

## **The role of regional factors in determining mortgage interest rates in the US**

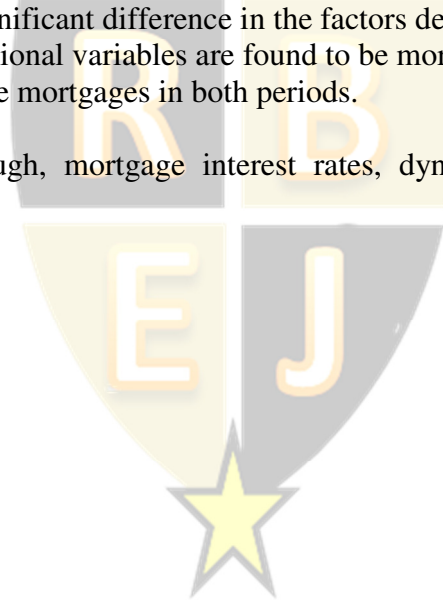
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### **ABSTRACT**

This paper develops a new technique to analyze determinants of retail interest rates that are exposed to the same monetary policy but different regional conditions. Mortgage interest rates of different parts of the US are analyzed by using this technique. The results show that monetary policy was highly influential on mortgage rates in the bubble period, while regional factors were more significant in the post-bubble period. More importantly, the analysis demonstrates that there is a significant difference in the factors determining fixed-rate and adjustable-rate mortgages. Regional variables are found to be more influential in the determination of adjustable rate mortgages in both periods.

Keywords: Interest pass-through, mortgage interest rates, dynamic factor analysis, regional effects of monetary policy.



## INTRODUCTION

Monetary policy has a significant influence on the “price-setting decision” of banks. When the policy rate is changed, it affects the opportunity costs that arise for a bank. This will then cause an adjustment in the retail interest rates. This mechanism, known as the “interest rate channel” of monetary policy, has been regarded as the most important factor determining retail interest rates.

In analyzing the interest rate pass-through process, the literature generally focuses on two areas: The differences in the pass-through process in multi-country studies, or studies that analyze the response of different rates-such as deposit and loan rates- to monetary policy. These studies have two things in common. First of all, they take the monetary policy shocks as almost always the single determinant of the retail rates. Second, most of these studies use average retail interest rates for a given country (which may be because of the lack of regional interest rate data). As a result, these studies ignore regional differences.

Ignoring the role of regional factors and focusing on the monetary policy shocks might be appropriate or harmless in various situations: In a cross-country study that analyzes the pass-through process for interest rates that are subject to different countries’ monetary policy shocks or in a study that compares interest rate pass-through for different types of rates. However, while similar retail interest rates of the different parts of the same country will be subject to the same monetary policy, they will be subject to different regional conditions. For this reason, focusing only on the monetary policy shocks may miss important information in understanding retail rates.

As shown in Figure 1 (Appendix 2), this might be true for the regional mortgage interest rates in the US. The first column of Figure 1 below shows the growth rates, while the second column shows the standard deviations of mortgage interest rates in five different regions of the US -the North Central, North East, South East, South West and West-. These figures indicate that although there is single monetary policy in the US, mortgage interest rates in these regions show considerable differences. As Figure 1 illustrates, differences become even more striking when adjustable-rate mortgage interest rates are considered. Therefore, the approach followed by the interest rate pass-through studies may overlook important issues in understanding these rates. This paper closes this gap of the literature by introducing a new tool that analyzes the role of both regional factors in addition to monetary policy on determining mortgage interest rates in the US. These local mortgage rates are analyzed in two steps in this new approach. In the first step, mortgage rates are decomposed into two factors by using dynamic factor analysis: a national factor and region-specific factors. In the second step, the determinants of these factors are analyzed in detail. Among region-specific variables, the role of real sector variables as well as financial variables are examined. In analyzing the common factor that influences all of these rates in a similar way, the role of monetary policy is examined thoroughly.

## LITERATURE REVIEW

Movements in retail interest rates have been commonly analyzed by monetary policy literature. These studies mostly focus on how quickly changes in central banks’ policy rates are transmitted to retail rates. Cottarelli and Kourelis (1994) is a prominent example of this literature. They explained the determinants of retail interest rate pass-through for a sample of countries that includes both developed and developing countries. They first estimated the interest

rate pass-through coefficients for various retail interest rates. They then analyze the determinants of the pass-through coefficients in a cross section framework. They find that macroeconomic characteristics of these countries such as inflation and GDP play a significant role in the determination of the pass-through process. Debond (2002) and Debond (2005) followed the same approach and used the EU members' data to analyze the behavior of retail rates in these countries. They find that the pass-through is higher in the long-term bonds. Egert et al (2007) analyzed the interest rate pass-through for Central and Eastern European countries they found that the pass-through has been declining over time in these countries for all rates.

