House Price, Transactions, and Structural Changes in the U.S. Housing Market: The Impact of First Time Home Buyers

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Abstract:

There is mixed evidence regarding the relation between prices and trading volume in the existing empirical studies. This paper investigates in the instability in the price-volume relationship by looking at the impact of changes in the number/proportion of first time homebuyers in the housing market. The results shows that the entry of the Baby Boom and the Baby Bust generation, the inflation expectation, and the Subprime Mortgage Crisis in 2008 all have impact on changes in the number/proportion of first time homebuyers, which leads the instability in the price-volume relationship in the U.S. housing market. These findings are able to explain the mixed evidence in the previous studies. Also, the significant impact of the inflation expectation on the price-volume relationship implies that the monetary policy such as the must recent quantitative easing (QE) can have impact in the U.S. housing market.

Introduction:

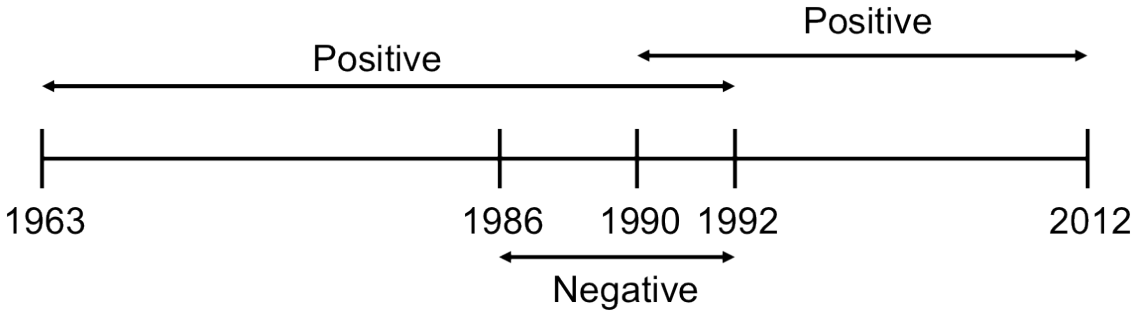
In studies of the housing market, much research investigates in the relationship of housing price and trading volume. Looking at this relationship, it greatly improves our understanding of the dynamics of the housing market. Furthermore, housing wealth accounts for two-thirds of the median US household wealth(Tracy and Schneider, 2001). Anari and Kolari (2002) also state that: "... For

most people, homeowner equity is the most important form of investment… Because homeowner equity represents the largest portion of most households' investment portfolio, changes in the real value of homeowner equity have important implications for personal as well as for the national economy." A well understanding of changes in housing prices and trading volume improves the predictability of local property tax collections and related local government budgets.

The aim of this paper is to examine the stability of the price-volume relationship in the U.S. housing market and the impact of the first time homebuyers on this relationship. During the past decades, there are several key events in the U.S. housing market. First, the entry of the peak of the Baby Boom generation in 1970s and the entry of the Baby Bust generation[1] in 1990s into the housing market (Mankiw and Weil, 1989). Second, the adjustable-rate mortgages (ARMs) put into action in 1982. Also, the inflation expectation has declined dramatically after 1980 and remained low after 1983. Third, during the housing bubble from 2000 to 2006, the minimum down payment was low. In 2006, the U.S government revoked non-profit status of organizations involve in down payment, which greatly reduce the incentive for these organizations to lend down payment for low income households. The last one is the Subprime Mortgage Crisis in 2008. It is hard to believe that the above events have no impact on the stability of the price-volume relationship in the U.S. housing market.

[1] The peak of the Baby Boom is in 1957, and there were about 4.30 million babies were born in the United States. The Baby Bust is in 1973, and there were about 3.14 million babies were born. Mankiw and Weil (1989) show that young households enter into the housing market in ages between 20 to 30, and the housing demand had increased dramatically due to the entry of the Baby Boom generation.

Indeed, there is mixed evidence regarding the relation between prices and trading volume, and the evidence is either from aggregate U.S. notional level data, or from U.S. metropolitan level panel data with limited sample periods. Stein (1995), Berkovec and Goodman (1996), Clayton, Miller and Peng (2010), and Akkoyun, Arslan and Kanik (2012) find a positive correlation between price and trading volume, while Follain and Velz (1995) suggest a negative price-volume relationship. Follain and Velz argue that the difference between these results can be referred to the period studied (p. 105). Stein (1995) and Berkovec and Goodman (1996) use the sample period from 1963 to 1992, while Follain and Velz use the sample period from 1986 to 1992. In the most recent papers, Clayton, Miller and Peng (2010), and Akkoyun, Arslan and Kanik (2012) use the post-1990 sample period and find a positive price-volume correlation. The follow diagram summaries the previous empirical findings according to the different period studied:



It shows that the relation between prices and trading volume changed from positive to negative, and then shifted back to positive. Based on this diagram, it is plausible to say that there was at least two structural changes occurred in the U.S.

housing market. If this is the case, what causes the structural changes in the U.S. housing market?

Andrew and Meen (2003) study the stability in the price-volume relationship and they state that changes in the number of first time homebuyers caused a structural change in the U.K. housing market during 1990s. It brings us to the next question: Was there any changes in the number of first time homebuyers in the U.S. housing market? Figure 1 is the ratio of first time homebuyers in the U.S. housing market from the America House Survey (AHS). One can easily observe that this ratio increases significantly from 1978 to 1985 and decline after 2009. Based on Andrew and Meen (2003), it is possible that the price-volume relationship in the U.S. housing market is not stable due to the changes in the number of first time homebuyer. This paper shows that the events mentioned above induce changes in number and proportion of first time homebuyers, and these changes cause the instability in the price-volume relationship in the U.S. housing market.

The main contributions of this paper are the following: First, this paper shows the evidence on structural changes in the price-volume relationship in the U.S housing market by using the Dynamic conditional correlation model and the three-stage least-square model. The finding indicates that the previous empirical studies might suffer from the structural changes. Second, this paper provides a link between changes in the number/proportion of first time homebuyer and the instability in the price-volume relationship. Third, the findings in this paper are able to explain the mixed evidence in the previous empirical studies: the price-volume relationship changed from positive to negative, and then shifted back to positive.

This paper is organized as follows. Section 2 summaries the existing theory regarding the price-volume relationship and shows how changes in the number/proportion of first time homebuyer influence this relationship. Section 3 is the literature view. Section 4 presents the structural model of the housing market. Section5 is the data and the descriptive statistic. Section 6 is the empirical results. The last section is the conclusion and future research.

Theory

While Lucas (1978) argues that there should be no correlation between housing prices and trading volume in a standard rational expectation asset market, there are three groups of theory suggest a positive relation between the housing price and transactions. The first group is lead by Stein (1995). He provides a down payment constraints model and shows that under the equity constraints, an increase in prices causes an increase in trading volume. He states that when the housing prices fall, this reduces the homeowner's home equity values. To ensure that the profit from selling the old house can cover the mortgages and the minimum down payment for new house, the homeowner have to ask for higher prices. Therefore, the time on the market increases and the trading volume decreases.

