The Effects of Adjustable Rate Mortgages on House Price Inflation

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Abstract

This paper examines two important issues regarding house prices and mortgage market activity. First given recent activity in the market regarding adjustable rate mortgages (ARMs), we study the determinants of such mortgages. Our second objective is with regards to a potential simultaneity between house prices and adjustable rate mortgages. If house prices are expected to appreciate, then lenders are less concerned about defaults and may make available more funds to a large extent in the form of ARMs and to lower quality borrowers, for financing the purchase of a house. We investigate this potential feedback relationship using a dynamic panel model for the 48 contiguous states over the years 1986-2010. Fixed effects estimates on the determinants of the share of adjustable rate mortgages are consistent with earlier findings on the importance of the spread, between fixed rate and adjustable rate mortgages. We also find evidence of a possible feedback relationship between house prices and adjustable rate mortgages.

Key words: Adjustable Rate Mortgages, House Price Inflation, Mortgage Choice, Simultaneity
JEL categories: C01, C23, C33

Introduction

The significance of adjustable rate mortgages (ARMs) as a share of the mortgage market is evident from the fact that more than two thirds of subprime lending, which is often cited as a cause of the recent housing crisis, was comprised of various forms of ARMs. The subprime crisis negatively affected banks and other lending institutions such as investment banks, as mortgage default rates increased. Numerous banks and bank-like institutions ultimately failed, because they could not cope with the losses suffered from the rise in foreclosures. As a consequence, the subprime crisis evolved into a general and severe economic downturn. Against the background of the recent economic crisis and its origin in the housing sector, this paper examines the determinants of what factors drive ARMs. The idea is to get a better understanding of the potential effects of ARMs on the overall economy.

We explore the possibility that a feedback relationship exists between house price appreciation and the share of ARMs. In particular, we suggest that the share of ARMs of the mortgage market may not only cause house prices to rise, but may also be the result of higher house prices or other causes, such as high interest rates. The intuition behind our idea is as follows. If house price are expected to appreciate, then lenders are less concerned about defaults and may make available more funds to a large extent in the form of ARMs and to lower quality lenders, for financing the purchase of a house[2]. At the same time, borrowers have a strong economic incentive to buy because they fear being priced out of the market in the future. Both behavioral patterns, those of lenders and those of buyers, cause the demand for housing to increase. Given the time lag in housing supply, or the physical limits of adding new housing in desirable locations, prices rise.

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[2] During the mid 1990's, the proportion of all mortgage originations that were subprime was only about 8%. At the height of the bubble, subprime mortgage origination was as high as 30% in such markets as California, Arizona, and Florida. The typical subprime loan is an adjustable rate mortgage.

As long as investors expect to be reimbursed for the rising risk of a downturn in prices with ever higher expected returns[3], it is rational for them to ride the price bubble. Blanchard (1979) has termed this a rational bubble[4]. We argue that changes in the share of ARMs can be both a result and a cause of the bubble in the housing market. Competition among lenders stimulated the growth in financial innovations to include other subprime mortgage instruments such as pay-option ARMs, negative amortization ARMs, and interest-only ARMs[5]. These arrangements have essentially the same objective: to reduce monthly mortgage payments at least temporarily and stimulate the demand for housing.

These new instruments made it easier for borrowers to obtain financing and led to an increase in home ownership rates from 61 percent in 1995 to 69 percent by 2006. Home ownership in minority households grew substantially during this time period[6]. Our key contribution is to demonstrate that there is a potential feedback relationship between house price appreciation and the percentage of total mortgages with adjustable rates. This potential simultaneity problem is addressed using two stage least squares (TSLS) methods. Given that there are two major choices of mortgages available to borrowers to finance a house purchase, understanding what determines one's choice between the alternatives is also of interest in its own right. We, therefore present results on the determinants of the share of ARMs using various methods of analysis.