While studies that analyze determinants of the retail interest rates for other countries are abundant, this process has not been frequently analyzed for the US retail rates until recently. A recent study of Xu et al (2011) examined the magnitude and persistence of the mortgage rate pass-through in response to U.S. monetary policy surprises. They used a creative measure of monetary policy surprises and show how different the pass-through processes are for these rates. They also analyzed how the pass-through of mortgage rates in response to monetary policy surprises were affected by the size and direction of monetary policy surprises. Although the topic of this paper is close to ours, once again their main focus is on monetary policy's influence on these rates.

Even though interest rate pass-through studies ignore the role of regional factors in determining the effect of monetary policy shocks on interest rates, the literature has looked at the importance of regional factors in determining the effectiveness of monetary policy changes. Carlino and DeFina (1998) and Fratantoni and Schuh (2003) are among well-known examples of this literature. Carlino and DeFina (1998) analyzed the regional influence of monetary policy by estimating a time series VAR model which includes variables from eight Bureau of Economic Analysis regions. They found that the size of a response to monetary policy shock depends on two regional variables- the share of manufacturing in the state's gross product and concentration of the small firms in the region. Fratantoni and Schuh (2003) specifically focused on the role of housing market. They estimated a heterogeneous agent VAR (HAVAR) model for 1986-1996 period by using housing market and regional income data that belongs to 27 MSAs in the US. Their results show that the magnitude and duration of regional responses vary widely. Similarly, Negro and Otrok (2007), Vargas- Silva (2008) and Jarocinski and Smets (2008) estimated the influence of monetary policy on regional house prices by running VAR estimations. All of these studies found some evidence that monetary policy has significant effects on housing investment and house prices in most regions and that the easy monetary policy between 2002-2004 has contributed to the boom in the housing market.

While regional differences in the response of retail rates to monetary policy have not been commonly analyzed, the literature did examine the role of regional differences in the amount of loans made, which is known as the credit channel of monetary policy. Seminal works of Kashyap and Stein (1995) and Kashyap and Stein (2000) found that there is significant difference in bank's credit decisions in different regions in the US. While monetary policy shocks were very influential on the amount of credit banks opened in areas populated by small banks, the same was not found to be true for areas populated by larger banks.

In the following sections, the determinants of regional mortgage interest rate will be analyzed by implementing an innovative technique that has not been used in studying interest rates. In this new technique, the role of local factors determining retail interest rates will not be ignored as the literature did before. As in Negro and Otrok (2007), national and regional factors

that influence regional mortgage interest rates will be identified. Differing from their study, determinants of both national and regional factors will be examined in detail.

## **EMPIRICAL SECTION**

### **Data**

The quarterly mortgage interest rate data used in this study are collected by Freddie Mac for five regions of the US that are defined in the Appendix 1. For each region, two fixed mortgage rates (fifteen and thirty-year terms) and two adjustable mortgage rates (one and 5/1 rate) have been reported. The difference between these is that the interest rate on the fixed rate mortgage is predetermined over the life time of the mortgage. On the other hand, for the adjustable rate mortgages, the interest rates stay fixed only for one or five to one year period and then vary over the term of the loan.

Figure 2 (Appendix 2) shows why it is important to take a look at both fixed and adjustable mortgage interest rates in the analysis of mortgage market in the US. While fixed-rate mortgages are the most common type of mortgages in the US, the share of adjustable rate mortgages goes as high as 40 per cent in the time period that is shown in the figure.

### **A New Methodology to Analyze the Retail Interest Rates**

Figure 1 (Appendix 2) shows that retail rates that are exposed to the same monetary policy but different regional conditions might behave differently. This means that empirical methods that neglect the role of regional factors might be lacking in analyzing retail interest rates. We first need to check how influential regional factors are in analyzing these rates. If regional factors are found to be unimportant, the literatures' approach can be safely used. Otherwise, a method that considers both regional factors and monetary policy should be used. In this section, a dynamic factor analysis will be used to evaluate the role of regional factors.

