflation uncertainty can be expressed as:

$$\eta^*(t) = 1\text{-}Prob[(\pi^*(t)\text{-}\ \pi(t))/\sigma(t)=0] \qquad (1)$$

where $\sigma^2(t)$ denotes the cross-sectional variance of expected inflation at time t and $\pi(t)$ is the actual or normal inflation experienced observed at time t. Equation (1) is consistent with the Diamond-Stiglitz notion of a 'mean-preserving spread' where weight from the center of the probability distribution is shifted to the tails while preserving the mean.[6]

The use of the mean preserving spread to model inflation uncertainty is based on the fundamental notion that borrowers are risk adverse and have strictly concave utility functions. The Diamond-Stiglitz mean preserving spread can be defined using a family of distribution functions, F(x, r), where x is a random variable. If F(x $,r_1$) is derived from F(x $,r_2$) by taking mass from the center of the distribution and shifting it to the tails while preserving the mean, then F(x,r_1) is said to be riskier than F(x $,r_2$). Formally, it is assumed that E[r] = 0, $E[r|x=0]$ and the Var[r] = 0.

Barney and White (1986) have theoretically examined the impact of increasing inflation uncertainty (in the Diamond-Stiglitz sense) on the residential selection decision and suggest that increasing uncertainty will decrease (increase) the relative ARM (FRM) origination share percentage. In effect, borrowers prefer the more uncertain real payment path and lack of interest rate risk of the FRM to the more certain real payment path and interest rate risk associated with the ARM.

The data on the mean ($\pi(t)$) and variance ($\sigma^2(t)$) of inflation expectations were obtained from the University of Michigan- Survey of Consumers. The survey is currently conducted monthly and a randomly selected sample of approximately 500 American households are asked (in telephone interviews) about expected changes to key macroeconomic variables such as inflation, interest rates, and unemployment. The sample is designed to be "rotating," in that for any one survey, approximately 60% of respondents are new and the remaining 40% of respondents are interviewed for a second time. Since 1977, the survey has asked by how much respondents expect the consumer price index (CPI) to increase over the next year and a long run forecast on five to ten year expectations is also taken.

Though the rationality of survey forecasts has been debated (see Croushore, 1998, for example) they are generally well regarded. Ang, Bekaert and Wei (2007) show that survey measures of expected inflation provide better forecasts of inflation than any other alternative that they consider, including a number of variants of the Phillips curve and term structure models. Mehra and Herrington (2008) use a VAR (vector autoregression) specified by Leduc, Sill and Stark (2007) to examine measures of survey expectations following the change in the monetary policy regime that took place around the end of the 1970s. They find that the expectations process changed in a way that is consistent with the change in the inflation process that took place at about the same time, suggesting that survey participants are able to detect changes in the inflation process relatively quickly. Bernanke, Laubach, Mishkin and Posen (2001) discuss how the behavior of survey forecasts relative to the monetary authority's inflation target provides information about credibility. [7]

The estimation of equation (1) or $\eta^*(t)$ consists of several variants, each having a different measure of $\pi(t)$. The monthly inflation rate, quarterly rate and moving averages of past inflation (two to six month periods) are analyzed. Moving averages of past inflation up to period *t* not only smooth temporary changes in monthly inflation measures, but also are more representative of normal trends or conditions of sustained price trends. Therefore, only information on anticipated inflation at the time the residential mortgage choice selection is made is used in the analysis. Each measure of $\pi(t)$ yields virtually identical parameter estimates and only those estimates of $\eta^*(t)$ computed from a two-period lagged monthly moving average are reported below.

IV. Modeling Residential Choice Selection

The differences in borrower preferences and mortgage possibility mixes outlined above allow for the determination of the conditions under which the ARM (FRM) share percentage will rise or fall at any point in time. In particular, the demand for mortgage origination shares depends on current and past values of strategic market variables and stochastic influences. The ARM (FRM) origination shares can be expressed, respectively, as:

$$D_{i,M} = f(r, g_y, \pi^*, \eta^*, p_{cs}) \tag{2}$$

where $D_{i,M}$ (i=A, F) represents the ARM and FRM origination shares respectively, *r* represents the effective fixed mortgage rate, g_y represents the growth of real permanent income, π^* represents the anticipated inflation rate , η^* represents our measure of inflation uncertainty, and p_{cs} represents the S&P/Case-Shiller U.S. national home price index.