The second group uses the theory of nominal loss aversion. Genesover and Mayer (2001) argue that the positive relationship between price and trading volume can be explained by the nominal loss aversion. This model shows that homeowners are averse to realizing losses. Therefore, they are less willing to sell their homes when the prices fall. Cauley and Pavlov (2002) also suggest that the option value of

homeowners implies that homeowners wait to sell as the upside benefits are larger than the net carry loss. Both of them indicate that there is a positive causality from price to transactions.

The third group focuses on the causality from transactions to prices by using search and matching models. Wheaton (1990) argues that, since the housing market is information asymmetric, an increase in transactions raises housing price due to searching cost. Berkovec and Goodmand (1996) also indicate that in response to house demand shock, transactions tend to change more quickly than price does.

However, none of the previous theories are able to explain the negative price-volume relationship found by Follain and Velz (1995), and none of them consider the role of first time homebuyer in this relationship. Andrew and Meen (2003) point out that the housing market consists of two components: first time homebuyers and existing owner-occupiers. Neither of them should be omitted in the study of housing market. They also find that the changes in the number of first time buyers can influence the price-volume relationship. In the next sub-section, I explain how the previous theories imply the effect of changes in the number/proportion of first time buyer on the price-volume relationship.

The role of first time buyer in the price-volume relationship:

The number/proportion of first time homebuyer in the housing market can influence the stability in the price-volume relationship through its impact on the effect of down payment constraints and nominal loss aversion.

According to Stein (1985), the down payment constrains only has impact on the existing owner-occupiers. When the prices drop, the transactions of existing owner-occupiers decrease due to the equity constraints. However, for the first time buyers, a lower housing price increases their incentive to enter into the housing market. As a result, the impact of down payment on the price-volume relationship decreases as the number/proportion of first time buyer increases. Also, theory of nominal loss aversion implies that the probability of existing owner-occupiers to sell and buy houses decreases as the housing prices drop, but a decrease in price should not decrease the willingness of first time buyers enter into the housing market.

According to the above arguments, an increase in the number/proportion of first time buyers should decreases the impact of down payment constraints and nominal loss aversion. Therefore, a positive price-volume relationship decreases if the proportion of first time buyer is larger. On the other hand, a decrease in the number/proportion of first time buyers strengthens the effect of both the down payment constraints and the nominal loss aversion, which lead a positive price volume relationship. After showing that changes in the number/proportion of first time buyers can cause the instability in the price-volume relationship, in the following sub-sections, I would like to show how the key events mentioned in the introduction affect the number/proportion of first time buyers in the U.S housing market.

The impact of Baby Boom and Baby Bust:

Andrew and Mean (2003) argue that young households are likely to be the first time homebuyers. Also, Mankiw and Weil (1989) indicate that individual generates little housing demand until age 20, and the demand of housing rises sharply when households are between ages 20 and 30, and remains approximately flat after age 30 (p.236). They also show that demand rises sharply in 1970s when the Baby Boom generation is in 20s and 30s. Since the Baby Boomers were those young house owners in 1970s, the number/ proportion of first time buyers should increase in the housing market in 1970s. After two decades, the Baby Bust generation starts to enter into the housing market, and the number/ proportion of first time buyers should decreases in 1990s.

Figure 2 shows the proportion of first time buyers and the number of live births 30 years age. It shows the first time buyer rate is in its peak when the peak of baby boom generation is 30 years old, which is consistent to Mankiw and Weil (1989)'s argument. Furthermore, since the entry of the peak of the Baby Boom generation in the housing market is from 1977 to 1987 and the entry of the Baby Bust generation is from 1993 to 2003, it can explain the mixed evidence from the previous empirical study: changes in the price-volume relationship from positive to negative and then positive. Engelhardt (2003) also finds that low equity because of fallen house prices does not significantly reduce house mobility by using the sample period from 1985 to 1996. This result is likely to be caused by the entry of the Baby Bust generation.

The impact of adjustable-rate mortgages (ARMs) and the inflation expectation:

Before 1982, the banks or creditors were only able to provide fixed-rate mortgage. However, the Garn–St. Germain Depository Institutions Act put in to action in 1982, which allows banks to provide adjustable-rate mortgage loans. Since fixed-rate mortgage has a higher starting interest rate than adjustable-rate mortgage because the lenders have to take a risk of inflation, adjustable mortgage rate is preferred by the high-risk borrowers. Indeed, there was a large proportion of the low-quality subprime mortgages are adjustable-rate mortgages before the Subprime mortgage Crisis in 2008.[2] Since young households or first time homebuyers are more likely to be the high-risk borrowers, adjustable mortgage rate make it easier for them to enter into the housing market.

On the other hand, households tend to choose adjustable mortgage rate if the inflation expectation is low but choose fixed mortgage rate if the inflation expectation is high.[3] According to this argument, when inflation expectation is high, it reduces the willingness of first time buyer getting into the housing market. Therefore, with a high inflation expectation, the number/proportion of first time buyer decreases. On the other hand, during the period of low inflation expectation, the advantage of adjustable mortgage rate increases the willingness of first time buyer to buy a house. As a result, the number/proportion of first time buyer increases.

[2] Approximately 90% of subprime mortgages issued in 2006 were ARMs.

[3] Cunningcham and Capone (1990) argue that the expected inflation has a positive effect on the default probability for the ARMs.

Figure 3 is the University of Michigan inflation expectation. It shows that the inflation expectation decreased dramatically after 1980 and remained low after 1983. Since a low inflation expectation increases the number/proportion of first time buyer, it explains the reduction in the impact of the down payment constraints after 1983.

The impact of down payment and the Subprime Mortgage Crisis:

During the period of housing bubble from 2000 to 2006, the minimum down payment was low. Furthermore, there was no minimum down payment in some cases. However, the U.S. government revoked non-profit status of organizations involve in down payment in 2006. After that, there was the Subprime Mortgage Crisis in 2008 and the minimum down payment increases until today. Changes in the down payment have significant impact on the willingness of first time buyers to enter into the housing market. A higher down payment after the Subprime Mortgage Crisis blocks the entry of firs time buyers. Moreover, after the Subprime Mortgage Crisis, there was a credit crunch that greatly reduced the mortgage lending especially to the high-risk borrowers or the first time buyers. Therefore, a decrease in the number/proportion of first time buyer enhances that the effect of down payment constraints after 2008.

We have already shown that these key events in the U.S. housing market have impact on the number/proportion of first time buyer during the past years. To examine the changes in the number/proportion of first time buyer on the instability of price-volume relationship empirically, this paper applies the Dynamic Conditional

Correlation (DCC) model and the three-stage least square model by using the U.S. quarterly national level data. Before we do that, I want to discuss the relevant study regarding to the relation between price and transactions and how this paper fits into the existing literatures.