Dynamic factor analysis has been used by the literature before. For instance, Kose et al (2008) used this method in an international study to examine the driving forces of G-7 countries' business cycles. They decompose GDP and inflation of G-7 countries into common and nation-specific components by using a dynamic factor model. They analyze the extent to which business cycles were synchronized among G-7 countries. Another example from this literature is Negro and Otrok (2007). They analyzed regional house prices and the role of monetary policy shocks in explaining house price movements. Their study was conducted in two steps: In the first step, they used a dynamic factor model to disentangle the relative importance of the common component in house price movements from local shocks. They took the time periods in which house prices are mostly determined by local factors as time periods that monetary policy did not drive the house prices. The time periods in which house prices were determined by a national factor was taken to be the period that the monetary policy was influential. They then used a VAR regression to investigate the extent to which monetary policy was the main factor determining the common component of the house prices across states.

Dynamic factor analysis in this paper has two targets. First, it examines if the regional factors were influential in any of the time periods that are analyzed. This will be helpful in deciding if the literature has been right in seeing the monetary policy as the sole determinant of

the retail rates<sup>1</sup>. Second target of this study is to examine the determinants of these factors. Once again, this paper's approach is going to be different from the literature. The regional factors that were not analyzed by the literature will be analyzed in detail.

### Dynamic Factor Analysis of Mortgage Interest Rates and Variance Decompositions

Suppose  $y_t$  in equation (1) below is a Q-dimensional vector of covariance stationary series. Factor analysis describes contemporaneous and temporal co-variation among variables in  $y_t$ . That is, all co-movements among the variables are controlled by dynamic factors.  $F_t$  in equation (1) measures the movement that is common to all variables in different regions, while  $f_{it}$  measure the region-specific co-movement. Finally,  $\xi_{ij}$  is the measurement error. The error term is assumed to be uncorrelated cross-sectionally at all leads and lags, and follows an autoregressive process of order  $p_i$  for each element in the vector. The B's and b's are factor loadings on the common and region-specific factors respectively.

$$y_{ij,t} = \alpha_{ij} + B_{ij}F_t + b_{ij}f_{i,t} + \varepsilon_{ij,t} \quad (1)$$

$$F_t = \theta_1 F_{t-1} + \dots + \theta_q F_{t-q} + u_t$$

$$f_{i,t} = \mu_1 f_{i,t-1} + \dots + \mu_q f_{i,t-q} + v_{i,t}$$

The estimation procedure of equation (1) is based on the Gibbs sampler, details of which can be found in Otrok and Whiteman (1998) and Kose et al (2008). A key identification assumption in this method which allows disentangling the factors from one another and from the idiosyncratic shocks is that all innovations are taken to be mutually independent.

This section will present the results of dynamic factor analysis. Since the target of the dynamic factor analysis is to gauge the relative share of regional and national factors in the determination of mortgage interest rates, variance decomposition analysis is used after estimating the factors shown in Figure 3(Appendix 2). The statistics in equation (2) below is computed to measure the variance of fluctuations due to the regional factor as the fraction of the sum of the variance of all three components.

$$\frac{(b_{ij})^2 \text{var}(f_{i,t})}{\text{var}(y_{ij,t})} \quad (2)$$

Next, the results of variance decomposition analysis for bubble and post-bubble period will be presented. As in Negro and Otrok (2007), it will be assumed that in time periods that the regional factor had an important role, monetary policy was not very influential. More formal analysis of this will be conducted in the second step when the determinants of common factor are analyzed.

Figure 4(Appendix 2) presents the results of variance decomposition analysis. It shows the share of regional factors on these interest rates for two time periods that are determined based on the housing market developments. The darker colors in the figures show the shares for the initial period. Lighter colors do the same for the later period. These figures reveal two important results: First of all, the role of regional factors in the determination of 15-year and 30-year mortgage interest rates is lower than the role of adjustable rate mortgages in all the time periods

<sup>1</sup> Since house prices peaked around the middle of 2000s and then went down afterwards, the empirical analysis will be conducted for two different time periods in the empirical section. This, in turn, will make it possible to see if the share of factors stayed the same in the bubble and post-bubble periods.

analyzed. These shares change between 2 to 35 percent. Thus, it is possible to conclude that these fixed-term mortgages are determined mostly by national factors. Secondly, for almost all regions and all interest rates, the role of the regional factor increases substantially in the post-bubble period. Once again, this situation is more obvious for adjustable-rate mortgages. This suggests the regional factors became more important in the period that followed the recent financial crisis.

