

REAL ESTATE AND MORTGAGE CRISIS  
A STUDY ON THE UNITED STATES

A Master's Thesis

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To Nami Kadriye and Zeynep

REAL ESTATE AND MORTGAGE CRISIS  
A STUDY ON THE UNITED STATES

The Institute of Economics and Social Sciences  
of  
Bilkent University

by

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in

THE DEPARTMENT OF  
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BİLKENT UNIVERSITY  
ANKARA

May 2009

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## ABSTRACT

### REAL ESTATE AND MORTGAGE CRISIS A STUDY ON THE UNITED STATES

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Like every asset price boom, the US Real Estate Boom expanded the economy until the burst occurred. Although the existence of an “irrational” boom was apparent, it has been questioned whether the increase suggested a bubble. This thesis analyzes the evolution of the US Real Estate Crisis and suggests that the real estate price increase was a bubble. A time series analysis is performed for the years 1990-2006, using monthly data on the US house prices, consumer prices, income per capita, population, unemployment rate, mortgage rate and housing starts. The results indicate that consumer prices and income per capita explain the trend in the housing prices, prior to the bubble. During the bubble, except population the fundamentals fall short in explaining the housing prices.

Keywords: Real Estate Prices, Mortgage Crisis

## ÖZET

### GAYRİMENKUL VE MORTGAGE KRİZİ AMERİKA BİRLEŞİK DEVLETLERİ ÜZERİNE BİR ÇALIŞMA

Karataş, Bilge

Mastır, Ekonomi Bölümü

Tez Yöneticisi: Yrd. Doç. Dr. Taner Yiğit

Mayıs 2009

Her varlık fiyat patlaması gibi, ABD Emlak Fiyatları Patlaması da ilk etapta ekonominin genişlemesine sebep oldu. Her ne kadar "mantıksız" patlamanın varlığı belli olsa da, bu artışın balon olup olmadığı sorgulanmıştır. Bu tez ABD Emlak krizinin geçirdiği evrimi analiz etmekte ve emlak fiyat artışının balon olduğunu göstermektedir. Araştırmada 1990-2006 yılları için ampirik zaman serisi analizi, ABD ev fiyatları, tüketici fiyatları, kişi başına düşen gelir, nüfus, işsizlik oranı, ipotekli konut oranı ve yeni konut sayıları aylık verileri kullanılarak yapılmıştır. Analizin sonucu tüketici fiyatları ve kişi başına düşen gelirin konut fiyatlarındaki balon eğilimi öncesinde konut fiyatlarındaki artışı açıkladığını göstermektedir. Konut fiyatları balonu sırasında, nüfus haricinde temel hiçbir indikatörün konut fiyat artışı üzerinde etkisi yoktur.

Anahtar Kelimeler: Emlak Fiyatları, Mortgage Krizi

## TABLE OF CONTENTS

|                                                                                               |     |
|-----------------------------------------------------------------------------------------------|-----|
| ABSTRACT .....                                                                                | iii |
| ÖZET .....                                                                                    | iv  |
| TABLE OF CONTENTS .....                                                                       | v   |
| LIST OF TABLES .....                                                                          | vi  |
| LIST OF FIGURES .....                                                                         | vii |
| CHAPTER I: INTRODUCTION .....                                                                 | 1   |
| CHAPTER II: THE EVOLUTION OF THE REAL ESTATE CRISIS.....                                      | 4   |
| II.1. First Phase of the Real Estate Crisis.....                                              | 4   |
| II. 1. 1. Indicators of the Bubble .....                                                      | 7   |
| II.1.1.1. The Affordability Index.....                                                        | 7   |
| II.1.1.2. House Prices to Rents Ratio.....                                                    | 8   |
| II.1.1.3. House Prices and Consumer Prices.....                                               | 9   |
| II.2. Second Phase of the Real Estate Crisis.....                                             | 11  |
| II.3. Third Phase of the Real Estate Crisis.....                                              | 16  |
| CHAPTER III: LITERATURE REVIEW ON BUBBLES.....                                                | 21  |
| CHAPTER IV: EMPIRICAL ANALYSIS: The Relation Between House Prices<br>and Consumer Prices..... | 26  |
| IV.1. Model.....                                                                              | 26  |
| IV.2. Data.....                                                                               | 27  |
| IV.3. Results.....                                                                            | 28  |
| IV.3.1. Results for the period 1990-1999.....                                                 | 30  |
| IV.3.2. Results for the period 2000-2006.....                                                 | 32  |
| CHAPTER V: POLICY IMPLICATIONS.....                                                           | 35  |
| CHAPTER VI: CONCLUSION.....                                                                   | 37  |
| SELECTED BIBLIOGRAPHY.....                                                                    | 39  |
| APPENDIX 1.....                                                                               | 42  |
| APPENDIX 2.....                                                                               | 46  |



## LIST OF TABLES

|    |                                                                              |    |
|----|------------------------------------------------------------------------------|----|
| 1. | Heteroskedasticity and Autocorrelation Consistent OLS for<br>1990-1999 ..... | 31 |
| 2. | Heteroskedasticity and Autocorrelation Consistent OLS for<br>2000-2007.....  | 33 |

## LIST OF FIGURES

|     |                                                                                        |    |
|-----|----------------------------------------------------------------------------------------|----|
| 1.  | Homeownership Rate for the USA (1965-2005) .....                                       | 6  |
| 2.  | Housing Affordability Index for the USA (Jan 2003-Aug 2007).....                       | 8  |
| 3.  | US House Prices to Rents Ratio (Jan 2000-Aug 2007) .....                               | 9  |
| 4.  | Ratio of Case & Shiller Index to Consumer Price Index<br>(Jan 1990-Sep 2007) .....     | 10 |
| 5.  | OFHEO House Price Index History for the USA (1990 Q1-2007 Q2) .                        | 11 |
| 6.  | Federal Reserve Short Term Funds Rate (1990-2007).....                                 | 13 |
| 7.  | Adjustable-Rate Mortgages Delinquencies and Foreclosures<br>(1998-2007) .....          | 14 |
| 8.  | Early Payment Defaults.....                                                            | 15 |
| 9.  | Quarterly Housing Vacancy Rate for the US (1995 Q1-2007 Q3).....                       | 16 |
| 10. | New Housing Units Started in the USA (Jan 2000-Aug 2007).....                          | 17 |
| 11. | Construction Expenditures in the US (1993-2007).....                                   | 17 |
| 12. | Nominal and Real National Average Contract Mortgage Rates<br>(Jan 1995-Sep 2007) ..... | 23 |

## **CHAPTER I**

### **INTRODUCTION**

With the crash of the US mortgage market in the beginning of 2007, high amount of financial companies declared their bankruptcy and many financial market leaders have experienced considerable decreases in their stock prices which have also affected global stock markets. Mortgage crisis has not only affected financial firms with poor lending standards but also created serious consequences for the whole US economy.

After the stock market boom and bust and terrorist attacks in the United States in 2001, when the GDP growth was only 0.5%, the economy started to recover again with the increase in investment which has had positive impact on both employment and consumer demand. Rising real estate prices has made a huge contribution in regaining the economic activities through high level of consumer confidence and improved economic expectations.