An important feature of the mortgage origination model in equation (2) is the well known logical consistency requirement. That is, mortgage origination shares (like firm market shares) are bounded between 0 and 1 and they must sum to unity ($\sum_{i=1}^{2} D_{i,M}$). This logical consistency requirement must be taken into account if one wants to study all the actors in such a market. Therefore, the approach followed here is similar to that of Frances, Srinivasan, and Boswijk (2001), Cable (1997), and Gallet and List (2001) who exploit the logical consistency requirement in the market share literature by employing a system equation approach using SUR (seemingly unrelated regression) methods originally proposed by Zellner (1962).[8]

To formalize the model, mortgage origination shares depend on current and past values of strategic market variables and stochastic influences. The empirical representation of equation (2) is given here as:

$$m_{A,t} = \alpha_A + \beta_{1A,t}\, r + \beta_{2A,t}\, g_y + \beta_{3A,t}\, \pi^* + \beta_{4A,t}\, t\, \eta^* + \beta_{5A,t} p_{cs} + u_{A,t} \qquad (3a)$$

$$\text{and} \quad m_{F,t} = \alpha_F + \beta_{1F,t}\, r + \beta_{2F,t}\, g_y + \beta_{3F,t}\, \pi^* + \beta_{4F,t}\, t\, \eta^* + \beta_{5F,t} p_{cs} + u_{F,t} \qquad (3b)$$

where $m_{A,t}$ and $m_{F,t}$ are the relative ARM and FRM origination shares respectively and r, g_y, π^*, η^* and p_{cs} are as given in equation (2). Under suitable assumptions about the disturbance terms $u_{A,t}$ and u_{Ft}, equations 3(a) and 3(b) can be expressed in logarithmic form. Note that in levels or origination shares (percentage) form, equations 3(a) and 3(b) must sum to unity, but this logical consistency restriction does not apply to the sum of the logarithmic transformation of origination shares.[9]

Upon first differencing equations (4a) and (4b) we obtain

$$\Delta m_{A,t} = \beta_{1A,t} \Delta r + \beta_{2A,t} \Delta g_y + \beta_{3A,t}\, \Delta \pi^* + \beta_{4A,t}\, t \Delta \eta^* + \beta_{5A,t}\, \Delta\, p_{cs} + v_{A,t} \qquad (4a)$$

$$and \qquad \Delta\ m_{A,t} = \beta_{1F,t}\Delta r + \beta_{2F,t}\Delta g_y + \beta_{3F,t}\ \Delta\pi^* + \beta_{5F,t}\ \Delta\ p_{cs} + v_{F,t} \qquad (4b)$$

Equations 4(a) and 4(b) represent a structural equation specification of mortgage origination shares in a simultaneous equation system. Since the regressors are the same across both equations, the OLS and GLS parameter estimates will be identical using SUR (Greene 2000).

The model specified in equations 4(a) and 4(b) employs time-series data and the variables (and hence error term) must be stationary (integrated of degree zero or I(0)). Otherwise, in the case of unit roots, the I(1) variables must be co-integrated for equilibrium relationships to exist (Granger (1981) and Engle and Granger (1987)). In the case of mortgage origination shares, the variables are expressed in log-difference form, and not surprisingly, augmented Dickey Fuller (ADF) unit root tests indicate stationarity in each of the relevant variables. [10]

The system equation approach employed here is closely related to prior research in the literature on mortgage share originations. Alm and Follain (1987) and Brueckner and Follain (1988) demonstrate that the effective fixed mortgage rate, *r*, is clearly an important factor in mortgage choice. In particular, $f_{A1} = \partial f_A / \partial r$ and $f_{F1} = \partial f_F / \partial r$ should be positive (negative), respectively, as a higher effective fixed mortgage rate increases (decreases) the ARM (FRM) choice probability. Basel and Biger (1980), Statman (1982), Brueckner and Follain (1988) and Smith (1987) suggest that the differential $f_{F2} = \partial f_F / \partial g_y$ is positive since borrowers are, in general, inclined to align real mortgage payments with real income.