### Analysis of Factors

So far, the share of common and regional factors determining the mortgage interest rates has been discussed. The analysis showed that regional factors that are totally ignored by the literature did play a significant role especially in the determination of adjustable rate mortgages. Now in the second step, the determinants of these factors will be examined in detail.

### Analysis of Regional Factors

Table 1 (Appendix 2) shows the characteristics of the financial sector and the real sector in the regions that are covered in this paper. In this table HPI is the average change in the house price index and total personal income measures personal income growth. These two variables are downloaded from the Federal Reserve Bank of St Louis's web site at the state level and then their averages are calculated for our regions. Last three lines in this table measures the banking sector characteristics in these regions. The "total asset" variable here is used to measure the size of the banking sectors; the "ROA" measures return on assets and the "nonperforming" measures the share of nonperforming loans in total loans. These variables are downloaded from the FDIC's web site at the state level and their regional averages are calculated as before.

Figures on this table indicate that regions exhibit very different characteristics in the time period we analyze. While total personal income growth is highest in the SW, the NE is found to be the region with the highest house price increase. Moreover, banks in the NE seem to have lowest non-performing loans and ROA as well. However, the sizes of banks' total assets are found to be very similar in NC, NE and SE.

In this section, the determinants of the regional factors are estimated in a panel data framework. As indicated in the literature survey section of this paper, while the literature ignored the role of regional factors in determining retail rates, Gambacorta (2008), Kashyap and Stein (1995) and others analyzed the role of characteristics of banking sector on banks' credit decisions. In this section, these authors' approach will be followed. The determinants of regional factors,  $f_{it}$ , estimated from equation (1) will be estimated by using three equations that are given below. In equation (3a), only financial sector variables will be included by following Kashyap and Stein (1995) and others. In equation (3b), only demand side of the housing market will be used. The last equation will include all of these variables.

$$f_{it} = \alpha_{0i} + \alpha_1 \ln tasset_{it} + \alpha_2 nonper_{it} + \alpha_3 roa_{it} + u_{it} \quad (3a)$$

$$f_{it} = \beta_{0i} + \beta_1 hpi_{it} + \beta_2 tpi_{it} + v_{it} \quad (3b)$$

$$f_{it} = \alpha_{0i} + \alpha_1 \ln tasset_{it} + \alpha_2 nonper_{it} + \alpha_3 roa_{it} + \alpha_4 hpi_{it} + \alpha_5 tpi_{it} + u_{it} \quad (3c)$$

where the "lntasset" is the log of the total assets, the "nonper" is the nonperforming loans to total loans, the "roa" is the return on assets, the "hpi" is the percentage change in the house price index and the "tpi" is the total personal income growth.

The results of the three fixed effect estimations are presented in Table 2 (Appendix 2). The first panel includes only financial sector variables as independent variables. The table shows that the size of banks is negatively associated with the regional factor, while banks' return on asset is not significant and the share of nonperforming loans has a positive relationship with the local factor.

In the second panel of Table 2 (Appendix 2), only house prices and personal incomes are used to estimate regional factor. The results show that regional factor has a negative relationship with the house prices and total personal income growth.

In the last panel of the table, all of these variables are included. The table shows that putting banking sector variables and house prices and personal income variables together improve the results considerably. The value of R-bar-square increases significantly in the last panel. The table also shows that all of the variables including return on assets that was found to be insignificant in the first panel are found to be significant this time. The result of the estimation of equation (3c) shows that the regional factor is going to be small in good times when house prices, personal income and bank sizes are increasing. This finding is actually in line with the variance decomposition analyses that are presented in Figure 4 (Appendix 2). In the most recent period which had a sharp decline in the personal incomes and house prices and deterioration in the banking sector indicators, the shares of regional factors were found to be higher than the bubble period.

### Analysis of Common Factor

So far the determinants of the regional factors have been analyzed. In this section, the determinants of the national factor, which is  $F_t$  in equation (1), will be examined in a VAR framework by following Fratantoni and Schuh (2003) who estimated a six-variable VAR model to analyze the influence of monetary policy on housing market.

$$X_t = \beta_0 + \sum_{l=1}^L \beta_l X_{t-l} + U_t \quad (4)$$

where  $X_t = [P_t, Q_t, Y_t, H_t, F_t, R_t]$ .