Literature Review:

Numerous articles study the relation between housing prices and trading volume in the housing market. Andrew and Meen (2003) investigate in the stability of price-volume relationship in 1990s in the U.K. housing market. They examine the instability by using VAR model with a dummy variable for post 1990 sample period. However, they indicate that it is not satisfactory to capture structural change purely in terms of a dummy variable. Therefore, in their companion paper, they use micro level data from the Survey of English Housing for young households in 1990s and the Bivariate Probit model to test structural change indirectly.

Clayton, Miller and Peng (2010) examine the price-volume correlation in the U.S housing market by VAR model. Compare to the existing empirical studies, they use a panel data with large number of metropolitan areas. In their results, they find a positive price-volume correlation that mainly explained by co-movement of housing prices and trading volume. They also show that home prices Granger cause trading volume, but the effects are asymmetric—decreases in prices reduce trading volume, and increases in prices have no effect.

Akkoyun, Arslan and Kanik (2012) investigate in the price-volume correlation across different frequencies by using both national time series data and

regional level panel data. They also find that the long-run price-volume correlation is larger than the short-run correlation, and both long and short rum correlations are positive.

However, none of the existing studies focus on the impact of changes in the number/ proportion of first time buyers on the price-volume relationship in the U.S. housing market. Also, Most of the studies use the metropolitan level data, and it limits the length of the sample period. With the limited sample period, it is hard to examine the instability in the relation between prices and trading volume. Diverging from the previously studies, this paper uses the national time series data for two reasons: (1) It allows us to test whether the changes in the price-volume relationship by using metropolitan level panel data can also be found in national level data. (2) Using national level time series data extends the length of the sample period, which allows us to examine the instability in the price-volume relationship.

Furthermore, none of the previous studies investigate in the impact of the key events mentioned in the introduction. As shown in the previous section, these events should have significant impact on the U.S. housing market. This paper attempts to fill this gap by examining the effect of these events on the stability in the price-volume relationship.

A well-known challenge in the study of the housing prices-volume correlation is that both price and trading volume are endogenous. To overcome this problem, the previous studies use either bivariate VAR model (Clayton, Miller and Peng, 2010; Akkkoyun, Arslan and Kanik, 2012) or the three-stages least square model (Follain and Velz, 1995). In this paper, I apply the three-stage least square

model in order to include interaction term and test the structural change directly from a macroeconomics perspective.

Structural model of the owner-occupied housing market:

Before we estimate the three-stage least-square model, we need to have the structural models for the housing market. This paper follows the structural models suggested by Follain and Velz (1995). They construct these model based on the definition of real estate sold (RES). RES represents the sum of the value of all real estate sold within a particular period, which equals to the dollar amount of sales (Follain and Velz, 1995; p.95). Therefore, it captures changes in both of the size and quality of the units being sold. The definition of RES and its four components can be shown by:

$$RES_t = N_t \times KHH_t \times PR_t \times NHO_t \quad (1)$$

where N_t represents the proportion of all owner-occupied housing units sold at time t, KHH_t represents the quality index of the average unit sold at time t, PR_t represents the Constant-Quality House Price Index in period t, and NHO_t represents the total number of owner-occupied units in the housing market at time t. These four elements in RES are assumed to be endogenous. The determinants of these components of RES can be examined by constructing the structural models for each variable.

The first equation is the model of turnover ratio (N_t). In each time period, turnover rate is affected by the amount of people who desire to sell or buy and the time it takes to sell or buy. The willingness of sell and buy can be captured by

household mobility, the down payment constraints, and nominal loss aversion behavior (Follain and Velz, 1995). The mobility of household depends on the imbalance between its current consumption of housing and the optimal consumption. Any factors that have impact on this gap can affect the variations in the turnover rate. Follain and Velz point out that the growth rate in employment and the growth rate in the cost of owner-occupied housing can capture the changes in the household mobility through their effects on the consumption gap. Then, the model of turnover rate can be written by:

$$N_t = \lambda_0 + \lambda_1 \Delta EMP_t + \lambda_2 \Delta UC_t + \lambda_3 PR_t + \delta PR_t * interaction + \mu_{1,t} \qquad (2)$$

where ΔEMP_t represents the growth rate of employment, ΔUC_t represents the growth rate of cost of owner-occupied housing, and PR is the housing price index. The first two variables are exogenous based on the theory. An increase in the growth rate of employment should raise the turnover rate, which can be shown by a positive value of λ_1. On the other hand, a negative shock in the cost of owner-occupied housing should decrease the willingness to buy a house so that λ_2 is expected to be negative. Follain and Velz state that the impact of down payment constraints is captured by the coefficient of PR. According to Stein (1985)'s argument, $\lambda_3$is assumed to be positive. The interaction term of PR captures the structural changes in the effect of price on turnover rate. The null hypothesis is that there is no structural change in the effect of housing price. In this case, δ should be zero. This interaction term can also explain changes in the impact of down payment constraints. For example, if the number of first time homebuyers or the proportion of first time homebuyers increases, based on our theory, it should reduce the impact

of down payment constraints. Therefore, the variables in the interaction term are the variables assumed to have impact on the changes in the number of first time buyers. In this paper, the variables in the interaction term of PR are dummy for the years when the baby boom generation are 20 to 30 years old, a dummy for the years when the baby bust generation are 20 to 30 years old, dummy variable for the years when the proportion of fist time buyers in the housing market are high, the inflation expectation and dummy variable for the years after subprime mortgage crisis. I use each aforementioned variable alternately to test the effect of each factor on the impact of down payment constraints.

The second equation is the housing size and quality (KHH) model. KHH is an index of the size and quality of house. Since PR is the constant quality price index, the product of PR and KHH equals the value of the housing unit. Similar to the basic determinants of quantity demanded, KHH can also be explained by household income and the cost of owning and occupying a house. The demand for KHH can be written by:

$$KHH_t = \alpha_0 + \alpha_1 \mathrm{YR}_t + \alpha_2 \mathrm{UC}_t + \alpha_3 PR_t + \mu_{3,t} \quad (3)$$

where YR represents the real person income per capita and α_1 is the income elasticity estimates. Since the demand function is downward sloping, the price elasticity α_3 is negative.