Barney and White (1986) have theoretically examined the impact of increasing inflation uncertainty (in the Diamond-Stiglitz sense) on the residential selection decision and suggest that $f_{A4} = \partial f_A / \partial \eta^* < 0$ and $f_{F4} = \partial f_F / \partial \eta^* > 0$ respectively. In effect, borrowers prefer the more uncertain real payment path and lack of interest rate risk of the FRM to the more certain real payment path and interest rate risk associated with the ARM. The impact of anticipated inflation held with certainty, $f_3 = \partial f / \partial \pi^*$, in both equations can be positive or negative depending on borrowers preferences. If the borrower prefers a rising real consumption path and nominal income is expected to rise by the inflation rate so that real income is constant, then the FRM will be preferred and $f_{3A} = \partial f_A / \partial \pi^* < 0$ and $f_{3F} = \partial f_F / \partial \pi^* > 0$. Conversely, if the borrower prefers a constant real consumption path under the same scenario then the ARM will be preferred and $f_{3A} = \partial f_A / \partial \pi^* > 0$ and $f_{3F} = \partial f_F / \partial \pi^* < 0$. In effect, the impact of anticipated inflation held with certainty can be ambiguous. Finally, as discussed above, increasing constant quality housing prices should be associated with $f_{5A} = \partial f_A / \partial \pi^* > 0$ and $f_{5F} = \partial f_F / \partial \pi^* < 0$.

An interesting feature of the mortgage market in recent years has been the rise of subprime mortgage originations. The system equation approach can be applied to tests on ARM prime and ARM subprime originations as follows:

$$\Delta\ m_F = \beta_{1F} \Delta\ r + \beta_{2F}\ \Delta g_y\ + \beta_{3F} \Delta\ \pi^*\ + \beta_{4F}\ \Delta\ \eta^* + \beta_{5F}\ \Delta p_{cs} +\ v_F \qquad (5a)$$

$$\Delta\ m_{AP} = \beta_{1AP}\ \Delta\ r + \beta_{2AP}\ \Delta g_y\ + \beta_{3AP} \Delta\ \pi^*\ + \beta_{4AP}\ \Delta\ \eta^* + \beta_{5AP}\ \Delta p_{cs} + v_{AP} \qquad (5b)$$

$$\Delta m_{AS} = \beta_{1AS}\ \Delta r + \beta_{2AS} \Delta g_y\ +\ \beta_{3AS}\ \Delta \pi^*\ + \beta_{4AS} t\ \Delta \eta^* +\ \beta_{5AS,t} \Delta\ p_{cs} + v_{AS} \qquad (5c)$$

where m_F is as defined as before, m_{AP} and m_{AS} are the relative ARM prime and subprime origination shares, respectively, and r, g_y, π^*, η^* are as given in equation (2). Equations 5(a)-5(c) represent a structural equation specification of FRM, ARM prime and ARM subprime mortgage origination shares in a simultaneous system.

Since the majority of subprime borrowers are constrained to choose an ARM origination, the impact of inflation uncertainty can have a differential impact on ARM prime and ARM subprime borrowers. That is, prime ARM borrowers have a valuable exchange option (to exchange an ARM for the FRM) that subprime borrowers generally do not possess. The option to exchange an ARM for the FRM is valuable since it will generally reduce the impact of inflation uncertainty on those borrowers who possess such a valuable exchange option. The exchange option value will increase (move deeper in-the-money) when inflation uncertainty increases and vary with the relative terms of the two mortgage originations (e.g., the 5:1 ARM would contain a more valuable exchange option than a 3:1 ARM all other factors constant). In effect, one would expect that $f_{AS4} = \partial f_{AS} / \partial \eta^* < 0$, but that $f_{AP4} = \partial f_{AP} / \partial \eta^*$ is ambiguous for prime ARM borrowers who possess valuable exchange options.