All the empirical models make uses of a panel data set constructed from data on the 48 contiguous states. The Federal Housing Finance Agency's (FHFA) monthly interest rate survey (MIRS) is our main source of mortgage data. The FHFA also provide data on the house price index. Our results confirm our claim of a possible feedback relationship between house price appreciation and adjustable rate mortgages.

Literature Review

Recently, Bucks and Pence (2006) and Coulibaly and Li (2007) have made use of a new data set from the Federal Reserve Board – the Survey of Consumer Finances (SCF) to analyze mortgage choice. Koijen, Van Hemert and Nieuwerburg (KVN) (2008) and Campbell and Cocco (2003) presents theoretical models of ARM choice. The fundamental conclusion of current and past analysis is that the spread between fixed rate and adjustable rate mortgages is the key determinant of ARMs as a mortgage choice. This remains true in spite of the recent subprime crisis.

Studies on the potential feedback relationship between the share of ARMs in the mortgage market and house prices is limited. Brueckner, Caleb, and Nakamura (BCN) (2011) examines whether there is a possible link between subprime lending and house price appreciation. Having shown in a theoretical model how a feedback relationship can exist between house prices and subprime lending their empirical results also suggest a potential simultaneity effect between subprime lending and house price inflation[7]. They suggest the use of instrumental variables methods to verify their findings. There is little disagreement in the literature as to the role of the subprime market in the recent rise and fall in house prices. However, at no time has the subprime market exceeded 30% of the overall mortgage market. On the other hand, ARMs can be found also in the much larger market for prime mortgages. How ARMs in this larger market interact with house prices appears to have not been addressed. It is the primary purpose of the current paper.

Del'Arricia et al. (2009) identify the decline in lending standards leading up to the housing price crash as the primary cause of the rapid growth of the subprime market. What they label as reduced lending standards is a decrease in the denial rates of mortgage applications and an increase in the loan to income ratio.

[3] Blanchard and Watson (1982) show that we also need a non-zero chance of the bubble deflating slowly over time. That means a sudden collapse of the bubble must not be a deterministic outcome.

[4] Blanchard and Watson (1982) give the theoretical framework for why bubbles can exist within a rational expectations framework. See Gurkaynak (2008) for a recent overview of empirical tests for the existence of rational bubbles.

[5] Interest only ARMS allow borrowers, for a period of time, to make interest payments only, leaving the principal the same. Pay option and negative amortization ARMS allow the borrower to make interest payments that are less than the interest due on a monthly basis.

[6] Chambers, Garriga, and Schlagenhauf (CGS) (2008) provide evidence that ARMs aided the increase in home ownership rates since the 1990's.

[7] Brueckner, Caleb, and Nakamura (2011) include lags of house price appreciation as an explanatory variable.

With denial rates as the dependent variable, and using fixed effects estimation techniques, they find that denial rates fall as house prices appreciate in value. This is true for both prime and subprime lenders. In addition, denial rates are significantly lower in areas with the highest appreciation in prices. Other regression results indicate that entry of new large lenders in an area forces existing lenders to lower their standards in order to compete.

According to Goetzman, Peng, and Yen (GPY) (2009), forecasts of house price appreciation prior to 2006 were typically bullish, not only for the near term but for far into the future and with little or no possible concern for a decrease in home values. These rosy forecasts they believe, led to the increase in the demand and supply of mortgages. Their empirical model suggests that at the MSA level, higher house price appreciation is associated with a higher volume of mortgage applications. They also show that for the same MSAs, subprime lenders behave differently from prime lenders in their loan approval process. Prime lenders tend to approve borrowers with lower loan to income ratios whereas subprime lenders approve borrowers with high loan to income ratios. At the loan level, the probability of a subprime loan being approved increases as the appreciation in house prices goes up. They conclude that both lenders and borrowers considered past house price appreciation as a key factor in the purchase and underwriting of mortgages.