However the increase in real estate prices was far more than the inflation rate. According to the S&P/Case-Shiller Home-Price Index, house prices in the US increased by 124% between 1997 and 2006. This was one of the main indicators that

the rise in the house prices could have been a “bubble”, which has been defined by Kindleberger (1987) as:

a sharp increase in the price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers – generally speculators interested in profits from trading in the asset rather than its use or earning capacity”.

During a house price bubble, homebuyers think that a home that they would normally consider too expensive for them is now acceptable purchase because they will be compensated by significant further price increases (Case and Shiller, 2003: 299-362).

Various economists analyzed this phenomenon in the US and have come to different conclusions. According to Case and Shiller (2003: 299-362), the rise in housing prices clearly indicated a housing bubble. On the other hand McCarthy and Peach (2005), made counter argument that the high house prices were not off the line considering the fundamentals. This question has been answered in view of the sub-prime mortgage crisis in the beginning of 2007 that has affected not only US economy but the global society. Actually, Shiller had been arguing that there would be epic decline in house prices. He said “People think that home prices go up a lot, but home prices in 1990 were at about the same level as in 1890.” (Fox, 2007).

According to Allen and Gale (2000: 236-255), asset bubbles have three distinct phases: The first phase is the expansion of credit with the increase in lending which is the result of financial liberalization followed by the central bank. With the increase in lending, asset prices (such as real estate or stock) start to increase. In the second phase the rise continues for several years until the burst of the bubble leading to a collapse in the asset prices. Bursting happens when people’s expectations about

the future prices start to change. In the third phase many agents that have borrowed to buy these assets at inflated prices start to default, leading to banking and foreign exchange crises. Thus, the burst of the bubble affects the whole economy by disruption in financial and real activity (output reduction, deflationary pressures) and this can last for several years. The U.S.A. has entered the third stage in February 2007, when the subprime mortgage crisis became the headline issue with the high rates of delinquencies and foreclosures.

In this thesis, the US mortgage crisis is analyzed, with a further focus on providing an empirical analysis on capturing the refraction in the correlation between increase in the house prices and consumer prices.

The remainder of this thesis is as follows: In the second chapter the evolution of the mortgage crisis is summarized by dividing the crisis in the three phases that have been described by Allen and Gale. The third chapter reviews the literature about asset and real estate bubbles. The fourth chapter focuses on the analysis which attempts to capture the change in the pattern of the percent increase in house prices and to empirically show that the effect of consumer prices on house prices disappears with the start of the bubble. For this purpose, the model by Case and Shiller (2003) is employed, using monthly time series data for the U.S. economy between 1990 and 2006. Policy Implications will be proposed in the fifth chapter and the conclusion will be given in the sixth chapter.

## **CHAPTER II**

### **THE EVOLUTION OF THE MORTGAGE CRISIS**

#### **II.1.First Phase of the Real Estate Crisis: The Start and Growth of Bubble**

From the beginning of 2001, Federal Reserve started to follow expansionary monetary policy with the cut in the short term Fed Funds rate by half a percentage point, to 6%. In addition, after the dotcom burst and terrorist attacks, with the fear of deflation Fed continued cutting the interest rates until they reached 1% in 2003 which was the lowest rate of 45 years. The main reason for this policy was to avoid more severe downturn and panic in the financial system by injecting ample liquidity in to the markets (Belke and Wiedmann, 2005). It has been known that high liquidity increases the chances of bubbles. Volatility of stock markets has made returns to property more attractive encouraging a portfolio shift from equities to real estate. With low interest rates, homebuyers can comfortably service bigger mortgages and support higher house prices, resulting in an increasing demand.

On the other side of the phenomenon there has been an increase in the sub-prime mortgages starting from the mid-1990s. Sub-prime mortgages are loans made to borrowers who are perceived to have high credit risk, often because they lack a

strong credit history or have other characteristics that are associated with high probabilities of default (Bernanke, 2007). This distinction can be made by looking at the loan to value (LTV) and debt service to income (DTV) ratios. Borrowers who have DTIs above 55% or LTVs over 85% are likely to be considered sub-prime (Kiff and Mills, 2007) and they are demanded higher interest payments, generally 2 percent higher, than prime borrowers. Sub-prime market has become active with the introduction of adjustable-rate-mortgages<sup>1</sup> in 1982. In 1986, the Tax Reform Act left residential mortgages as the only consumer loans on which the interest was tax deductible. This made home equity withdrawal a preferred means of financing home improvements and personal consumption relative to other forms of consumer loans. Besides this, automated underwriting<sup>2</sup> has led to easier credit scoring with technological advances and securitization<sup>3</sup> made the mortgages easily tradable with the introduction of mortgage-backed securities. These improvements have helped the development of the sub-prime mortgage market by relaxing of the credit rationing of the borrowers who were previously considered too risky by lenders (Kiff and Mills, 2007).

Thus with the increase in sub-prime lending there has been a considerable increase in the homeownership rate<sup>4</sup> since the households that might not reached the resources before have easy access to the mortgages (Figure 1). Non-conforming sub-prime mortgages have rapidly taken the place of the mortgages that are guaranteed

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<sup>1</sup> Interest rate is periodically adjusted based on an index, for the U.S.A. it can be LIBOR, COFI, MTA, etc. This suggests that payments of borrower may change (in the interest rate resets).

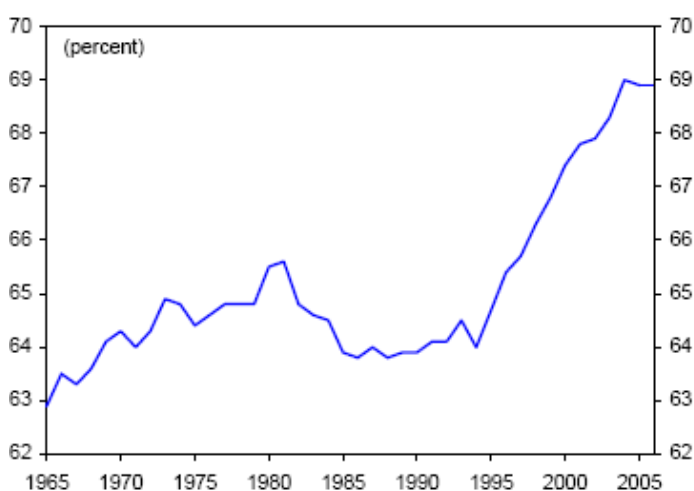
<sup>2</sup> Underwriting is done to determine risk-based price by looking at the credit history and LTVs of the borrowers.

<sup>3</sup> Securitization which allows intermediaries to pool large number of mortgages and to sell the resulting cash flows to investors has separated the original lender from borrower who is the ultimate bearer of credit risk.

<sup>4</sup> The number of owner-occupied housing units is divided by the number of occupied housing units or households.

by Federal Housing Association (FHA) which has less flexibility and low lending limits. By 2006, only 51% of mortgage loans were conforming loans (requires detailed credit history) and the remaining part was consisting of Alt-A, a category between prime and sub-prime mortgages, and sub-prime loans both of which contain high delinquency risks.