Although the exchange option is not directly observable in the market, its value will vary over time and is implicit in the residential mortgage selection decision. One would expect, for example, that the value of the exchange option would decline as overall housing prices decline. As housing prices decline (as measured by the Case-Shiller adjusted price index), one would expect that it is generally more difficult for existing prime ARM borrowers to refinance at lower loan to value ratios and exercise the exchange option. The exchange option value also depends on related economic factors including regulatory changes in the mortgage origination market, secondary mortgage market conditions, Federal Reserve monetary policy and the level of inflation uncertainty.

V. Data and Empirical Findings

The data used in this study come from several sources. Mortgage closings were obtained from the Mortgage Bankers Association. The fixed rate mortgage data was obtained from the Federal Home Loan Mortgage Corporation (FHLMC). These data were accessed quarterly from Q1 1994 through Q4 2007 and the sample includes 56 observations. Real personal income data for the same period were obtained from the government National Income Accounts. The data on the mean and variance of inflation expectations were obtained from the University of Michigan-Survey of Consumers (see the prior section for details).[11] Home price data were acquired from the S&P/Case-Shiller Home Price Index which is a composite of single-family home price indices for the nine U.S. Census divisions and is updated monthly.[12] The Case –Shiller index is adjusted for inflation using the CPI housing index component and computes a measure of housing price consistent with the other variables based on related change.

The data on prime and subprime ARM mortgage originations were obtained from *Inside Mortgage Finance* (Mortgage Origination Indicators) for the period 1994-2007 and therefore restricts our SUR regression results to this sample period. *Inside Mortgage Finance* compiles prime and subprime origination data from HMDA (Home Mortgage Disclosure Act) and HUD (Housing and Urban Development) data sources.[13] Table 2 reports summary statistics including those for the ARM and FRM origination shares for the 1987-2007 sample period.

Insert Table 2 here

Table 3 includes two alternative model specifications for the mortgage share equations. The reduced model (A) is estimated using only the effective fixed mortgage rate (RATE), growth in real personal income (INCOME), and adjusted house price (PRICE). Consistent with prior work, these variables are highly significant at the 5% level or better. Model B is the full model and includes the reduced form model and expected inflation and inflation uncertainty variables on mortgage origination share for both the FRM and ARM. All parameter estimates are statistically significant at the 10% level or better.

As shown in Table 3, the parameter estimates for real permanent income (INCOME) are positive (negative) for the FRM (ARM) share equations respectively for both the full and reduced form models and are statistically significant at the 1% level or better. A positive and statistically significant estimate for the FRM equation indicates that the proportion of FRM originations increases with increasing real personal income and is consistent with previous literature. Basel and Biger (1980), Statman (1982), Brueckner and Follain (1988) and Smith (1987) suggest that the differential $f_{F2} = \partial f_F / \partial g_y$ is positive and $f_{A2} = \partial f_A / \partial g_y$ is negative since borrowers are, in general, inclined to align real mortgage payments with real income.

The parameter estimates for the fixed effective mortgage rate (RATE) have a negative (positive) impact on the FRM (ARM) share equations as expected. Both parameter estimates are statistically significant at the 1% level or better. Alm and Follain (1987) and Brueckner and Follain (1988) demonstrate that the effective fixed mortgage rate, *r*, is clearly an important factor in mortgage choice. In particular, $f_{A1} = \partial f_A / \partial r$ and $f_{F1} = \partial f_F / \partial r$ are expected to be positive (negative), respectively, as a higher effective fixed mortgage rate increases (decreases) the ARM (FRM) choice probability. As the effective fixed mortgage rate increases, borrowers tend to substitute the variable for the fixed rate mortgage loan instrument.