Here, "P" is the CPI, "Q" is the house price index, "Y" is the industrial production, "H" is the housing starts, "F" is the mortgage interest rate and finally "R" is the non-borrowed reserves. First difference of P, Q, Y, H and R are used in the VAR estimation.

Instead of having the mortgage interest rate in equation (4), the common factor estimated in the first step will be used. Once again, the model will be estimated separately for bubble and post-bubble periods. In these regressions, the number of lags of the VAR models is selected to be equal to 2 by using the AIC criteria for both periods. The VAR model is identified by orthogonalization based on the common ordering of prices, quantities and monetary policy variable by following Fratantoni and Schuh (2003) and others.

Figure 5(Appendix 2) shows the impulse response functions of the common factor to a one standard deviation monetary policy shock. The figure on the left shows the IRF for the bubble period, while the one on the right shows the bust periods' IRF. Comparing these two figures indicates how the monetary policy influenced the cost of financing house purchases in the housing bubble and post-bubble periods.

As the figure shows<sup>2</sup>, the common factor declines following an expansionary monetary policy, then increases slightly. The increase in the mortgage common factor here indicates the possibility of a Fisher effect. That is to say, agents adjust their inflationary expectations after the shock and when they do, that common factor increases. Overall, it takes around ten periods for the effect of shock to disappear.

Interestingly, in the second figure, the mortgage common factor declines only very little in response to a monetary policy shock. This indicates that in the post-bubble period, the Fisher effect was more prevalent. Agents in the second period seem to anticipate an increase in inflation and then adjust their behavior based on their expectations here very quickly.

To summarize, the result of the VAR analysis indicates that the decline in the common factor in response to the monetary policy shocks were more prevalent in decreasing mortgage interest rates in the first period. This finding is in line with the findings of the other studies in the literature such as Vargas -Silva (2008) and Jaroncinsky and Smets (2008), whose works also find that monetary policy was more effective in influencing the mortgage rates in the bubble time period.

## SUMMARY AND CONCLUSIONS

When analyzing the interest rate channel of monetary policy, the literature neglects the role of regional factors in determining these rates and looks at only the role of monetary policy. However, empirical data shows that retail rates that are subject to the same monetary policy and different regional effects can show substantial differences. The contribution of this paper to the literature is in providing a new method which considers both monetary policy and regional factors to analyze retail rates. In this new method, the rates are decomposed into two components that are region-specific and common to all regions. In the second step, determinants of these components are analyzed.

After proposing a new methodology to study the retail interest rates, this paper analyzes the determinants of fixed and adjustable rate mortgage interest rates in the US. It first proves that the role of regional factors in determining these rates depends on the type of mortgage that we analyze. Adjustable rate mortgage interest rates are found to be influenced by local factors more than fixed rate mortgages. Additionally, the impact of regional versus common factors changes from time to time. The paper shows that while monetary policy shocks were more influential in the bubble times, regional factors were found to be more prominent when macroeconomic indicators and banking sector indicators were deteriorating.

Considering monetary policy efforts on improving the housing market in the post-crisis period, the findings of this article provides important insights for monetary policymakers. First of all, it shows that policymakers should examine mortgage interest rates separately when they evaluate the effectiveness of their policies on the mortgage market. The analysis indicates that monetary policymakers in the US have more control over influencing fixed rate mortgages. Secondly, findings of this article show that the monetary policy has been less effective lately in influencing mortgage rates (and therefore the housing market), compared to the bubble period. This suggests that policy makers should consider region-specific solutions to help the recovery of the housing market instead of following a nation-wide policy such as the monetary policy. Finally, the findings indicate that as the banking sector indicators improve, the local factors will become less significant in determining the mortgage rates. Therefore, in addition to the other

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<sup>2</sup> The IRF's of other variables are available upon request.



benefits, our results suggest that improving the health of the banking sector could cause an improvement in the effectiveness of the monetary policy as well.