Coleman et al. (2009) however find no evidence that subprime lending was a leading cause of the rise and subsequent fall in housing prices experienced recently. They argue that economic fundamentals provided adequate explanation of house price fluctuations up to early 2004. After that, economic fundamentals became practically insignificant in explaining housing prices.

They also argue that the rise in financial innovation along with the higher house price appreciation was a result of the changing regulatory environment after early 2004. While more than 50 percent of all conventional mortgages were issued and purchased by Fannie Mae and Freddie Mac prior to early 2004, new legislation made it no longer possible for them to do so. This vacuum was filled by private issuers of these products and these private issuers typically had lower standards.

The study by BCN (2011) examines a feedback relationship between credit risk scores for consumers in all 50 states and expected house price appreciation. Our study appears to be the first attempt at analyzing a potential feedback between ARMs and house price appreciation.

Methodology

To capture the relationship between the share of ARMs in the prime mortgage market (*arm*) and house price appreciation we estimate the model:

$$hpi_{it} = \beta_0 + \beta_1 hpi_{it-1} + \beta_2 arm_{it} + \beta_3 x_{it} + \mu_i + \lambda_t + \upsilon_{it}, \quad (1)$$

where subscript i stand for the ith state and the subscript t represents the tth year. *hpi* represents the dependent variable house price appreciation, which is constructed as the first difference in logs of house prices. Case and Shiller (2003) consider a bubble to be a condition in which expectations of future rises in house prices cause current house prices to be elevated. Given that expectations are formed on the basis of past observations, we include a lag of the dependent variables as a proxy for expected house price appreciation. A lagged dependent variable can also reduce the effects of autocorrelation that may be caused by omitted variables.

Our key variable of interest is the percentage of mortgages with adjustable rates (*arm*). The variables contained in x include a number of control variables. All are measured at an annual frequency. More specifically, they include at the state level the unemployment rate (*ur*), the growth rate of non-farm employment (*empl*), and the growth rate of population (*popn*). We also include two variables more specific to the housing market: the interest rate on 30-year mortgages (*mortg*) and the loan to value ratio (*ltv*). We note that β_2 and β_3 are short run impact parameters that represent the change in house prices as a result of a change in *arm* and the explanatory variables in x. The error term is comprised of state specific fixed effects μ_i, year specific fixed effects λ_t, and a disturbance term $v_{it} \sim$ IID($0,\sigma^2_v$). The year specific effects are estimated as time dummies.

Year specific fixed effects account for the numerous policy regulations enacted over the years that directly impact the housing market in all states and in the same way. Some of the more recent policy interventions include (i) the Housing and Economic Recovery Act of 2008 (HERA), (ii) the American Dream Down payment Initiative (ADDI) of 2003, and (iii) the Community Reinvestment Act (CRA), first enacted in 1977.

Unobserved heterogeneity across states is accounted for by state-specific fixed effects. State specific fixed effects account for, among others, inter-state differences in the treatment of real estate transactions. For example in some states such as Florida and New Jersey, foreclosures are handled through a judicial process, but in other states such as Michigan and New Hampshire, foreclosures are handled by state statutes.

Our specification of equation (1) presents two econometric problems. First, given our assumption of a feedback relationship between *arm* and *hpi*, the variable *arm* is necessarily endogenous and therefore correlated with the error term. Second, because of the lagged dependent variable, serial correlation may be an issue. That is since the dependent variable is a function of μ_i, lags of the dependent variable are also functions of μ_i. Therefore the lagged dependent variable is correlated with the error term. To remove these problems, of endogeneity we employ a two stage least squares model approach. In particular, our first stage model makes the share of ARMs in each state (*arm*) a function of (i) expected housing price appreciation, (ii) the control variables contained in equation (1), and (iii) additional exogenous covariates that have been found in the previous literature to drive ARMs. Expected house price appreciation serves as a valid instrument given that it is pre-determined and hence uncorrelated with the error term (BCN 2011). As in previous studies, for example Goetzman, Peng and Yen (GPY) (2009), we use past house price appreciation to proxy expectations. The additional exogenous covariates that have been found in previous studies to drive ARMs include the difference between the 30-year fixed and the 1-year adjustable rate mortgage (*spread_mortg*) and the difference between the 10-year and the 1-year treasury constant maturity rate (*spread_treas*)[8]. Increases in the variable *spread_mortg* are expected to increase *arm* because it suggests that as *spread_mortg* widens, *arm* becomes more attractive.