The home price variable (PRICE) also performs as expected. Holding real income constant, the higher the home price the greater the affordability problem. This implies that the parameter estimate must be positive for ARMs and negative for FRMs. More simply, ARM (FRM) originations increase (decrease) as home prices increase.

Insert Table 3 here

The inflation uncertainty coefficient (UNCERTAIN) is positive (negative) for FRM (ARM) originations, and the parameter estimate is significantly different from zero at the 5% level in both models. These results strongly support the hypothesis that borrowers prefer the fixed rate loan over the variable rate loan as inflation uncertainty increases. With Diamond-Stiglitz mean preserving increases in risk, borrowers prefer the fixed to variable rate loan with increasing inflationary uncertainty. Systematic and consistent inflation uncertainty effects are observed for borrower choice of mortgage instruments. These results are consistent with the theoretical work of Barney and White (1986), who argue that with constant real income and price level uncertainty, borrowers prefer a less graduated or more present tilted payment path.

The coefficient on expected inflation (EXPECT) is positive (negative) for FRM and ARM originations at the 5% and 10% levels of significance, respectively. As discussed previously, the impact of anticipated inflation held with certainty can be ambiguous (see Barney and White, 1986). Given the statistical significance of the coefficient on expected inflation in the FRM equation, we conclude that with an increase in expected inflation held with certainty, borrowers prefer the variable to fixed rate mortgage. This result indicates that borrowers prefer a constant or decreasing real consumption path to the rising real consumption path of the fixed rate mortgage (as real permanent income growth is controlled for in the model). Rising real fixed rates on mortgages should tilt borrower preference toward the selection of ARMs.

Insert Table 4 here

Table 4 presents the SUR statistical regression results for reduced form and full FRM, ARM prime and subprime borrowers. The impact of anticipated inflation and inflation uncertainty is significant for subprime, but not for prime ARM borrowers. As inflation uncertainty increases, holding anticipated inflation constant, subprime ARM originations decrease ($f_{AS4} = \partial f_{AS} / \partial \eta^* < 0$). The impact of inflation uncertainty, holding anticipated inflation constant, is statistically insignificant for prime ARM borrowers. The Chow F-statistics indicate that the addition of the anticipated inflation (EXPECT) and inflation uncertainty (UNCERT) variables are statistically significant for the subprime ARM origination regression results, but not for the prime ARM origination results. All other parameter estimates for the ARM prime and subprime equations are statistically significant at the 5% level of significance or better. The results for the FRM origination results across Tables 3 and 4 are similar, but not exactly identical.[14]

The SUR regression results from Table 4 strongly support the hypothesis that ARM prime borrowers possess a valuable exchange option that is generally not available to subprime ARM borrowers. Although the exchange option is not directly observable, the exchange option reduces the impact of anticipated inflation and inflation uncertainty on prime ARM borrowers. In effect, the results confirm that $f_{AS4} = \partial f_{AS} / \partial \eta^* < 0$ for subprime ARM originations. The impact of anticipated inflation and inflation uncertainty indicate that $f_{AP4} = \partial f_{AP} / \partial \eta^*$ is ambiguous for prime ARM originations.

6. Summary and Conclusions

This study focuses on the residential mortgage selection problem in both inflationary and deflationary environments. Using data from the Mortgage Bankers Association on the proportion of adjustable and fixed rate total mortgage originations for the Q1-1994 through Q4-2007 period, we find that several variables play a key role in the residential mortgage selection decision, and the number of adjustable and fixed rate mortgage originations occurring during this time (including the real estate bubble of the 2000s) follows a reliable pattern. Consistent with previous studies, the effective fixed mortgage rate and overall price level are found to significantly impact the mortgage selection decision. The relative ARM (FRM) share of mortgage originations increase (decrease) with higher effective fixed interest rates/housing price levels and decrease (increase) the lower the effective fixed mortgage rate/housing price levels. As numerous other studies have found, the relative FRM share percentage of total originations also increased with rising real permanent income growth. These relationships appear to be extremely robust and stable over time.