The third model is the house price (PR) equation. Basic price theory suggests that not only the demand of house is affected by house price but also the housing price is simultaneously influenced by the demand for housing. Follain and Velz indicate that the short-run supply of housing is inelastic, and the upward pressure

in the housing price due to an increase in demand for housing will generate a positive gap between the housing price and the replacement cost of housing if the bulk of the replacement cost is consisted of factors whose prices are determined in larger market. These factors can be wage rates and cost of capital that are determined by labor and capital market (p.101). Then, the house price model or the supply equation can be written by:

$$PR_t = \beta_0 + \beta_1 \mathrm{RPRC}_t + \beta_2 Q_t^d + \beta_3 N_t + \phi N_t interation + \mu_{2,t} \quad (4)$$

where RPRC represents the real replacement cost, Q^d represents the aggregate demand for housing, which is the product of the housing size and quality (KHH) and the number of owner-occupied units (NHO). Since an increase in the cost of building house should raise the housing price, β_1 is expected to be positive. The upward pressure on housing price due to an increase in demand for housing implies that β_2 should be positive. β_3 captures the effect of turnover rate on the housing price. Wheaton (1990) suggests that an increase in turnover rate increase the housing price due to the search cost and β_3 is expected to be positive. Berkovec and Goodman (1996) also state that a shock from housing demand affects transactions first and then the housing price, and the effect of transactions due to a demand shock on housing price should be positive. ϕ is the coefficient of interaction term of N, which captures the effect of first time homebuyers on the impact of turnover rate. The variables in the interaction term of N are the same variables in the interaction term of PR in the equation (2).

The last equation is the model of number of owner-occupied units (NHO). The determinants of NHO are the economic and demographic variables. The

demographic variable is the size of population and the economic variable is the real personal income per capita. This model can be written by:

$$NHO_t = \gamma_0 + \gamma_1 \mathrm{YR}_t + \gamma_2 \mathrm{POP}_t + \gamma_3 UC_t + \mu_{4,t} \quad (5)$$

where POP represents the population at time t. Holding all else being equal, an increase in the size of population increases the number of owner-occupied units, which implies that γ_2 is expected to be positive. Also, a higher income leads more owner-occupied household so that one should expect γ_1 be positive. The user cost of homeowner is expected to have a negative impact on the number of owner-occupied units, which implies that γ_3 should be negative.

Data:

In the studies of the U.S. housing market, the must commonly source for the data of housing prices and trading volume is the National Association of Realtors (NAR). The NAR is the largest trade association of realtors. The NAR reports the monthly sales and prices of existing homes sold through the Multiple Listing Services (MLS). While the NAR generates the series for a large number of metropolitan areas, the series for metropolitan areas are only available since 1981. Also, when compared to the list of variables at the national level on which data are available, at the local level it is usually found to be lacking. Therefore, I use only the time series data for the U.S. as a whole to extend the length of the sample period. Since the main purpose of this paper is to examine the structural changes in the price-volume relationship, the length of the sample period is essential in this study.

To be consistent with the previous studies, the turnover rate is used to measure trading volume. The turnover rate is defined by the fraction of existing single-family home sales to the stock of existing single-family homes. The NAR provides the non-seasonal adjusted monthly data of existing single-family home sales from 1968 to 2012. The number of existing single-family homes units is the product of homeownership rate and the number of households. The U.S. Bureau of Census provides the homeownership rate for every quarter from 1968 to 2012. Economagic .com provides the monthly data for the number of households (in thousands) from 1956 to 2012.

The NAR also provides the non-seasonal adjusted monthly average price in dollars of existing single-family home sales from 1968 to 2012. The index of house size and quality is the ratio of the average price to the Constant-Quality House Price Index (CQHPI) estimated by the U.S. Census Bureau. The CQHPI is the quarterly data from 1963 to 2012, which employs the hedonic methodology that controls for differences in the quality of houses.

The U.S. Department of Commerce: Bureau of Economic Analysis provides monthly population (in thousands) and non-seasonal adjusted monthly real personal income per capita (dollars) from 1959 to 2012. The U.S. Department of Labor: Bureau of Labor Statistics provides the total nonfarm employees. The housing cost of homeowner is estimated by the monthly average interest rate for 30 year fixed rate mortgages provided by Freddie Mac from 1971 to 2012. It is also include by Clayton, Miller and Peng (2010) in their study as borrowing cost. The replacement cost is the constant quality price index of new single-family house

under construction from 1964 to 2012 provided by the U.S. Bureau of Census. For the variables in the interaction terms, the National Center for Health Statistic provides the annual data for the number of live births from 1910 to 2012. The America House Survey publishes the number of first time homebuyer annually since 1977, and after 1981, it only publishes in odd-number years. The University of Michigan inflation expectation index provides the Inflation expectation by from 1978 to 2012 every quarter. The total sample period in this paper is from 1971:03 to 2012:03. To examine the impact of changes in the number/proportion of first time homebuyers, the best-case scenario is to use the number of first tome buyer directly in the interaction term. However, we do not have such data for the United States. Therefore, in this study, I use the year dummies that equals to 1 if the number/proportion of first time homebuyers is high and zero otherwise. The detail of the year dummies is discussed in the results.

The descriptive statistic is in Table 1. The average housing price per quarter is about one hundred and thirty thousands dollar with a high standard deviation. The average existing single-family home sales is about thirty-four hundred units and the average number of owner-occupied units is about sixty hundred units. The average turnover rate shows that the percentage of transactions is about 6% per quarter. The replacement cost has high standard deviation. Since it is measured by the construction cost, the large standard deviation can be explained by the difference in the price of input used in the construction across areas. The average mortgage rate is about 8.7% with a standard deviation closed to 3%. Part of the

standard deviation is from inflation in the given time period. The average number of total nonfarm employees is about 50% of the average of the total population.

In the next section, I examine the impact of changes in the number/proportion of first time buyer on the price-volume correlation. Before going into the results, readers should keep in mind that there are some drawbacks when using a national level time series data in this study: The results of this study might be affected by the heterogeneity in the different regions. The area that has high trading volume can dominate the results.

Empirical results:

To examine the stability in the relation between housing price and turnover rate, I apply the Dynamic Conditional Correlation model suggested by Engel (2002). This model assumes that there is structural change in the price-volume correlation in each period, and the correlation coefficient is time vary. The dynamic conditional correlations are calculated from the residuals of an unrestricted VAR(p) process. The order of the VAR, p, is set to be the minimum lag length that renders the residual vector e to be serially uncorrelated and stationary, which equals to 2 in this case. The estimated model is shown below:

$$X_t = B_0 + X_{t-1} + e_t;$$

$$h_{it} = c + \alpha\varepsilon_{i,t-1}^2 + \beta h_{i,t-1}, i = y, p$$

$$H_t = D_t \times R_t \times D_t$$

where ρ is the unconditional correlation that is constant. $X_t = [y_t , P_t]'$ and $e_t = [\varepsilon_{yt} , \varepsilon_{pt}]'$, where y_t is the turnover rate at time t and P_t is the housing price at time t. H_t represents the variance-covariance matrix, h_{it} represent the elements in H_t which is the conditional covariance between price and output shocks, R_t represents the matrix of dynamic conditional correlation.