**Figure 1: Homeownership Rate for the USA (1965-2005)**



Source: U.S. Census Bureau

The increase in the mortgage borrowing has led to a rise in the demand for houses. However, the supply side of the industry cannot respond immediately to the increased demand due to the time lag of new construction. Thus, real estate market is mainly driven by demand factors, at this case by low interest rates. Therefore this has led to the increase of the house prices.



### **II.1.1. The Indicators of the Bubble**

There are various indicators that can be taken into account in order to decide if the increase in the real estate prices in the US showed bubble symptoms. In this part the most crucial three indicators are discussed: The Affordability Index, the ratio of house prices to rents and the relation between house prices and consumer prices.

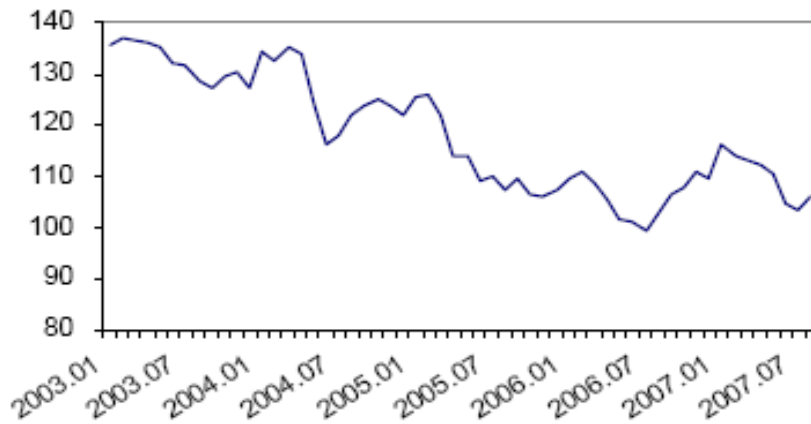
#### **II.1.1.1. The Affordability Index**

From the definition of Realtors, Affordability Index shows the ability of a median income household to afford the payments of a mortgage loan. For this index 100 means that the household has enough income to pay the down payments and monthly mortgage payments of the mortgage loan. If the index is above 100, then the median income household has more than enough income to afford the mortgage payments. (National Association of REALTORS)<sup>5</sup> From Figure 2, although the affordability index has been above 100, it has been decreasing gradually since 2003. The decrease from January 2003 to August 2007 is 22% which means that debts of median income households have been increasing relative to their income.

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<sup>5</sup> The index takes both fixed-rate-mortgages and adjustable-rate-mortgages into account and calculates a composite mortgage payment.

**Figure 2: Housing Affordability Index for the U.S.A. (Jan 2003-Aug 2007)**



Source: Research Division of the National Association of REALTORS

#### II.1.1.2. House Prices to Rents Ratio

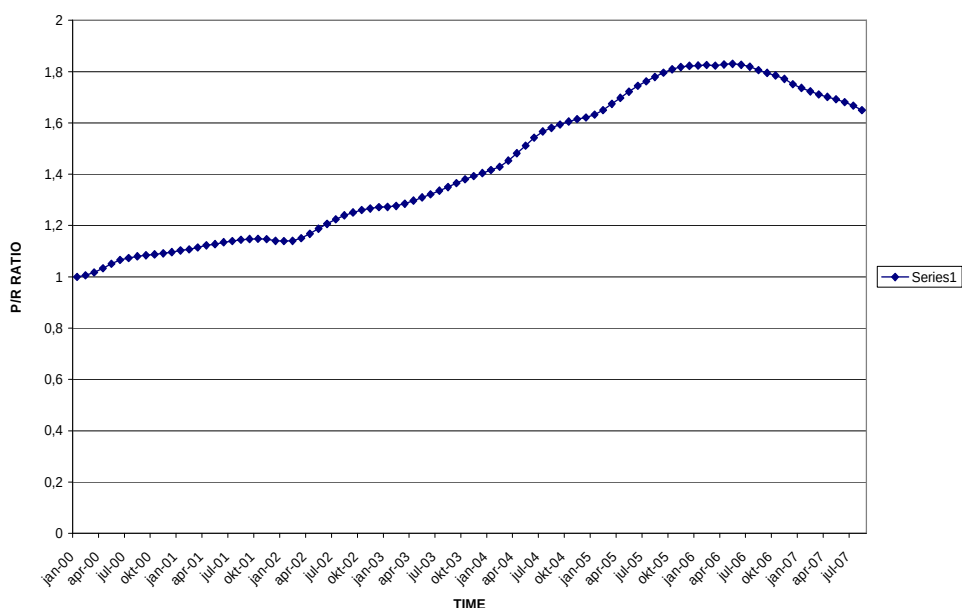
House prices to rents ratio has the same intuition as the price to earning ratio, known as “Gordon Equation”: The market value of an asset is determined by the present risk adjusted discounted value of its expected income stream.<sup>6</sup> So, the price of a house should reflect the future benefits of ownership which is indicated by rental income earned by a landlord or the implicit rent saved by an owner-occupier (The Economist, 2003). If Price/Rents ratio is high, meaning the house prices are increasing faster relative to rents, then the houses are bought because of the expectation of future increase in the prices. In the US there has been a divergence between house rents and prices, the ratio reached its highest value in May 2006 with

$$^6 \frac{P_t}{E_t} = \frac{\delta(1+g)}{i+\rho-g}$$

Where  $P_t$  is the price of the asset,  $E_t$  is the earnings,  $\delta$  is percentage share of earnings,  $g$  is the growth rate of earnings,  $i$  is the risk-free interest rate and  $\rho$  is the risk premium. This equation indicates that the price of an asset should rise as the risk-free interest rate and/or risk premium falls. (IMF World Economic Outlook, 2000:78-79)

83% (see Figure 3), which clearly indicates that individuals buy houses for speculative reasons. These buyers do not base their investment decisions on future income streams from rents but on higher resale price at a future date.

**Figure 3: US House Prices to Rents Ratio (Jan 2000- Aug 2007) (2000=100)**

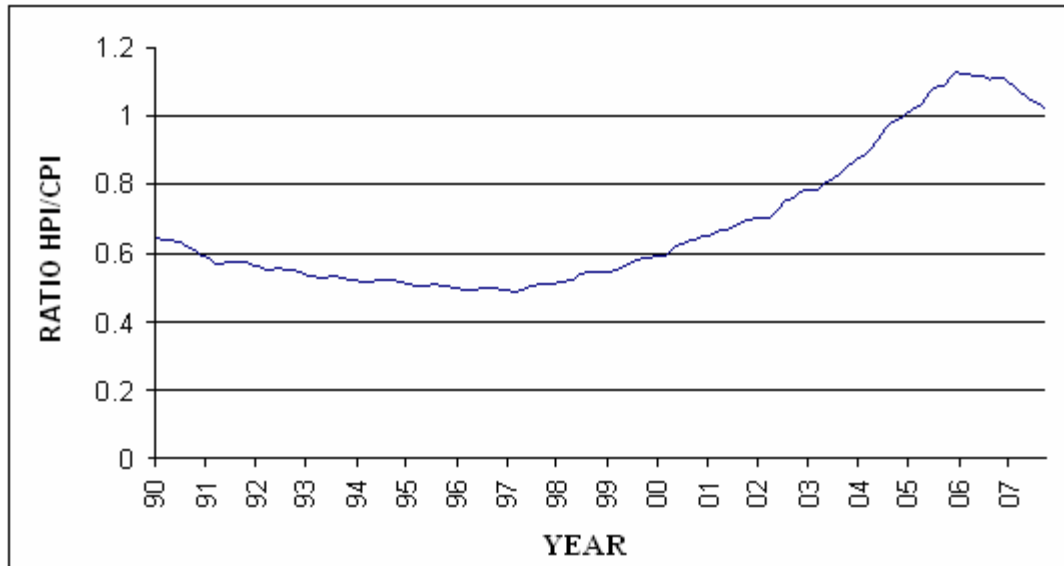


Sources: Standard&Poor's Case-Shiller Index and U.S. Bureau of Labor Statistics CPI, Rent of Primary Residence (all urban consumers)