In the presence of mean preserving increases in inflation uncertainty, a higher proportion of residential borrowers are found to prefer the fixed rate mortgage. This result is consistent with the notion that residential borrowers prefer not to accept the transfer of interest rate risk through the variable rate mortgage and may be more risk adverse than was previously thought. On the other hand, lower levels of inflation uncertainty imply that lenders can increase the effective rate differential while simultaneously transferring interest rate risk to borrowers.

An interesting and novel feature of this study is that inflation uncertainty has a differential impact on ARM prime and subprime borrowers. Since the majority of subprime borrowers are constrained to choose an ARM origination, the impact of inflation uncertainty, holding anticipated inflation constant, is found to significantly impact ARM subprime borrowers, but not ARM prime borrowers. In effect, prime ARM borrowers have a valuable exchange option (to exchange an ARM for the FRM in the future) that subprime borrowers generally do not possess. The exchange option is valuable since it will generally reduce the impact and severity of inflation uncertainty on prime ARM borrowers. This result is confirmed empirically above.

One of the most important costs of inflation is the uncertainty it creates about future inflation. Unexpected inflation leads to a transfer of wealth whenever mortgage payments are made in nominal dollars. When inflation is higher than forecast, the real value of nominal payments to the lender is lower than expected. However, if inflation is lower than forecast, the real value of nominal payments to the lender is higher than expected. While many view variable rate mortgages as a method for transferring risk from lenders to borrowers, this result is highly dependent not only on the level of inflation, but also on the secular trend in inflation uncertainty. The uncertainty associated with inflation imposes costs and can often lead to unintended wealth transfer.

Endnotes

1. Theoretical work on the real payment tilt and borrower choice of mortgage instruments has been presented by Brueckner (1984), Brueckner and Follain (1986), Alm and Follain (1984), Basel and Biger (1980), Statman (1982), Smith (1987) and Barney and White (1986).

2. Following Milton Friedman's (1977) well known conjecture that inflation uncertainty reduces economic efficiency and real output, the effects of inflation have been extensively examined [see, for example, Ball and Cecchetti (1990), Evans (1991), and Grier and Perry (1998) among others].

3. Most researchers have examined the relationship between the inflation rate and inflation forecast uncertainty, often finding a direct empirical link. Other studies by Engle (1983) and Bollerslev (1986) suggest that inflation uncertainty is highest when the inflation rate is relatively low.

4. Federally chartered lending institutions first received permission to offer adjustable rate mortgages (ARMs) in 1981.

5. Goldberg and Heuson (1992) develop and test a unified equilibrium model of the proportion of variable rate credit originations from both the borrower and lender perspectives.

6. See Diamond and Stiglitz (1974) for a formal presentation.

7. For an extensive discussion of how various kinds of survey data are used for modeling expectations and testing hypotheses about expectations formation see Pesaran and Weale (2006).

8. In econometrics, the equation-by-equation estimation method using standard ordinary least squares (OLS) produces estimates that are consistent, but generally are not as efficient as the SUR method, which amounts to feasible generalized least squares with a specific form of the variance-covariance matrix. Two important cases when SUR is in fact equivalent to OLS are:

either when the error terms are in fact uncorrelated between the equations (so that they are truly unrelated), or when each equation contains exactly the same set of regressors on the right-hand-side. The SUR model can be further generalized into the simultaneous equations model, where the right-hand side regressors are allowed to be endogenous variables as well. In the model proposed here, the right-hand side regressors are identical and OLS will yield identical results as SUR.

9. In the market share literature, Cable (1997) proposes squaring and then first differencing market shares (rather than taking natural logarithms and then first differencing the series) to avoid the logical consistency requirement. Consistent with previous work, we adopt the standard procedures of the log-difference approach.