Borrowers may therefore opt for arm-type mortgages. *spread_treas* serves as an indication of short term expectations for interest rates. An increase in *spread_treas* is therefore expected to reduce *arm* (Berkovec, Kogut and Nothaft 2001).

The second issue we face in estimating equation (1) is how to deal with the lagged dependent variable in our panel data setting. As is well known, the fixed-effects estimator is biased, but in contrast to the least squares estimator, it is consistent. However, the number of time series observations we have per state may not be enough to rely on consistency. We therefore, also estimate a dynamic panel model as proposed by Arellano and Bond (1991), which uses additional instruments in the form of differenced lagged levels of the variables in the model. Adding lags of the endogenous variables makes them pre-determined and uncorrelated with the error term in equation (1).

Data

Data are obtained from several sources. The key variables in this study are the percentage of mortgages with adjustable rates (*arm*), interest on fixed rate mortgages (*mortg*), interest on adjustable rate mortgages (*armrate*), employment (*empl*), population (*popn*), *spread*, and *treasury*. The data on *arm* is from the Monthly Interest Rate Survey (MIRS), while the data on fixed rate and adjustable mortgages are obtained from the primary mortgage market survey (PMMS). The PMMS is conducted by Freddie Mac. The house price index is from the FHFA. Data on economic conditions are obtained from various federal agencies: state level employment and unemployment is from the Bureau of Labor Statistics (BLS). Table 1 summarizes the definitions and sources of data used in this study.

MIRS provide mortgage information differentiated by property type, loan type, and type of lender. Information is for new or previously occupied single family homes. Fixed rate and adjustable rate mortgages are included in the survey. Five days prior to the end of the month, a sample of lenders are asked to provide information on mortgages they have issued to borrowers. FHA insured and VA loans are excluded from the survey. Therefore these are conventional conforming mortgages which normally require a higher down payment of at least 20 percent, and a strong credit history for the borrower. The MIRS data provides the most comprehensive information on conventional mortgages.

[8] See for example BKN (2001), and Vickery and Aragon (2010).

The FHFA updates MIRS monthly. Historical data are presented in tables. Our model uses data from table 15 titled "Terms on Conventional Single Family Mortgage by State." Data can be obtained from FHFA website[9]. From this table we also extract information on the loan to value ratio (*ltv*), and the percent of adjustable rate loans (*arm*). The data are yearly and starts in 1978. Our model uses yearly data from 1986-2010. The PMMS data, obtained from Freddie Mac, are based on a weekly survey of financial institutions in the United States, that are offering mortgage products to borrowers. The survey compiles data on 30-year and 15-year fixed mortgage rates. Information on points and origination fees are also collected as part of the survey. Data on interest for adjustable rate mortgages are based on a 1-year treasury index. The PMMS data are limited to conventional rate mortgages with an *ltv* of 80%.

Data on state level house price indices are obtained from the Federal Housing Finance Agency (FHFA), previously known as the Office of Federal Housing Enterprise Oversight (OFHEO). House prices from mortgages purchased or securitized by government sponsored agencies Fannie Mae and Freddie Mac are used to compute the index. The index is a weighted repeat sales index. It measures the average price change from repeat sales of single family dwellings in the metropolitan areas of each of the 50 states and the District of Columbia. The data are available on a quarterly basis; they begin in the first quarter of 1975 and end in the fourth quarter of 2010. 1980 is the base year for computing the average. Calhoun (1996) provides an in-depth description of the construction of the OFHEO house price index. Table 2 presents summary statistics for the data used in the analysis.