### II.1.1.3. House Prices and Consumer Prices

Former to the housing bubble, it has been said that house prices and inflation tended to move parallel. However, the dramatic increase in the house prices has broken down this relationship between consumer prices and house prices. Figure 4 depicts the monthly trend of the ratio between the house price index to the consumer price index, for the period between January 1990 and September 2007.

**Figure 4: Ratio of Case & Shiller House Price Index to Consumer Price Index (January 1990-September 2007)**



Sources: Standard&Poor's Case-Shiller Index and U.S. Bureau of Labour Statistics CPI (all urban cons)

It can clearly be seen from this figure that after 2000, the increase in house prices outweighed the increase in consumer prices. The house prices doubled the consumer price index in 2005, when the house prices reached the peak. Further empirical focus is given to this relationship in the succeeding chapters.

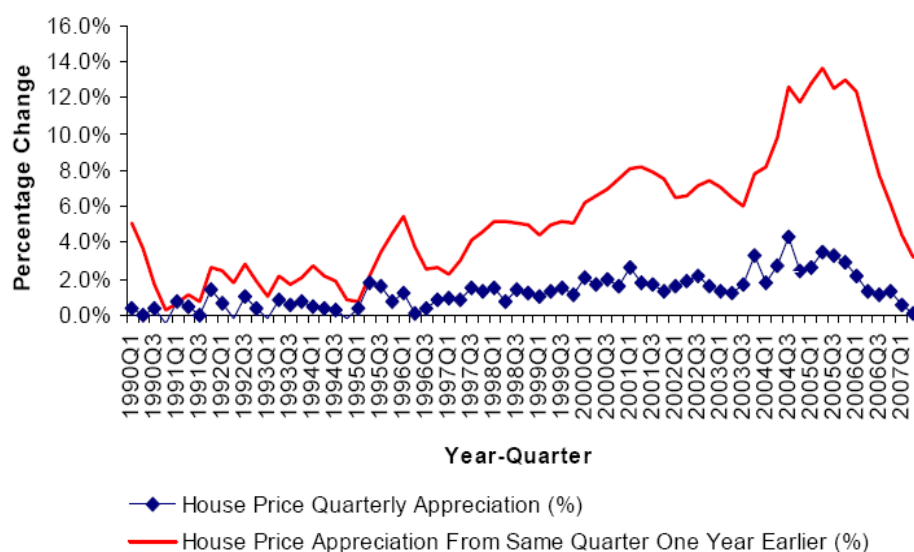
Consequently, these indicators precisely suggest that there have been fundamental misalignments in the US real estate market.

## II.2. Second Phase of the Real Estate Crisis: The Peak and Burst of the Bubble

Office of Federal Housing Enterprise Oversight (OFHEO) conducts various researches on the house prices and publishes house price index for the U.S.A. every quarter<sup>7</sup>. According to the report of OFHEO the house prices in the United States has increased by 50.76% in five years as of June 2007. The yearly appreciation of the house prices was 10%. For second quarter of 2005, where the appreciation reached its peak, the annualized growth of the prices was 14.05 %.

As credit becomes more freely available, there is a positive wealth effect: if lenders increase their loans relative to house values and borrowers' incomes, the negative effect of rising property prices on first-time buyers' spending will fall. Homeowners can borrow or refinance non-housing debts using the increased collateral value of their property.

**Figure 5: OFHEO House Price Index History for the USA (1990 Q1-2007 Q2)**



Source: Office of Federal Housing Enterprise Oversight (OFHEO)

<sup>7</sup> OFHEO and Case&Shiller use the similar index construction methodology.

The increase in the prices led to huge gains in the US economy until its rapid burst. Despite the sharp fall in share prices and a worldwide plunge in industrial production, business investment and profits, consumer spending has held up relatively well, supported by low interest rates and the wealth-boosting effects of rising house prices. Boosting wealth not only increased spending, but also allowed owners to borrow more against the rising value of their homes (The Economist, 2002).

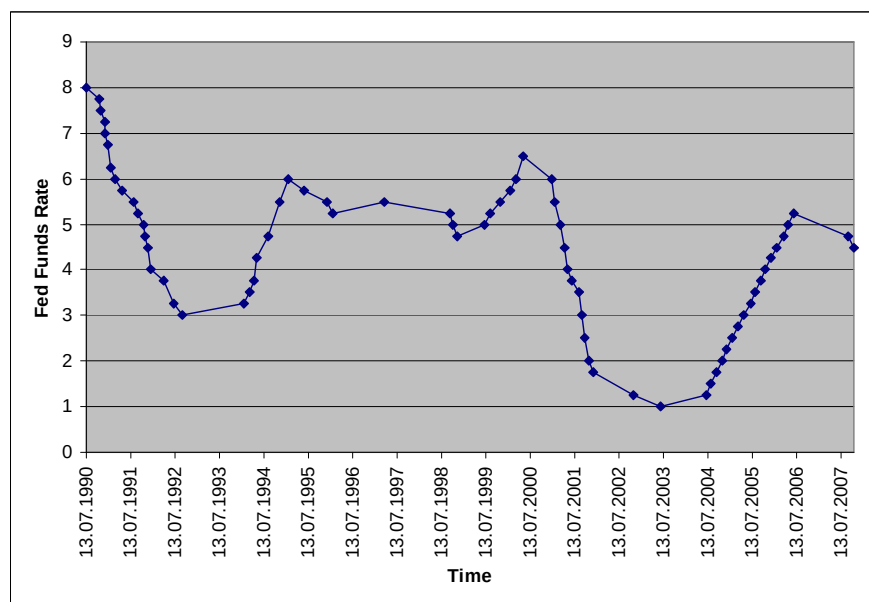
The number of housing starts jumped from 1.5 million at an annual rate in August 2000 to a peak 2.3 million in January 2006. In 2005, housing construction accounted for 6.2% of GDP which was the highest rate since 1950 (The Economist, 2007). This has also led to increasing employment rates in the real estate market. Real estate, residential construction and three other housing related Labor Department job categories together add up to 6.6% of U.S. employment. They accounted for 46% of the new jobs created in the U.S. between January 2001 and May 2006 (Fox, 2007).

Also, financial markets gained a lot from the housing bubble. According to Wall Street Journal, from 2004 to 2006, more than 2500 banks, thrifts, credit unions and mortgage companies made a combined \$1.5 trillion in the risky high-interest-rate mortgage loans.