Let $$R_t = Q_t^* \times Q_t \times Q_t^{*-1}$$

where $$Q_t = \begin{bmatrix} q_{y,yt} & q_{y,pt} \\ q_{y,pt} & q_{p,pt} \end{bmatrix}$$

$$Q_t^* = \begin{bmatrix} \sqrt{q_{y,yt}} & 0 \\ 0 & \sqrt{q_{p,pt}} \end{bmatrix}$$

Then, we can model Q_t and estimate the dynamic conditional correlation (R_t) by:

$$Q_t = (\bar{R} - a^2\bar{R} - b^2\bar{R}) + a^2\varepsilon_{t-1}\varepsilon'_{t-1} + b^2 Q_{t-1}$$

where $$\varepsilon_{i,t} = \frac{\mu_{it}}{\sqrt{h_{it}}}$$

$$\bar{R} = E(\varepsilon_t \varepsilon'_t)$$

where a and b represent the estimated parameters. The estimated dynamic conditional covariance of price and volume shock is plotted in Figure 3. It shows that most of the negative correlations of the price and transaction shocks are in the period from 1985 to 1998. This finding is consistent to the diagram mentioned in the introduction. Furthermore, this result indicates that the previous empirical findings regarding the relation between price and turnover rate can suffer from

structural changes. However, the estimated dynamic conditional correlation in Figure 3 does not answer the following question: What causes the instability in the housing market?

In Section 2, I have shown that how the number/proportion of first time buyer can cause structural changes in the relation between housing prices and turnover rate. In the following exercise, I examine the impact of changes in the number/proportion of first time homebuyers on the stability of the price-volume relationship by using the three-stage least-square model.

The Baseline Model

Table 2 is the result from the baseline model. Since some variables are likely to have seasonal effects, I include three seasonal dummies in this model. To be able to compare our results with the previous study, I exclude the interaction terms for price and turnover rate in this exercise. Also, this model does not control for the effect of the Subprime Mortgage crisis. Therefore, the baseline model is identical to the model used by Follain and Velz (1995). In this result, the numbers in bold indicate that the estimated coefficients have different sign from Follain and Velz. The sign of coefficients are different might because this model do not control for the Subprime Mortgage Crisis. For some variables, the coefficients that have different sign are insignificant. Nevertheless, the result shows that both the effect of price (PR) on turnover rate (N) and the effect of turnover rate on price are positive and significant, which conflicts to Follain and Velz's findings. Since we have already shown the evidence of instability in the price-volume correlation in the previous

exercise, the estimates in the baseline model can be biased due to structural changes. Therefore, in the next model, I use the interaction term to test whether the changes in the number/proportion of first time buyers induce structural changes.

Examining the impact of changes in the number of first time homebuyers

To test the structural changes, the first thing has to do is to find out in which dates do structural changes occur. There are several ways to do this (e.g. Boughton (1981) uses Chow test and Quandt's log-likelihood ratio to indicate the periods of structural change in the money demand in the U.S.) In this paper, I indicate the dates of structural changes based on theory. As noted in Section 2, the entry of the Baby Boom and the Baby Bust generation can cause changes in the number/proportion of first time homebuyers and the instability in the price-volume relationship. Mankiw and Weil (1989) suggest that young households start to enter into house market when they are 20 to30 years old. Therefore, I use a year dummy that equals to 1 from 1977 to 1987 for the period when the peak of the Baby Boom generation is 20 to 30 years old, and zero otherwise. For the period of the entry of the Baby Bust generation, I use a year dummy that equals to 1 from 1993 to 2003, and zero otherwise. Since the proportion of first time buyers in the housing market is also important, I use a year dummy equals to 1 for the years that have high first-time-buyer ratio, which is the period from 1985 to 2000. To test the null hypothesis that there is no structural change, these year dummies are included in the model through the interaction terms. If the price-volume relationship is stable, the coefficient in the interaction terms should be insignificant.

Table 3 is the result of the model includes the interaction term of price and baby-boom year dummy (lnPR*baby_boom), the interaction term of price and baby-bust year dummy (lnPR*baby_bust), the interaction term of turnover rate and baby-boom year dummy (N*baby_boom), the interaction term of turnover rate and baby-bust year dummy (N*baby_bust), and post-2008 year dummy to control for the impact of the Subprime Mortgage Crisis (dummy2008). The result shows that, except the interaction term of turnover rate and baby-bust year dummy, all of the coefficients in the interaction terms are significant. It indicates that there were structural changes in the price-volume relationship. Furthermore, since the year dummies are the period of the entry of the Baby Boom and the Baby Bust generation, it also shows that the structural changes can be explained by changes in the number of first time homebuyers.

The result in the first column shows that the coefficient of the prices is positive and significant. Since this coefficient captures the impact of the down payment constraint and nominal loss aversion, this finding is consistent with Stein (1985) and Genesover and Mayer (2001): An increase in the housing prices increases turnover rate. Also, the interaction term of price and baby-boom dummy indicates that the entry of the Baby Boom generation decreases the positive effect of housing price on turnover rate, which is consistent with the arguments in Section 2: The entry of the Baby Boom generation increases the number of first time homebuyers and reduces the impact of the down payment constraints. The result also shows that the entry of the Baby Bust generation decreases the number of first time buyers and increases the impact of the down payment constraints.

Changes in number of first time homebuyers also have impact on the effect of turnover rate. The result in third column shows that the entry of the Baby Boom generation increases the impact of turnover rate on the housing price. The entry of the Baby Bust generation, on the other hand, decreases this impact. However, the effect of entry of the Baby Bust generation is insignificant. The positive and significant impact of entry of the Baby Boom generation is consistent with Berkovec and Goodmand (1996) and Wheaton (1990)'s argument: An increase in number of first time buyer leads a positive shock in housing demand, which increases the impact of turnover rate on housing prices due to the effect of searching cost.

The impact of the entry of the Baby Bust generation on the effect of turnover rate is insignificant because a decrease in number of first time buyers do not necessary reduce the housing demand. The positive and significant coefficient of turnover rate in the third column is also consistent with the search and matching model.

The sign of other variables is not different from Table 2: The growth rate of employment (ΔlnEMP) has a positive and significant impact on the turnover rate. However, the impact of aggregate demand for housing (Q^d) on price is negative and insignificant, which is inconsistent with the theory. More than that, the forth column shows that the effects of real personal income (YR) and the cost of homeowner (UC) also conflicts to the theory. These results might be caused by the drawbacks of using the national level data.

Examining the impact of changes in the proportion of first time homebuyers

Table 4 is the model includes the interaction term of price and the year dummy for high first-time-buyer ratio (lnPR*first_time_buyer) and interaction term of turnover rate and the year dummy for high first-time-buyer ratio (lnN*first_time_buyer). The result in the first column shows that the positive effect of price on turnover rate was lower in the period when the proportion of first time buyer was high. The interaction term in the third column indicates that an increase of the proportion of first time buyer has a positive impact on the effect of turnover rate, which is also consistent with Berkovec and Goodmand (1996) and Wheaton (1990)'s argument. However, the effect of this interaction term is insignificant. For the other variables, their signs are not different from Table 3.

Over all, the results of Table 3 and Table 4 are consistent with the argument in Section 2: Changes in the number/proportion of first time buyers induce the instability in the price-volume relationship. An increase in the number/proportion of first time buyers reduces the impact of the down payment constraints. Furthermore, most of the coefficients of the post-2008 dummy are significant, which suggests that the Subprime Mortgage Crisis has a significant impact in the U.S. housing market.