Data on the percent of ARMs are missing for all states in 2008. Multiple imputation methods are used to fill in the missing data. Multiple imputations use existing data to find imputed values by regression, using the variable with missing data as the dependent variable and the other variables in the data set as independent variables. An error component drawn at random from the residuals is added to the predicted values. This process is repeated several times to reduce the chance of underestimating the error terms. Details of the procedure are beyond the scope of this paper. However, technical details on the procedure are found in Allison (2002) and Schafer (1999). Penn (2008) also provides an in-depth analysis of multiple imputations with economic applications.

Results

Results from a fixed effects model

Table 3 presents results from a fixed effects model that explains the determinants of the share of ARMs in the primary mortgage market. Results are reported for several models with *arm* as the dependent variable, and with alternative combinations of the explanatory variables. The lag of house price appreciation, which we interpret to represent expected house price appreciation stimulates lending by raising the percentage of loans offered to borrowers seeking adjustable rate mortgages. This observation is consistent and statistically significant throughout the various models estimated. These results support the findings of earlier studies (BCN, 2011, GPY, 2008) and our earlier suggestion that anticipated higher future prices stimulates lending activity.

With respect to the other covariates, most of them are statistically significant at least at the 5% level and with the expected signs. Population and the unemployment rate however are notable exceptions. One would expect a rise in population to increase the share of ARMs, since there are more borrowers when the population increases. However, the results indicate otherwise. A rise in unemployment is also seen to have a positive rather than the expected negative influence on *arm* share in some of the models. Consistent throughout are the signs on the interest rate measures. A rise in the 30-year fixed rate mortgage raises the percentage of adjustable rate mortgages. This makes sense because adjustable rate mortgages typically carry lower interest rates at least initially, compared to the 30-year interest rate. This suggests that some borrowers will choose adjustable rate mortgages over the 30-year fixed rate mortgage. This is also verified by the sign of the coefficient of *spread_mortg*, which measures the difference between the fixed rate and the adjustable interest rates. As the *spread_mortg* increases, more borrowers will choose adjustable rate mortgages. It is also plausible to suggest that anticipation of future rate increases, as indicated by *spread_treas* reduces the percentage of adjustable rate mortgages.

[9] http://www.fhfa.gov/default.aspx?page=252

Moench, Vickery and Aragon (2010) documents that the share of ARMs has fallen to less than 10% of the overall mortgage market in the last several years. They argue that while most people blame the subprime crisis for this decline, the primary cause of the decline was and still is the term structure of interest rates. Current interest rates are at unusually low rates and are expected to remain low in the foreseeable future. Borrowers therefore choose the more conventional 30-year fixed rate mortgage. The importance of the term structure of interest rate is indicated in our model by the variable *spread_treas*.

Results from Two Stage Least Squares

Estimates from both OLS and TSLS of house price inflation are presented in Table 4. State specific fixed effects are used. Since our model is dynamic in nature, OLS and fixed effects estimates do not account for the simultaneity presented as a result of the lagged dependent variable. TSLS is used to address our concern of a simultaneous relationship between the share of ARMs in the mortgage market and house price inflation. In estimating the TSLS model, we use the fitted values of *arm* from Model 5 of Table 3 at the second stage to estimate Equation 1[10]. Our choice of the first stage model is based on its R-square value and the fact that it contains variables most pertinent to the determinants of ARMs.

All the coefficients of the lagged dependent variable are statistically significant, with estimated coefficients of at least 0.61. This suggests a significant level of persistence for house prices appreciation. The marginal effect for employment is significant in all of the models estimated and range from 0.4 to 0.65. Estimates for *mortg* and *ltv* are also significant and with the expected signs. Estimates from the TSLS results suggest that *arm* has a positive and statistically significant relationship with house price appreciation. This relationship is consistent across all of the alternative specifications of TSLS. Holding everything else constant, a 1% increase in the level of *arm*, raises house price appreciation by a factor of 10%. Long run marginal effects are obtained by multiplying the short run effects by $1/(1-\hat{\beta}_1)$, where $\hat{\beta}_1$ is the coefficient estimate for expected house price inflation. The long run marginal effect for *arm* in Model 6 is 0.31, suggesting a significant long run influence of *arm* on house price inflation. We note that *arm* is not statistically significant in the least squares estimates, which suggests an endogeneity bias in those estimates.