This positive image, however, did not last long. In 2004, Federal Reserve started to increase its short term funds rate gradually from 1%, until it reached to 5.25% in June 2006 (see Figure 6). As Shiller (2000) argued, tightened monetary

policy, which was the rise in the interest rates, is associated with the bursting of the bubbles.

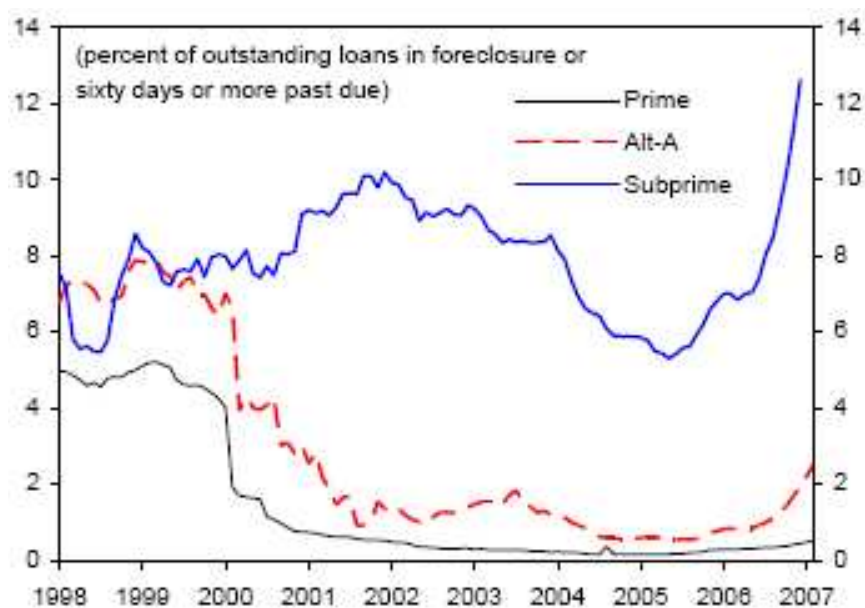
**Figure 6: Federal Reserve Short Term Funds Rate (1990-2007)**



Source: Federal Reserve

With the slow-down in the increase of the house prices and the upward movement in the interest rates on both fixed and adjustable rate mortgages in 2006, there has been a rapid deterioration in the mortgage loans originated in 2006. Formerly, rising house prices combined with low interest rate levels made prepayment easy for distressed borrowers since their equity had an increasing value. However, increased monthly payments and decreased equity value forced subprime borrowers to default on their payments. The rise in delinquencies has led to the rise in the foreclosures. In the fourth quarter of 2006, about 310,000 foreclosure proceedings were initiated. However the quarterly average for the previous two years was 230,000. In the second quarter of 2007, almost 3% of subprime loans entered foreclosure (The Economist, 2007).

**Figure 7: Adjustable-Rate Mortgages Delinquencies and Foreclosures (1998-2007)**



Source: Citigroup

As the underlying pace of mortgage originations began to slow, but with investor demand for securities with high yields still strong, some lenders evidently loosened underwriting standards. So-called “risk-layering”, combining weak borrower credit histories with other risk factors, such as incomplete income documentation or very high cumulative LTV, became more common. These looser standards were likely an important source for the rise in “early payment defaults”(see Figure 8)--defaults occurring within a few months of origination--among subprime ARMs, especially those originated in 2006 (Bernanke, 2007).



**Figure 8: Early Payment Defaults**

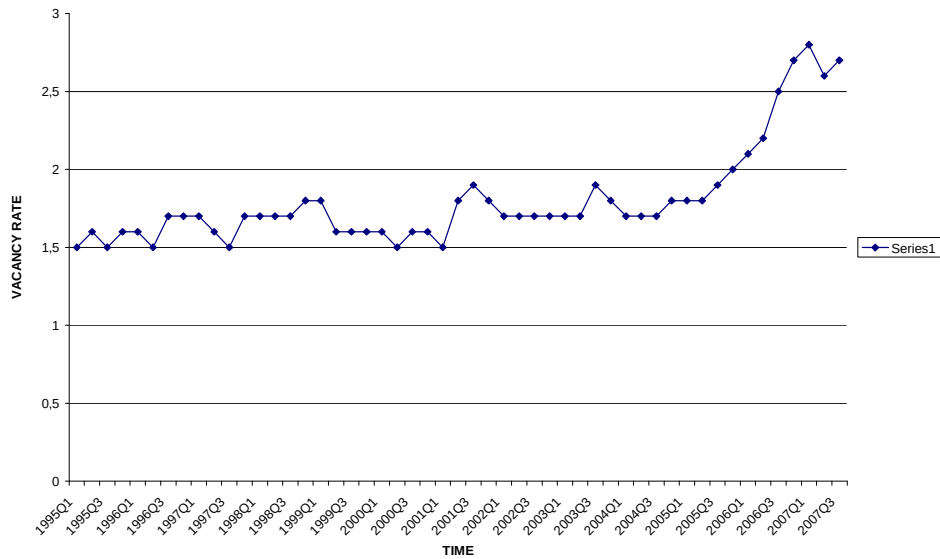


Source: Credit Suisse and Loan Performance

The improvements in the mortgage market that are mentioned before has also increased the rates of delinquencies in the market. With securitization assessing the risk was particularly difficult when risky mortgages were packed into securities that combined other types of risk profiles. Hence, lenders have bought mortgage-backed securities not knowing the risk they entailed. Mostly banks with subprime-specialist subsidiaries and speciality finance companies have adversely affected from subprime crisis. Since mid-2006, some non-depository, poorly capitalized firms representing 40% of 2006 subprime originations have closed down operations, declared bankruptcy or been bailed out (Kiff and Mills, 2007).

Foreclosures have led to an increase in the vacancy rates because owners have had to leave their properties. As can be seen from the Figure 9, the housing vacancy rate for the US has started to rise sharply since the second quarter of 2006, with the increase in the delinquency rates.

**Figure 9: Quarterly Housing Vacancy Rate for the US (1995 Q1-2007 Q3)**

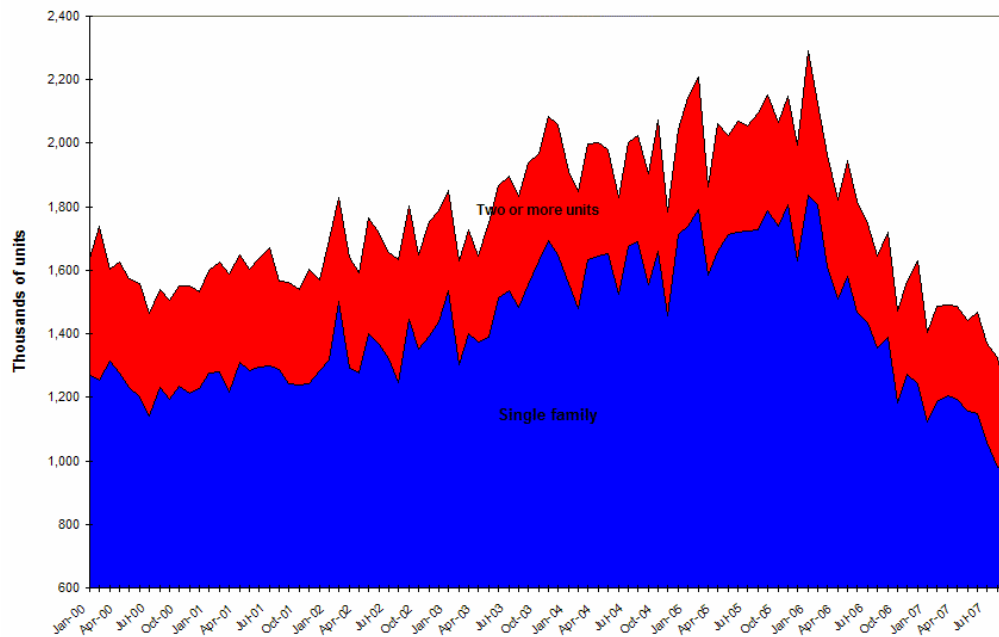


Source: U.S. Census Bureau (Based on current population survey)