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## APPENDIX 1: DEFINITION OF REGIONS

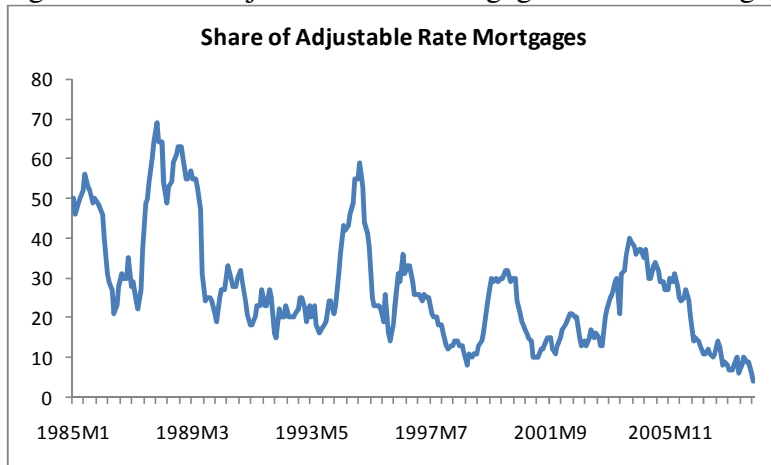
**North Central:** Illinois, Indiana, Iowa, Michigan, Minnesota, North Dakota, Ohio, South Dakota, Wisconsin; **North East:** Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia; **South East:** Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina Tennessee; **South West:** Arkansas, Colorado, Kansas, Louisiana, Missouri, Nebraska, New Mexico, Oklahoma, Texas, Wyoming; **West:** Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington.

**APPENDIX 2: FIGURES AND TABLES**

**Fig. 1: Mortgage Interest Rate Growths and Standard Deviations between 2000-2010**

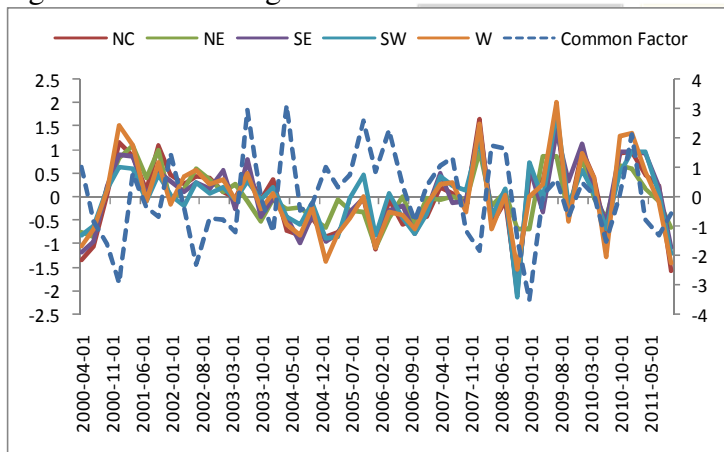


Fig. 2: Share of Adjustable Rate Mortgages in Total Mortgages



Source: Federal Housing Finance Agency

Fig. 3: Estimated Regional Factors and Common Factor of the Mortgage Rates



Source: Authors' calculations

Fig. 4a: The Role of Regional Factors on 15-Year Fixed Mortgage Interest Rate in the Bubble and Post-bubble Period