Results from a Dynamic Model

Table 5 presents parameter estimates from the Arellano-Bond (1991) estimator which removes the potential bias in the estimates presented in Table 4 that have their origin with the lagged dependent variable[11]. In Models 1 and 2 we use the Arellano-Bond one-step estimator, and in Models 3 and 4 we use the two-step Arellano-Bond estimator[12]. To eliminate the simultaneity bias as in Table 4, we use the predicted *arm* values from the estimates of Model 5 in Table 3.

In all the regressions reported in Table 5, the parameters are of the correct signs and are mostly statistically significant at least at the 5% level. The estimates from Models 1 and 2 are inconsistent because they do not satisfy the autocorrelation tests. According to Arellano and Bond (1991), estimates are consistent only if there is evidence of first order but not of second order autocorrelation in the residuals. In Models 1 and 2 the null of no first order autocorrelation is rejected; but the null of no second order autocorrelation is also rejected, which indicates inconsistency. Model 3 satisfies the autocorrelation tests, but does not satisfy the Sargan test of over-identifying restrictions. The null hypothesis of the Sargan test is that the instruments are valid. The test results of Models 1, 2 and 3 reject the null hypothesis of valid instruments. The test results of Model 6 satisfy all of the specification requirements and hence provide us with consistent estimates.

The parameter estimates of Model 6 suggest a long run marginal effect of 0.739 for employment and a long run marginal effect with respect to population of 0.92. With respect to *arm* the long run marginal effect is 0.026, which suggests that a 1% percent increase in *arm* raises house price appreciation by 2.6%.

[10] Standard errors and R-square values are adjusted properly to account for the fact that the fitted values of *arm* are used in a two stage OLS estimate with fixed effects.

[11] We note in this context that the two-stage fixed effects estimates of Table 4 are consistent.

[12] The one-step estimator assumes homoscedastic errors, while the two-step estimator constructs heteroscedasticity-consistent errors using the residuals from the one-step estimator.

This is more plausible compared to the increase in house appreciation implied by the TSLS results of Table 4. As we mentioned earlier our Equation 1 is similar to BCN's (2011) model. However the dependent variable in their case is credit risk scores. Just as we do here, they use a panel data set comprised of information on the 48 contiguous states. Our results are similar to theirs in that we find strong evidence of persistence in house price appreciation. Additionally, our model reveals that fluctuations in the share of adjustable rate mortgages can influence house price appreciation.

Conclusion

This paper considers two important issues regarding house prices and mortgage market activity. First, we study the determinants of the share of adjustable rate mortgages over time. Second, we look at the possibility of a simultaneous relationship between appreciation in house prices and the share of adjustable rate mortgages. For our analysis, we construct a panel data set at the state level with yearly frequency. Fixed effects estimates are used to study the determinants of *arm*, whilst a dynamic panel model is used to investigate the potential simultaneity between ARMs and house price appreciation.

Studying the determinants of ARMs is important given the recent crisis in the mortgage market which showed that two thirds of the subprime market was made up of ARMs. We use several modeling techniques to analyze this issue. Our fixed effects model uses state specific and year specific effects to account for differences in state characteristics and changes in the regulatory environment over time. Our results confirm earlier results of the importance of the spread between the 30-year fixed and the 1-year adjustable rate mortgages. The difference between the 10-year and the 1-year treasury constant maturity rate is also an important determinant of ARMs. These results remain consistent even during the housing boom and bust cycle that we experienced. In addition, expectations of higher house prices have a positive and statistically significant effect on the share of ARMs.