10. The unit root tests were carried out using Eviews 6.0 and the augmented Dickey Fuller (ADF) test is based on the equation: $X_t - X_{t-1} = bX_{t-1} + \sum_{j=1}^{k} c_j(X_{t-j} - X_{t-j-1}) + \varepsilon_t$. The hypotheses under test are H_o: $b=0$ ($X_t \sim I(1)$) and H_1: $b < 0$ (X_t is stationary). Following standard procedure, a constant and a trend term were included in the Dickey-Fuller equation.

11. There are two primary sources of data on inflation expectations. One is derived from the market prices of various financial securities; the other is surveys of the general public and professional forecasters. A well-known market-based measure uses the spread between the yields of nominal Treasuries and TIPS (Treasury Inflation Protected Securities). The relatively short history of the TIPS market makes it impossible to assess the performance of this spread as a forecast of inflation expectations over the sample period employed in the current study.

Moreover, market based measures of inflation expectations do not include distributional data among market participants which is required to create the inflation uncertainty variable.

12. The S&P/Case-Shiller national index is normalized to have a value of 100 in the first quarter of 2000. The national home price index is a composite of single-family home prices based on a constant quality house price index for the U.S.

13. The prime and subprime data is available yearly and the quarterly data on ARM originations was determined by the same fixed percentage for the year. Quarterly data on prime and subprime ARM origination data was not readily available. The HMDA data include all mortgages originated by lenders that have a home or branch office in a metropolitan statistical area and exceed exemption thresholds on the size and the number of home purchase or refinancing loans made in a calendar year. For depository institutions, the threshold on asset size is adjusted annually on the basis of changes in the Consumer Price Index for Urban Wage Earners and Clerical Workers (CPI-W).

14. The Chow F-statistics for the reduced form and full model specifications in Table 4 are F=3.822 ($F_{2,50,.05} = 3.18$) for the ARM subprime models, F=1.3017 ($F_{2,50,.05} = 3.18$) for the ARM prime models and F=3.01 ($F_{2,50,.10} = 2.42$) for FRM models. The Chow F-test examines the following hypotheses for the full and reduced form models: H_0: $\beta_4 = \beta_5$ versus H_α: At least one of $\beta_4, \beta_5 \neq 0$. The parameter estimates β_4 and β_5 represent the regression coefficients for the anticipated inflation and uncertainty variables, respectively. The inclusion of the inflation

expectation and uncertainty regressors are statistically significant explanatory variables in both the ARM subprime and FRM models.

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Table 1: Subprime mortgage originations 2005-07

Quarter	FRM Subprime Originations (%)	ARM Subprime Originations (%)
Q3-2005	29.1	51.65
Q4-2005	27.17	57.24
Q1-2006	31.89	51.9
Q2-2006	33.59	50.3
Q3-2006	29.54	58.1
Q4-2006	28.96	57.14
Q1-2007	32.26	57.5
Q2-2007	38.44	56.79

Source: Mortgage Bankers Association

Table 2: Residential Mortgage Selection Summary Statistics

Variable	RATE	EXPECT	UNCERTAIN	INCOME	PRICE	FRM	ARM
Mean	7.8095	3.8928	26.404	168.6605	104.49	73.5119	26.4881
Median	7.5	3.9	21.5	145.865	83.505	76.5	23.5
Maximum	11	5.8	65	296.72	190.22	92	64
Minimum	6	1.9	9	100	62.47	36	8
Std. Dev.	1.5008	0.7758	15.5277	58.5113	39.4510	13.3023	13.3020
Skewnis	0.4783	0.3416	0.9150	0.9592	1.0430	-1.1734	1.1734
Kurtosis	2.0737	2.9810	2.8741	2.7084	2.6656	3.8131	3.8151
Jarque-Bera	6.2064	1.6350	11.7761	13.1792	15.6260	21.6003	21.6003
Probability	0.0449	0.4415	0.0028	0.0014	0.0004	0.0000	0.0000

Table 3: Residential Mortgage Selection SUR Model Estimates: January 1994-December 2007