### **II.3. Third Phase of the Real Estate Crisis: The Impacts on the Economy**

The rise in the demand on houses, forced the supply side of the market to become active. New constructions have increased rapidly until 2006. While demand was beginning to decline, homebuilders were still running at a high speed. Because of the time lag between demand and supply in the real estate industry, the slowing down in construction, which can be clearly seen from the decline in the number of housing starts (the number of new constructions), in Figure 10, has started in the second quarter of 2006.

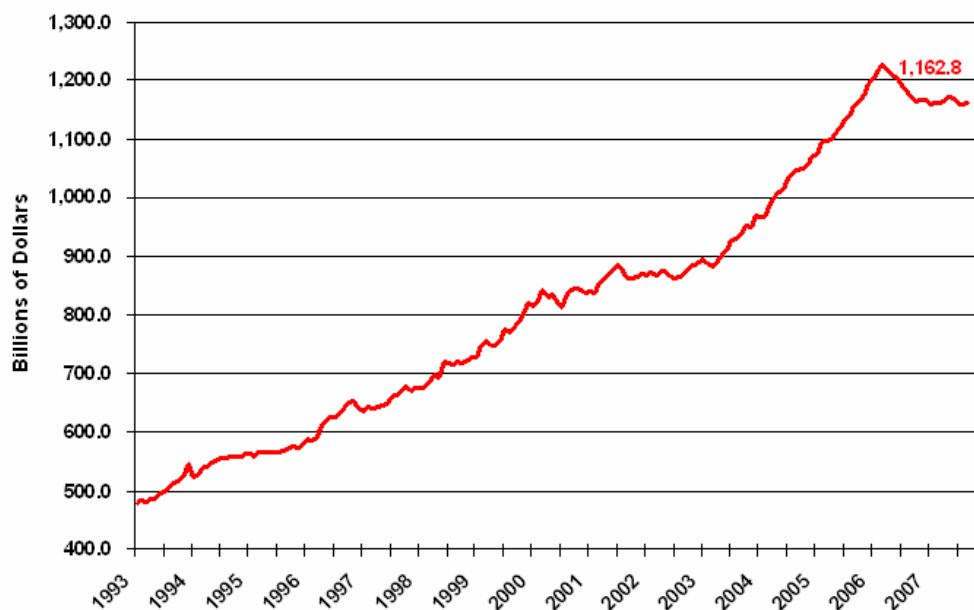
**Figure 10: New Housing Units Started in the U.S.A. (Jan 2000- Aug 2007)**



Source: U.S. Census Bureau

The impact of the diminished demand on the supply side of the economy can also be observed by the decrease in the construction expenses (Figure 11). The hit in construction also hit the labor market. According to the Labor Department (2007), job creation had lurched into reverse after four years of gains.

**Figure 11: Construction Expenditures in the US (1993-2007)**



Source: U.S. Census Bureau

The defaults on the subprime mortgages have decreased the reliability of the mortgage backed securities. Major lenders as Countrywide Financial have tightened the credit conditions and avoided sub-prime lending. Overall sub-prime originations were down by 50 percent from the second quarter of 2007. Not only mortgage lenders and thrifts as Washington Mutual have incurred considerable losses, but also major banks such as Citigroup, brokerage firms such as Merrill Lynch, the two government sponsored mortgage-finance firms Fannie Mae and Freddie Mac have been severely hit by the mortgage crisis (Isidore, 2007).

Banks raised 3-month interbank rates, because they lack the confidence to loan money to one another. The credit squeeze has raised market interest rates which made harder for distressed borrowers to finance. Since August 2007, Fed has injected liquidity to the markets to ensure their smooth functioning. Besides this, Fed has also decreased the short-term fed funds rate by 0.75% to 4.50% to overcome the adverse affects of the credit crunch.

The tighter credit conditions leads to a deeper and more protracted housing downturn then assumed. This would extend the decline in the residential investment and put great downward pressure on the household finance and consumption.

Consequently, the reduction in household and construction spending and the increase in the unemployment, has been rising from 4.4% in April 2007 to 4.7% in September 2007, will further weaken the growth of GDP, which had grown only by 0.9% in the first quarter of 2007. In addition, RealtyTrac, a company that tracks foreclosures, has estimated up to 1.5 million households has entered the foreclosure

process in 2007, double 2006's figure, and with some 2.5 million adjustable-rate mortgages resetting to higher rates before the end of 2008 (The Economist, 2007).

Rising delinquencies on these so-called sub-prime home loans in the US were infecting a broad swathe of markets around the world at an alarming pace. Northern Rock and the Cremos were swept up in the global credit crisis. The reason of this widespread effect of mortgage crisis is the securitization that has made trading the mortgages easily while spreading their risks all over the world to prevent major financial institution from collapsing. It has also tied far-flung markets more closely together. That means a crisis in a niche market in one country can contaminate lots of other markets that at first glance have little to do with each other. Technology transfers information in seconds, giving the infection a more potent scope (Barr, 2007). For instance the M&G Investment Management, which is a London-based investment firm, expects \$400 billion and Scottish Widows Investment Partnership, with almost \$200 billion in assets, experienced that blow-up firsthand on 20<sup>th</sup> of August 2007.

The first effect of the sub-prime mortgage backed securities on the overseas emerged in July 2007 when German bank IKB Deutsche Industriebank AG was bailed out by state-owned KFW Group. Three months later German savings banks rescued Sachsen LB. In addition to these incidents some of the world's most known banks (besides Citigroup) as HSBC and ABN Amro has lent huge amounts of money to money market managers who have been trying to fight with the sub-prime crisis. In the UK the situation was not different Barclays PLC had to finance Cairn High Grade Funding, an investment vehicle and HBOS PLC lent a huge amount of money

to Grampian. The Bank of England had given billions of pounds in emergency loans to Northern Rock to keep it afloat.