Our second objective addresses the possibility that a simultaneous relationship exists between adjustable rate mortgages and house price appreciation. When house prices are projected to increase in the future, both lenders and borrowers increase the supply of funds and demand for housing, respectively, in a feedback type loop. A dynamic panel model which uses lags of the explanatory variables in the model as instruments provides the most consistent results. It shows that house prices are affected positively by the share of mortgages with adjustable rates.

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Table 1. Definitions and Sources of Data Used in the Analysis

Variables	Definition	Source
hpi	Quarterly house price index	Federal Housing and Finance Agency (FHFA)
empl	State level non-farm employment	Bureau of Labor Statistics (BLS)
arm	Percent of conventional mortgages with adjustable rates	Monthly Interest Rate Survey (MIRS)
popn	Yearly estimates of population by state	US census Bureau
mortg	30-year fixed mortgage interest rate	Federal Reserve Economic Database (FRED)
armrate	1-year interest rate on adjustable mortgages	Primary Mortgage Market Survey (PMMS)
r-mortg	Average 30-year fixed mortgage interest based on Freddie mac regions	Freddie mac
spread_mortg	Difference between 30-year fixed and 1-year adjustable rate mortgages.	
Spread_treas	Difference between 10-year treasury constant maturity rate and the 1-year treasury constant maturity rate	
ltv	Loan to value ratio	Monthly Interest Rate Survey (MIRS)
ur	Unemployment rate by state	Bureau of Labor Statistics (BLS)

Notes: Data from FRED is provided by the Federal Reserve Bank of St. Louis.

Table 2. Summary Statistics for the Data Used in the Analysis

Variables	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
hpi	234.64	105.93	81.16	713.94	1200
empl	2502.60	2564.00	183.10	15174.00	1200
arm	20.87	14.82	0.00	78.00	1200
popn	5650.90	6047.50	453.59	37254.00	1200
mortg	7.59	1.68	4.69	10.34	1200
armrate	5.89	1.45	3.76	8.80	1200
r-mortg	7.59	1.68	4.65	10.43	1200
spread	1.71	0.69	0.08	3.33	1200
treasury	1.38	1.02	-0.14	3.12	1200
ltv	77.11	3.78	63.40	96.70	1200
ur	5.50	1.82	2.20	14.90	1200

Notes: The data is yearly and covers the period 1986-2010.

Table 3. Results from a Fixed Effects Model with Arm as the Dependent Variable

Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Constant	0.404***	0.218	0.259	-0.573***	0.718***	-0.442**
	(0.124)	(0.177)	(0.180)	(0.175)	(0.175)	(0.178)
dln hpi (-1)	0.619***	0.700***	0.694***	0.441***	0.407***	0.451***
	(0.085)	(0.101)	(0.102)	(0.111)	(0.112)	(0.111)
dln empl	1.414***	1.566***	1.544***	0.975***	-0.304	0.950***
	(0.240)	(0.245)	(0.246)	(0.257)	(0.265)	(0.269)
dln popn	-0.917*	-0.932*	-0.910*	-0.713	0.674	-0.713
	(0.555)	(0.552)	(0.551)	(0.541)	(0.464)	(0.552)
mortg	0.015**	0.022***		0.195***		
	(0.007)	(0.008)		(0.011)		
armrate				-0.118***		-0.106***
				(0.007)		(0.007)
r-mortg			0.019**			0.175***
			(0.008)			(0.011)
spread_mortg					0.152***	
					(0.011)	
spread_treas					-0.049***	
					(0.006)	
ltv	0.032	0.052	0.056	-0.036	-0.092	-0.024
	(0.209)	(0.208)	(0.209)	(0.192)	(0.199)	(0.194)
ur		0.007	0.006	-0.006	-0.012**	-0.006
		(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
Adj. R^2	0.467	0.468	0.467	0.539	0.538	0.528