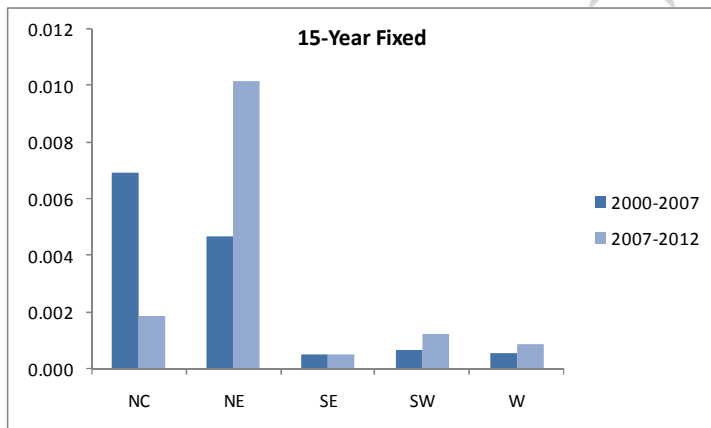


Fig. 4b: The Role of Regional Factors on 30-Year Fixed Mortgage Interest Rate

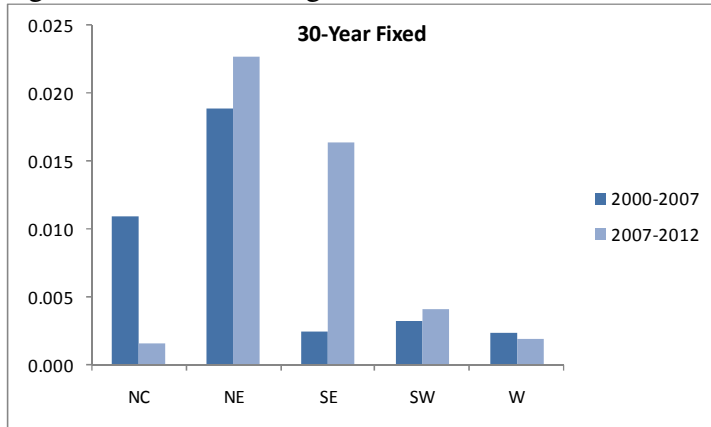


Fig. 4c: The Role of Regional Factors on 1-Year Adjustable Mortgage Interest Rate

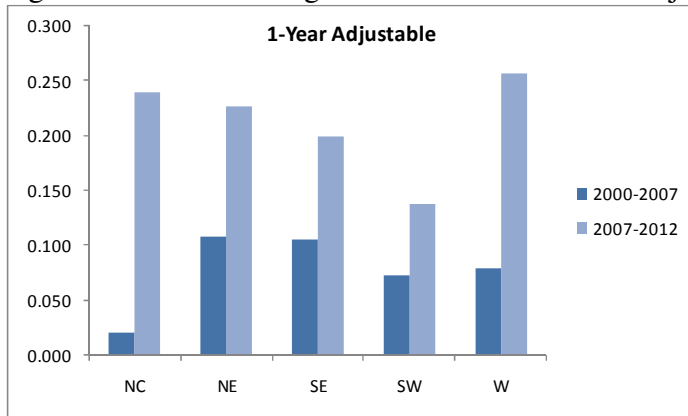
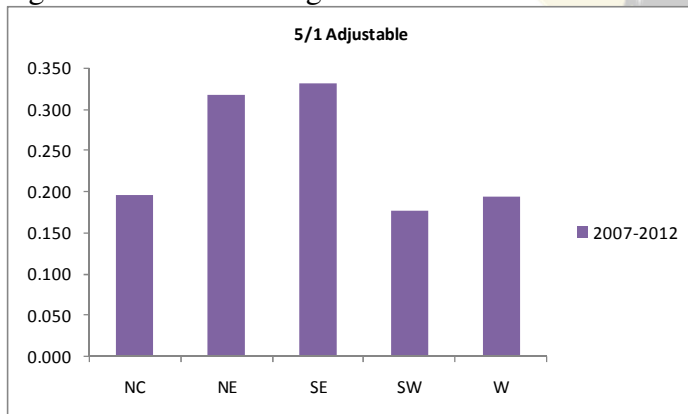


Fig. 4d: The Role of Regional Factors on 5/1-Year Adjustable Mortgage Interest Rate<sup>3</sup>



Source: Author's calculations

<sup>3</sup>This rate is available only for the most recent period.

Table 1: Summary of Regional Variables

	NC	NE	SE	SW	W
HPI	2.45	5.11	2.69	3.16	3.83
Total Personal Income	3.33	4.15	4.45	4.99	4.48
Total Asset (billions)	2.993	2.939	2.398	0.704	1.686
ROA	1.028	0.914	0.913	1.036	1.120
Nonperforming	1.430	0.972	1.454	1.256	1.252

Source: The Fed St. Louis and the FDIC.

Table 2: Determinants of Regional Factors

	Coef.	Std.	t	Coef.	Std.	t	Coef.	Std.	t
Ltasset	-0.36	0.20	-1.82				-0.36	0.19	-1.91
Nonper	0.30	0.06	5.06				0.19	0.06	3.22
Roa	-0.11	0.11	-1.03				-0.54	0.12	-4.38
Hpi				-0.11	0.03	-3.82	-0.17	0.03	-5.01
Tpi				-0.04	0.01	-3.22	-0.06	0.02	-3.91
_cons	4.66	2.82	1.65	0.3	0.07	4.34	4.79	2.7	1.78
R_bar_square	0.12			0.15			0.25		
F-test	10.1			19.72			14.66		

Source: Authors' calculations.

Fig. 5: The Response of Common Factor to a One Standard Deviation Shock to Non-Borrowed Reserves in Pre and Post Crisis Periods