## **CHAPTER III**

### **LITERATURE REVIEW ON BUBBLES**

In regard to property bubbles Robert Shiller is one of the major researchers in this area. He made his name in the 1980s by attacking the notion that “the stock market rationally reflects the true value of the companies whose shares are traded on it” (Fox, 2007). In March 2000, he analyzed the stock market bubble in his book “Irrational Exuberance”. “Irrational Exuberance” which means wishful thinking on the part of investors is often used to describe a heightened state of speculative fervor. The phrase was first used by Alan Greenspan at the Annual Dinner and Francis Boyer Lecture of The American Enterprise Institute for Public Policy Research in December 5, 1996. His words were

...sustained low inflation implies less uncertainty about the future, and lower risk premiums imply higher prices of stocks and other earning assets. We can see that in the inverse relationship exhibited by price/earnings ratios and the rate of inflation in the past. But how do we know when irrational exuberance has unduly escalated asset values, which then become subject to unexpected and prolonged contractions as they have in Japan over the past decade?”

These words indicate that there could be speculative bubble in the stock market and a possibility of a decline in stock prices. Immediately after those words, the stock market in Tokyo, which was open as he was giving this speech, fell sharply,

and closed down 3% and Hong Kong fell by 3%. Then markets in Frankfurt and London fell by 4%. The stock market in the US fell by 2% at the open of trade. The strong reaction of the markets to Greenspan's seemingly harmless question was widely noted, and made the term irrational exuberance famous.

Shiller (2000), mentions psychological factors that affect people's decisions: "People do not even know to any degree of accuracy what the "right" level of market is: not many of them spend much time thinking about what its level should be or whether it is over/under priced today." There is a "money illusion" in the markets that people take into account nominal interest rates rather than real interest rates as happened in the real estate market. In addition he also indicates that speculative bubble cannot grow forever, when demand decreases then the growth in the asset prices stop.

These psychological factors were also apparent in the mortgage market. Because of the bubble concerns in the media, Case and Shiller (2000)<sup>8</sup> conducted a survey in several cities of the US and found out some interesting results about the homeowners point of views regarding the housing market. 90 percent of the homeowners expected an increase in the future house prices and they did not perceive themselves in the middle of bubble even at the height of the bubble. In addition, homeowners indicated that they have found investment on house is safer than investing on stocks and they have changed their portfolios from stock market to real estate markets. They indicated that nominal interest rates are the most important reason for them to decide on buying the house. Economists have been arguing on this

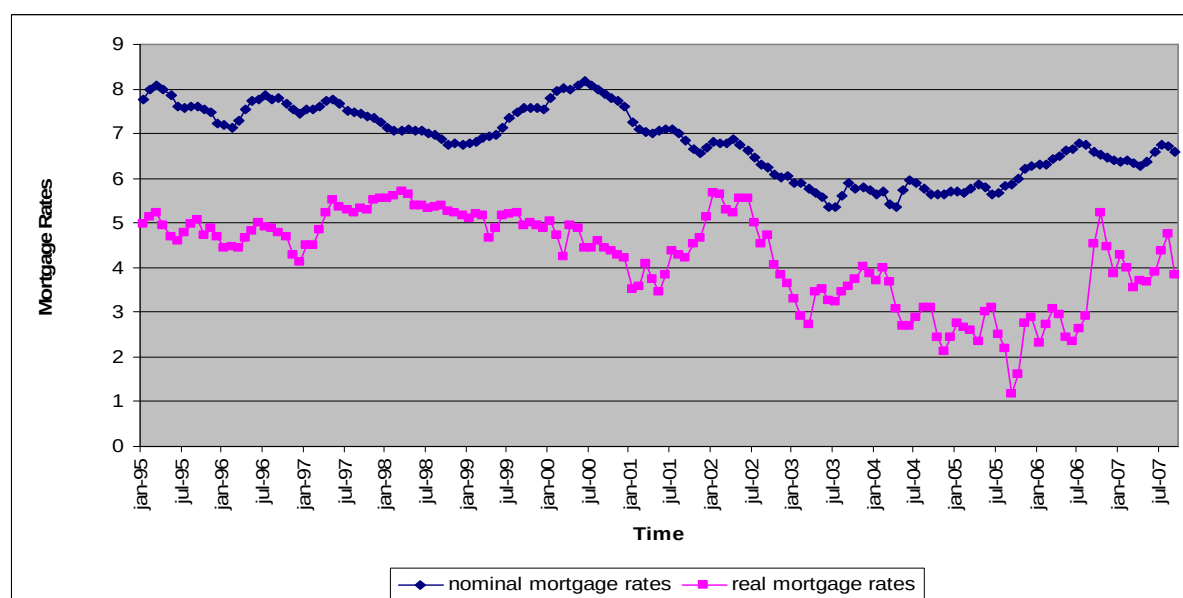
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<sup>8</sup> Survey has been done on 2000 individuals, who bought new houses between March and August 2002, in Los Angeles, San Francisco, Boston and Milwaukee.



issue, because although nominal interest rates were low, since the inflation level was also low, real interest rates on mortgages were high. However, as this survey suggests while borrowing, households take nominal interest rates into consideration. Figure 12 shows the movement of monthly nominal and real average contract mortgage rates for the years between 1995 and 2007. Although the nominal rates have followed a stationary path during this period, the real mortgage rates were highly volatile and they have increased dramatically in the last two years. Thus the “money illusion” clearly showed itself in the mortgage market.

**Figure 12: Nominal and Real National Average Contract Mortgage Rates (January 1995- September 2007)**



Sources: Mortgage-X and Inflationrate.com

Other major studies in these fields are the ones conducted by Case, Quigley and Shiller (2001) and Case and Shiller (2003). Case, Quigley and Shiller (2001), looked at the relationship between increases in housing wealth, financial wealth, and consumer spending. They have conducted a panel data analysis firstly with 14 countries using annual data in the years between 1975 and 1999 for various periods.

Secondly they used a panel with quarterly data of US states for the years between 1982 and 1999. The estimation has been done by relating consumption to income and wealth measures. The results suggest that mainly for the United States, the real estate market is more important in determining the consumption behavior of households than the stock market. Accordingly, wealth effect is stronger in real estate market. This suggests that when the house prices increase consumers increase their spending much more than the effect of an increase in the stock prices.

The study by Case and Shiller (2003) has also related house prices with income. They have done empirical research and conducted a questionnaire survey to find out the symptoms of the bubble. Their empirical research was based on defining house prices by looking at the major economic indicators as population, employment, number of housing starts, income per capita, mortgage rate and unemployment rate. Their research focused on prices – volatile states for the period 1985-2002. They have found that income explains the changes in the house prices and during the period 2000-2002 they could not reject the null hypothesis that a bubble existed in the states that they have studied.

On the other hand, McCarthy and Peach (2005) arrived to the conclusion that there was no bubble in the housing market in United States. The main argument that they have based their reasoning was that OFHEO house price index is not a truly “constant quality” index which means that the increases in this index could have been caused by the increase in the quality of the houses. Thus, although they have found an increase in the price/rents ratio, they argued that, OFHEO index was misleading. Besides this, they also argued that the decrease in the interest rates has

created a doubt of bubble. Thus without taking into account the other considerations, as the dramatic increase in the mortgage lending, in house prices in major states, in the construction expenditures and expectations, and basing their reasoning on a not supported argument, they came in to the suspicious conclusion that there was no house price bubble.

## **CHAPTER IV**

### **EMPIRICAL ANALYSIS: The Relation Between House Prices and Consumer Prices**

It has unambiguously been observed in various empirical papers that the increase in house prices tended to move parallel with the increase in consumer prices, prior to 1999 (Lansing, 2008). However, the dramatic rise in the house prices from 2000 onwards ceased this parallel relationship. To analyze this refraction, an empirical analysis is conducted in this chapter.