Examining the impact of the inflation expectation

In this sub-section, I examine the impact of the inflation expectation on the price-volume relationship by including the interaction term of price and the change in inflation expectation (lnPR*Δ E(inflation)) and the interaction term of turnover

rate and the change in inflation expectation (N*Δ E(inflation)) in the model. The result is in Table 5.

In the first column, the interaction term shows that an increase in the inflation expectation enhances the impact of price on turnover rate. This finding is consistent with the discussion in Section 2: A rise in the inflation expectation reduces the willingness of first time buyer to enter into the housing market. As a result, the number/proportion of first time buyer decreases, which increases the impact of the down payment constraints. The result in the first column also shows that the effects of the housing price and the inflation expectation on turnover rate are both negative and significant. It looks like that the impact of the down payment is now captured by the interaction term: The negative impact of the inflation expectation is smaller as the housing price increases.

The result in the third column shows that the positive impact of turnover rate on price increases as the inflation expectation decreases. This finding is consistent with Berkovec and Goodmand (1996) and Wheaton (1990)'s argument: A decrease in inflation expectation increases the number/proportion of first time buyers and causes a positive demand shock. A positive demand shock increases the impact of turnover rate on price due to search cost. However, the impact of the inflation expectation can be asymmetric because the result in Table 3 implies that a decrease in the number of first time buyers does not necessary decreases the housing demand.

Examining the impact of the Subprime Mortgage Crisis in 2008

So far, I already show that changes in the number/proportion of first time buyers induce the instability in the price-volume relationship. Since the Subprime Mortgage Crisis should also influence the number/proportion of first time buyers as discussed in Section 2, it is worthwhile to examine the impact of the Subprime Mortgage Crisis on the stability in the price-volume relationship. In this sub-section, I include the interaction term of price and post-2008 dummy (lnPR*dummy2008) and the interaction term of turnover rate and post-2008 dummy (lnN*dummy2008) in the model. Table 6 is the result.

The interaction terms in the first and third column are all significant. It indicates that there was a structural change in the price-volume relationship after the Subprime Mortgage Crisis. Then, this finding implies that the previous empirical findings from Akkoyun, Arslan and Kanik (2012) can suffer from the structural change in 2008. We can also interpret the coefficients of the interaction terms from the impact of changes in the number/proportion of first time homebuyers. The positive coefficient of the interaction term in the first column implies that the impact of price-volume relationship increases after the Subprime Mortgage Crisis. Based on the argument in Section 2, after the Subprime Mortgage Crisis, there was a credit crunch and an increase in the minimum down payment, which blocks the entry of first time homebuyers. As a result, the reduction in the number of first time homebuyer enhances the impact of down payment constraints after 2008. The coefficient of the interaction term in the third column is negative and significant. It implies a decrease in the housing demand due to the crisis. Different from the

impact of the entry of the Baby Bust generation, the Subprime Mortgage Crisis not only decreases the number of first time buyers but also the number of the existing owner-occupiers. Indeed, the default rate of mortgage loan increases dramatically during the crisis. Therefore, a decrease in the housing demand reduces the effect of turnover rate on the housing prices.

Conclusion and future research:

The main findings of this paper are the following: Frist, this paper shows that there were structural changes in the price-volume relationship in the U.S. housing market, and the instability in this relationship is caused by the changes in the number/proportion of first time homebuyers. Second, the entry of the Baby Boom generation decreases the effect of the housing prices on turnover rate but increases the effect of turnover rate on the housing prices. On the other hand, the entry of the Baby Bust generation increases the effect of the housing prices on turnover rate significantly. However, it do not have significant impact on the effect of the housing prices on turnover rate because the entry of the Baby Bust generation does not reduce the number of the existing owner-occupiers. The above findings are able to explain the mixed evidence from the previous studies: the price-volume relationship changed from positive to negative, and then shifted back to positive. Third, the results show that an increase in the inflation expectation increases the effect of price on trading volume but decreases the effect of trading volume on price. This finding implies that the monetary policy such as the quantitative easing (QE) has impact on the price-volume relationship through its effect on the inflation expectation. The last

finding is that the Subprime Mortgage Crisis causes a structural change in the price-volume relationship in the U.S. housing market.

This paper investigates in the instability in the price-volume relationship in the U.S. housing market from a macroeconomic perspective. As I mentioned in Section 5, there are some weakness from using the national level data. In the future research, one might want to study the impact of first time homebuyers on the price-volume relationship from a microeconomic perspective. The National Longitudinal Survey of Young (NLSY) might have such micro data of first time homebuyers.

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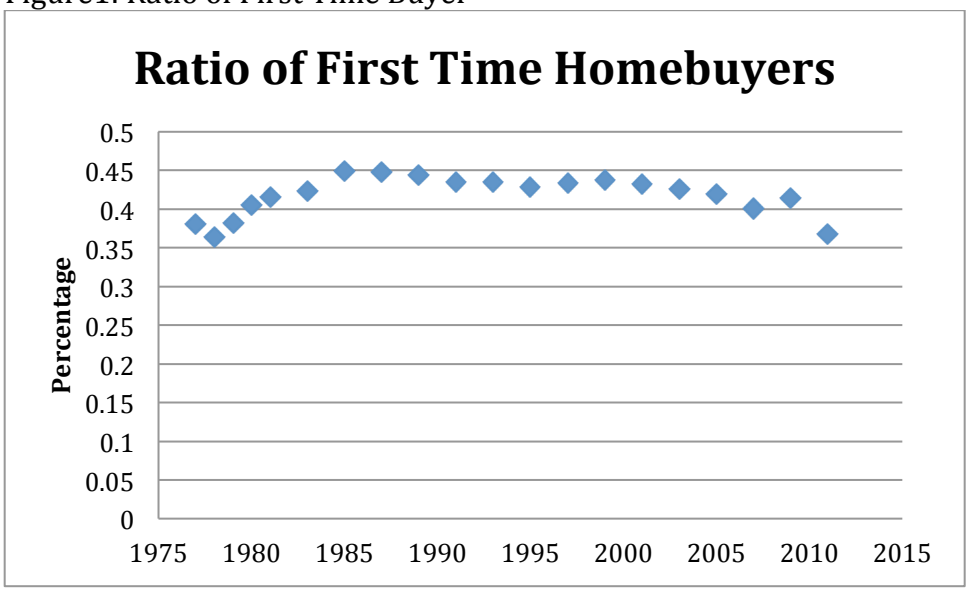
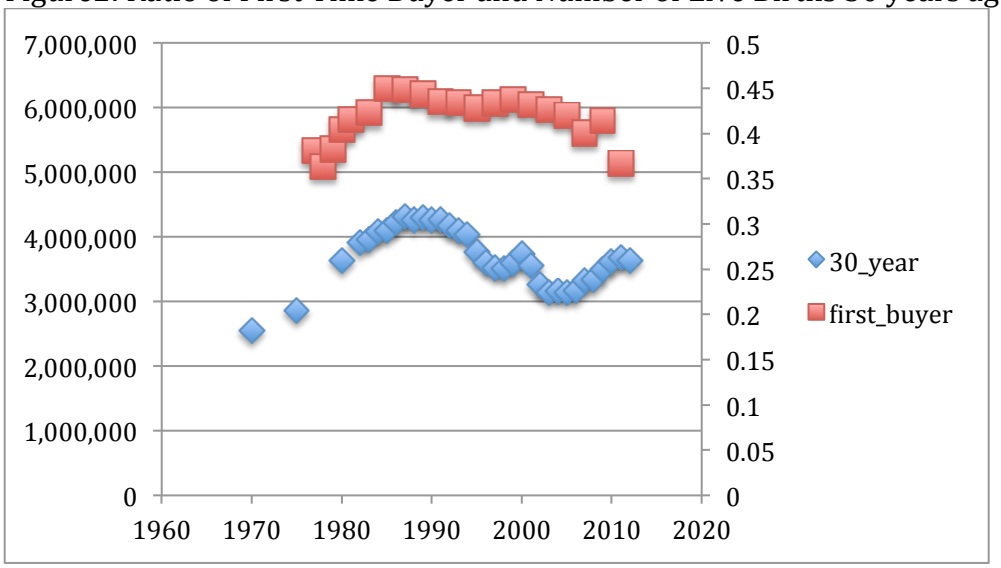
Figure1: Ratio of First Time Buyer