Constant	RATE	INCOME	PRICE	EXPECT	UNCERTAIN	R^2
Dependent variable: ARM share percentage of total mortgage closings.						
Q1 1994-Q4 2007 (N=56)						
Model A						
0. 053678	3.03760	-7.97615	7.412003	--	--	0.57456
(1.09)	(6.65)***	(-2.19)**	(3.65)***	--	--	
Model B						
0.088774	2.977111	-10.6654	8.183488	0.619451	-0.79255	0.61467
(1.77)*	(6.57)***	(-2.86)***	(4.09)***	(2.13)* *	(-2.28)**	
Dependent variable: FRM share percentage of total mortgage closings.						
Q1 1994-Q4 2007 (N=56)						
Model A						
-0.02687	-1.05102	2.798349	-1.94608	--	--	0.54180
(-1.55)	(-6.53)***	(2.18)**	(-2.72)***	--	--	
Model B						
-0.03995	-1.05944	3.78816	-2.23241	-0.18242	0.283644	0.59150
(-2.28)**	(-6.69)***	(2.91)***	(-3.19)***	(-1.79)*	(2.33)**	

Variables are expressed in logarithmic difference form for the period Q1 1994-Q4 2007.
t-statistics are in parentheses.
*denotes statistical significance at the 10% level
**denotes statistical significance at the 5% level
***denotes statistical significance at the 1% level or better

Mortgage origination share data was obtained from the Mortgage Bankers Association (MBA), the fixed rate mortgage data was obtained from the Federal Home Loan Mortgage Corporation (FHLMC), the housing price data was obtained from Case-Shiller, the CPI data was obtained from the St. Louis Federal Reserve Fred II database, real personal income data was obtained from the National Income Accounts and the inflation expectations data was obtained from the University of Michigan Survey Center. All of the data was obtained from the indicated sources through a subscription with Haver Analytics.

Table 4: ARM Prime, Subprime and FRM Selection SUR Model Estimates: January 1994-December 2007

Constant	RATE	INCOME	PRICE	EXPECT	UNCERTAIN	R^2
Dependent variable: ARM Prime share percentage of total mortgage closings.						
Q1 1994-Q4 2007 (N=56)						
Model A						
0. 033035	3.128502	-6.67672	7.005664	--	--	0.55735
(0.63)	(6.54)***	(-1.74)*	(3.29)***	--	--	
Model B						
0.057342	3.143248	-8.54881	7.544479	0.357516	-0.56176	0.57926
(1.05)	(6.47)***	(-2. 13)***	(3.51)***	(1.15)	(-1.50)	
Dependent variable: ARM Subprime share percentage of total mortgage closings						
Q1 1994-Q4 2007 (N=56)						
Model A						
0.110099	2.763393	-11.1628	8.128902	--	--	0.38772
(1.55)	(4.24)***	(-2.13)**	(2.80)***	--	--	
Model B						
0.161620	2.553148	-15.1756	9.269417	1.108159	-1.22726	0.46891
(2.28)**	(4.04)***	(-2. 90)***	(3.31)***	(2.74)***	(-2.52)**	
Dependent variable: FRM share percentage of total mortgage closings.						
Q1 1994-Q4 2007 (N=56)						
Model A						
-0.02791	-1.05405***	2.855464**	-1.96446***	--	--	0.54054
(-1.57)	(-6.48)	(2.18)	(-2.17)	--	--	
Model B						
-0.04014**	-1.0599***	3.79833***	-2.23574***	-0.18229*	0.28308**	0.58971
(-2.24)	(-6.62)	(2.87)	(-3.15)	(-1.77)	(2.30)	

Variables are expressed in logarithmic difference form for the period Q1 1994-Q4 2007.
t-statistics are in parentheses.
*denotes statistical significance at the 10% level
**denotes statistical significance at the 5% level
***denotes statistical significance at the 1% level or better

The ARM origination data on prime and subprime mortgage originations was compiled from data obtained from HMDA (Home Mortgage Disclosure Act) and HUD (Housing and Urban Development) data sources. All other data was obtained as indicated in Table 3.