*Note: Standard errors are in parenthesis. -dln stands for log-difference. The stars ***, **, and * indicate significance at the 1-, 5-, and 10% level respectively.*

Table 4. Results from Two Stage Least Squares Model with hpi as the Dependent Variable

Variables	(1) OLS	(2) TSLS	(3) OLS	(4) TSLS	(5) OLS	(6) TSLS
Constant	0.084***	0.061***	0.089***	0.078***	0.088***	0.080***
	(0.018)	(0.019)	(0.019)	(0.023)	0.018)	(0.021)
dln hpi (-1)	0.722***	0.668***	0.716***	0.609***	0.715***	0.637***
	(0.015)	(0.016)	(0.016)	(0.022)	(0.015)	(0.019)
dln empl	0.650***	0.523***	0.641***	0.411***	0.639***	0.470***
	(0.054)	(0.060)	(0.057)	(0.078)	(0.057)	(0.072)
arm	-0.007	0.103***	-0.006	0.153***	-0.006	0.111***
	(0.007)	(0.016)	(0.007)	(0.026)	(0.007)	(0.018)
dln popn	-0.095	-0.029	-0.095	0.002	-0.095	-0.024
	(0.097)	(0.110)	(0.096)	(0.120)	(0.095)	(0.110)
mortg	-0.002***	-0.005***	-0.002***	-0.007***		
	(0.000)	(0.001)	(0.000)	(0.001)		
r-mortg					-0.001***	-0.005***
					(0.000)	(0.001)
ltv	-0.090***	-0.045**	-0.093***	-0.045**	-0.090***	-0.058**
	(0.023)	(0.023)	(0.023)	(0.027)	(0.022)	(0.025)
ur			-0.0003	-0.002***	-0.0004	-0.002***
			(0.000)	(0.001)	(0.0004)	(0.001)
Adj. R^2	0.690	0.622	0.689	0.548	0.689	0.692

*Note: Standard errors are in parenthesis. The dependent variable is dln hpi, where dln stands for log difference. The stars ***, **, and * indicate significance at the 1-, 5-, and 10% level respectively.*

Table 5. Results from a Dynamic Panel Model with dln hpi as the Dependent Variable

Variables	Model 1	Model 2	Model 3	Model 4
constant	-0.001***	-0.001***	-0.002***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
dln hpi (-1)	0.619***	0.730***	0.606***	0.716***
	(0.023)	(0.026)	(0.022)	(0.023)
dln hpi (-2)		-0.184***		-0.180***
		(0.026)		(0.032)
dln empl	0.516***	0.392***	0.460***	0.343***
	(0.055)	(0.057)	(0.043)	(0.057)
arm	0.010	0.014*	0.009**	0.012**
	(0.008)	(0.008)	(0.003)	(0.005)
dln popn	0.458***	0.443***	0.446***	0.425***
	(0.118)	(0.1160	(0.060)	(0.062)
mortg	-0.005***	-0.004***	-0.005***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.031)
ltv	-0.158***	-0.193***	-0.143***	-0.192***
	(0.030)	(0.030)	(0.040)	(0.031)
ur	-0.0004***	-0.002**	-0.001*	-0.003***
	(0.0010	(0.001)	(0.001)	(0.0010
Arellano-Bond test of no AR(1)	-13.207 (0.000)	-17.178 (0.000)	-2.615 (0.009)	-3.456 (0.001)
Arellano-Bond test of no AR(2)	-2.660 (0.008)	-1.722 (0.085)	-2.400 (0.016)	-1.008 (0.313)
Sargan test of over-identifying restrictions	1084.480 (0.000)	1072.590 (0.000)	46.201 (0.998)	46.507 (0.998)

*Notes: Standard errors are in parenthesis. The variables dln hpi is the dependent variable, where dln stands for log difference. The stars ***, **, and * indicate significance at the 1-, 5-, and 10% significance level. Models 1 and 2 uses the one-step estimator and models 2 and 3 uses the two-step estimator.*