Data source: *America Housing Survey (AHS).*

Figure2: Ratio of First Time Buyer and Number of Live Births 30 years ago



Note: Left Y axis – Number of live births from The National Center for Health Statistic.
Right Y axis (%) – Ratio of first time home buyers from America Housing Survey (AHS).

Figure 3: Dynamic Conditional Correlation between the housing price and transaction shock

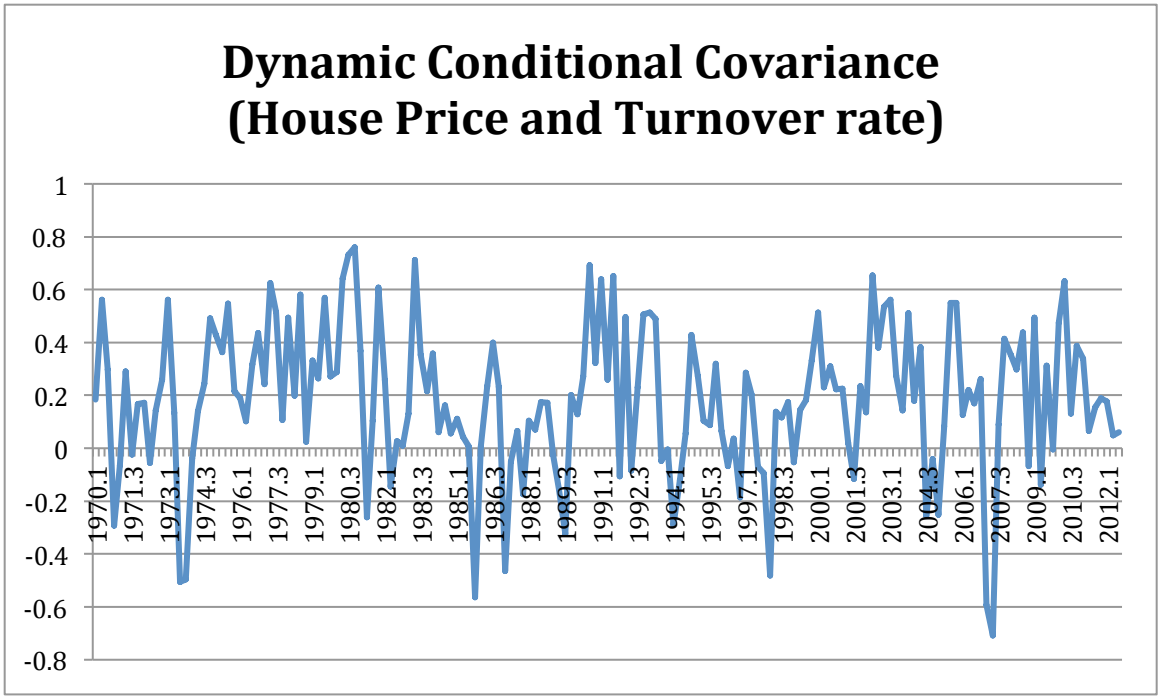


Table 1: Descriptive Statistic

	Average housing price (dollar)	Constant-Quality House Price Index	Existing single-family home sales	Number of owner-occupied units	Turnover rate
Mean	127517.5	0.45	3496.7	59770.38	0.0576765
Median	120600	0.44	3496.67	60348.1	0.0553273
Std. dev.	76128.11	0.03	1132.07	9459.233	0.0127261

Table 1 (Continue):

The index of house size and quality	Replacement cost index	Martgage rate	Total nonfarm employment (Thousands of Persons)	Population (Thousands of Persons)	Real personal income per capita (dollars)
2114.781	58.0	8.70	106197.4	254378.9	23749.64
2149.759	57.7	8.18	108267.7	249711	23432
306.2579	28.33	2.96	22497.34	34385.71	5875.98

Table 2: Baseline model
Three-Stage Least-Squares Regression Results with Seasonal Dummy

	N_t (1)	$lnKHH_t$ (2)	$lnPR_t$ (3)	$lnNHO_t$ (4)
Constant	-0.05	7.21	5.74	-9.00
	(-3.36)***	(85.88)***	(32.46)***	(-10.26)***
$lnPR_t$	**0.25**	-0.2		
	(7.06)***	(-1.02)		
lnN_t			**1.43**	
			(7.67)***	
$\Delta lnEMP_t$	0.88			
	(2.81)***			
$\Delta lnUC_t$	**0.01**			
	(0.81)			
ln UC_t		**0.007**		**0.07**
		(0.49)		(14.76)***
ln YR_t		0.0000213		**-9.14e-06**
		(21.26)***		(-5.3)***
$lnRPRC_t$			0.003	
			(10.8)***	
ln $Q^d{}_t$			**-0.3**	
			(-11.15)***	
$lnPOP_t$				1.61
				(21.89)***
Seasonal adjustment	Yes	Yes	Yes	Yes
Number of observations	165	165	165	165
Adjusted R^2	0.42	0.84	0.51	0.98

Note: Numbers under coefficients in parentheses are t statistics. The numbers in bold represent the signs of the coefficient are different from Follain and Velz (1995)

* The variable is significantly different from zero at 10% level

** The variable is significantly different from zero at 5% level

*** The variable is significantly different from zero at 1% level

Table 3: Test for Structural Changes (due to Baby Boom and Baby bust)
Three-Stage Least-Squares Regression Results with the Interaction Terms and Seasonal Dummy

	N_t (1)	$lnKHH_t$ (2)	$lnPR_t$ (3)	$lnNHO_t$ (4)
Constant	-0.12	7.37	4.88	-10.19
	(-6.10)***	(139.33)***	(4.20)***	(-11.88)***
$lnPR_t$	0.39	-0.67		
	(9.59)***	(-5.85)***		
$lnPR_t$*baby_boom	-0.03			
	(-5.94)***			
$lnPR_t$*baby_bust	0.03			
	(5.04)***			
lnN_t			1.41	
			(8.73)***	
lnN_t*baby_boom			0.24	
			(2.84)***	
lnN_t*baby_bust			-0.05	
			(-0.3)	
$\Delta lnEMP_t$	1.05			
	(3.29)***			
$\Delta lnUC_t$	0.01			
	(-0.42)			
ln UC_t		-0.03		0.06
		(-3.05)***		(10.99)***
ln YR_t		0.00		-0.00
		(43.3)***		(-6.31)***
$lnRPRC_t$			0.003	
			(4.50)***	
ln $Q^d{}_t$			-0.25	
			(-3.89)***	
$lnPOP_t$				1.71
				(23.73)***
Dummy2008	0.001	-0.18	-0.04	-0.03
	(-0.3)	(-20.71)***	(-6.12)***	(-6.74)***
Seasonal adjustment	Yes	Yes	Yes	Yes
Number of observations	165	165	165	165
Adjusted R^2	0.56	0.96	0.76	0.99

Note: Numbers under coefficients in parentheses are t statistics. Baby boom is a year dummy that equals to 1 if years are between 1977 and 1987. Baby Bust is a year dummy that equals to 1 if years are between 1993 and 2003, zero otherwise.

* The variable is significantly different from zero at 10% level

** The variable is significantly different from zero at 5% level

*** The variable is significantly different from zero at 1% level

Table 4: Test for Structural Changes (due to the ratio of First Time Home Buyers) Three-Stage Least-Squares Regression Results with the Interaction Terms and Seasonal Dummy

	N_t (1)	$lnKHH_t$ (2)	$lnPR_t$ (3)	$lnNHO_t$ (4)
Constant	-0.03	7.31	1.4	-9.62
	(-1.72)*	(135.89)***	(0.47)	(-11.23)***
$lnPR_t$	0.21	-0.57		
	(5.83)***	(-4.93)***		
$lnPR_t$*first_time_buyer	-0.04			
	(-9.19)***			
lnN_t			1.04	
			(1.55)	
lnN_t*first_time_buyer			1.88	
			(1.46)	
$\Delta lnEMP_t$	1.22			
	(3.69)***			
$\Delta lnUC_t$	0.02			
	(1.44)			
ln UC_t		-0.03		0.07
		(-2.61)***		(12.08)***
ln YR_t		0.00		-0.00
		(43.65)***		(-5.52)***
$lnRPRC_t$			0.002	
			(3.97)***	
lnQ_{dt}			-0.06	
			(-0.4)	
$lnPOP_t$				1.66
				(23.08)***
Dummy2008	-0.01	-0.18	-0.05	-0.03
	(-3.46)***	(-21.26)***	(-3.24)***	(-6.33)***
Seasonal adjustment	Yes	Yes	Yes	Yes
Number of observations	165	165	165	165
Adjusted R^2	0.53	0.96	0.27	0.99

Note: Numbers under coefficients in parentheses are t statistics. First time buyer is a year dummy that equals to 1 if years are between 1985 and 2003, zero otherwise.

* The variable is significantly different from zero at 10% level

** The variable is significantly different from zero at 5% level

*** The variable is significantly different from zero at 1% level

Table 5:
Three-Stage Least-Squares Regression Results with the Interaction Terms of inflation expectation and Seasonal Dummy

	N_t (1)	$lnKHH_t$ (2)	$lnPR_t$ (3)	$lnNHO_t$ (4)
Constant	0.34	7.42	4.89	-6.07
	(5.04)***	(108.17)***	(11.24)***	(-6.90)***
$lnPR_t$	-0.56	-0.44		
	(-3.87)***	(-4.58)***		
$lnPR_t$*Δ E(inflation)$_t$	0.28			
	(6.74)***			
ΔE(inflation)$_t$	-0.14		0.04	
	(-6.90)***		(3.38)***	
lnN_t			3.98	
			(3.91)***	
lnN* Δ E(inflation)$_t$			-0.52	
			(-2.69)***	
Δ$lnEMP_t$	0.47			
	(1.01)			
Δ$lnUC_t$	0.01			
	(0.4)			
ln UC_t		-0.06		0.02
		(-3.94)***		(3.03)***
ln YR_t		0.00		-0.00
		(20.25)***		(-4.20)***
$lnRPRC_t$			0.002	
			(12.01)***	
lnQ^d_t			-0.26	
			(-10.26)***	
$lnPOP_t$				1.38
				(19.00)***
Dummy2008	-0.003	-0.17	-0.02	-0.03
	(-1.12)	(-19.79)***	(-2.29)**	(-7.91)***
Seasonal adjustment	Yes	Yes	Yes	Yes
Number of observations	165	165	165	165
Adjusted R^2	0.31	0.94	0.75	0.99

Note: Numbers under coefficients in parentheses are t statistics.
* The variable is significantly different from zero at 10% level
** The variable is significantly different from zero at 5% level
*** The variable is significantly different from zero at 1% level

Table 6:
Three-Stage Least-Squares Regression Results with the Interaction Terms of Subprime Mortgage Crisis and Seasonal Dummy

	N_t (1)	$lnKHH_t$ (2)	$lnPR_t$ (3)	$lnNHO_t$ (4)
Constant	-0.08	6.94	5.56	-8.94
	(-3.57)***	(76.04)***	(13.20)***	(-10.23)***
$lnPR_t$	0.29	0.06		
	(6.20)***	(0.31)		
$lnPR_t$*dummy2008	0.05			
	(4.5)***			
lnN_t			1.01	
			(5.79)***	
lnN_t*dummy2008			-1.22	
			(-7.87)***	
$\Delta lnEMP_t$	1.58			
	(3.83)***			
$\Delta lnUC_t$	0.03			
	(2.07)**			
ln UC_t		0.04		0.08
		(2.89)***		(14.36)***
ln YR_t		0.00		0
		(29.82)***		(-4.86)***
$lnRPRC_t$			0.003	
			(13.19)***	
lnQ^d_t			-0.29	
			(-12.34)***	
$lnPOP_t$				1.61
				(21.81)***
Seasonal adjustment	Yes	Yes	Yes	Yes
Number of observations	165	165	165	165
Adjusted R^2	0.04	0.85	0.72	0.99

Note: Numbers under coefficients in parentheses are t statistics.
* The variable is significantly different from zero at 10% level
** The variable is significantly different from zero at 5% level
*** The variable is significantly different from zero at 1% level