#### **IV.1. Model**

The analysis of this thesis is based on the study by Case and Schiller (2003). In an attempt to ameliorate their model, several modifications have been made. First of all, instead of using quarterly data, monthly data is employed. In search of the relation between house prices and consumer prices, the monthly percentage change in consumer prices is included. Furthermore, the variable employment has been eliminated from the model. Lastly, the entire period is divided into two time periods

in order to capture the structural break in the end of 1999. The first period runs from January 1990 until December 1999, and the second period starts from January 2000 and lasts until December 2006. This break follows logically from the fact that the bubble has started in the beginning of 2000.

The model that is analyzed is denoted by equation (1):

$$(1) \quad \begin{aligned} \% \Delta HPI_t = & \beta_0 \% \Delta CPI_t + \beta_1 PersonalIncome_t + \beta_2 Population_t \\ & + \beta_3 MortgageRate_t + \beta_4 HousingStarts_t + \beta_5 UnemploymentRate_t + \varepsilon_t \end{aligned}$$

It is hypothesized that a positive correlation exists between the increase in the house prices and consumer prices in the first period, January 1990 - December 1999, that the expected coefficient for the change in the CPI is positive and significant. In the second period, from January 2000 until December 2006, it is expected this relationship to break, meaning that previously positive and significant coefficient becomes insignificant in the second period. This will indicate that the consumer prices do not have any influence on the movement of house prices. Additionally, it is expected that the macroeconomic indicators also will fall short in explaining the house price growth for the second period analysis. The rationale for this expectation is to prove the movement in the house prices was solely directed by speculative and psychological factors rather than by the movement in the economic indicators.

## IV.2.Data

In order to estimate the model (1), monthly data is employed for the time period from January 1990 until December 2006. The total number of observations is

204. The dependent variable is measured as the monthly percentage change in the house prices which are taken from the Standard & Poor's Case-Shiller Index.

One independent variable is the percentage change in the Consumer Price Index, which is taken from U.S. Department of Labor Bureau of Labor Statistics. The data reflects all urban consumers and is seasonally adjusted. Another regressor is the variable Personal Income and Its Disposition, which is seasonally adjusted at annual rates and is measured in billions of dollars. The data is from the National Accounts provided by the Bureau of Economic Analysis, U.S. Department of Commerce. Thirdly, population data are retrieved from the U.S. Bureau of Economic Analysis, measured in thousands of individuals. Fourthly, the Civilian Unemployment Rate is collected from the U.S. Department of Labor: Bureau of Labor Statistics. The data is seasonally adjusted, and is measured in months in percentages, for individuals of age 16 and older. Fifthly, seasonally adjusted at annual rates data on Housing Starts is taken from the U.S. Department of Commerce: U.S. Census Bureau. Lastly, our measure for the mortgage rate as expressed in percentages is the National Average Contract Mortgage Rate which is taken from the Mortgage-X, Mortgage Information Website.

### **IV.3.Results**

Empirical analysis departed from employing an OLS regression measuring the percentage change in house prices using the fundamentals mentioned above (and denoted in equation 1). First, in order to verify the assumption of the existence of the

structural break, a representative regression of the model for the whole sample period, between 1990 and 2006 has been conducted. (Appendix Table A1). Chow Breakpoint test is done for the first month of 2000 in order to clarify the structural break (can be seen in the Appendix, Table A2) The P-value of the test is 0.00 indicating that the null hypothesis of no structural change in the house price changes before and after January 2000 is rejected.

Second, since the analysis involves time series, at this point it is important to test for serial correlation. The Durbin- Watson test statistic from the representative regression shows a low value (0.30) indicating that there exists first-order autocorrelation in the model. In order to test for higher order correlation, Breusch-Godfrey Serial Correlation LM test is conducted with including lags up to 2. The test rejected the null hypothesis of no serial correlation. Table A3 in Appendix depicts the correlogram of squared residuals, from which it can be seen that there is autocorrelation and partial correlation. Following these indications, the analysis on two different periods is done with second order autoregressive process and second order moving average error processes, i.e. ARMA (2,2). Before analyzing the results, it is crucial at this point to test the structural break with Wald test by using the regressions of two different time periods.

The validity of the Chow test is limited because it assumes the variances of residuals in two sub-samples are equal. Thus it is convenient to conduct the structural break test with Wald test in case the residual variance is different. The null hypothesis is no structural break with a Chi-square distribution.

The Wald test is constructed as:

$$(2) \quad W = (b_1 - b_2)'(V_1 + V_2)^{-1}(b_1 - b_2)$$

Where  $b_1$  and  $b_2$  are coefficient vectors for two estimated models and  $V_1$  and  $V_2$  are the covariance matrices for the models. Using E-views, Wald test is 56.69, the probability of Chi-square distribution with eleven degrees of freedom is 0.00 suggesting that the null hypothesis of no structural break is rejected. In the next sub-sections the results of the two regressions are going to be analyzed in detail.

#### **IV.3.1. Results for the period 1990 – 1999**

The OLS regression results for the period 1990-1999 have been tested for the existence of heteroskedasticity. White-test rejected the null hypothesis of homoskedasticity with a P-value of 0.003. Accordingly the regression is done by controlling both for heteroskedasticity and autocorrelation –using Newey-West Errors. Because of the change in the method, it is crucial to conduct the Wald-test for structural break for the heteroskedasticity and autocorrelation consistent regression results, the test again has been conducted in the same way as before and the P-value again rejects the null of no structural break for the results between two regressions. The results thereof for the first sub-sample are depicted in Table 1.



**Table 1: Heteroskedasticity and Autocorrelation Consistent OLS for 1990-1999**

Dependent Variable: PERHPI

Method: Least Squares

Sample (adjusted): 1990M03 1999M12

Included observations: 118 after adjustments

Convergence achieved after 27 iterations

Newey-West HAC Standard Errors &amp; Covariance (lag truncation=4)

MA Backcast: 1990M01 1990M02

|                    | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| PERCP              | 0.241077    | 0.138367              | 1.742292    | 0.0843    |
| INCOME             | 0.196018    | 0.043923              | 4.462767    | 0.0000    |
| POP                | -5.342663   | 3.565874              | -1.498276   | 0.1370    |
| RNMAR              | 0.042684    | 0.062966              | 0.677892    | 0.4993    |
| START              | -1.30E-05   | 0.000249              | -0.052378   | 0.9583    |
| UNEMP              | 0.067321    | 0.073281              | 0.918661    | 0.3603    |
| C                  | -4.011484   | 1.895126              | -2.116738   | 0.0366    |
| AR(1)              | 1.666425    | 0.050323              | 33.11455    | 0.0000    |
| AR(2)              | -0.915740   | 0.047538              | -19.26326   | 0.0000    |
| MA(1)              | -0.824079   | 0.125567              | -6.562835   | 0.0000    |
| MA(2)              | 0.270024    | 0.152405              | 1.771759    | 0.0793    |
| R-squared          | 0.882377    | Mean dependent var    |             | 0.164080  |
| Adjusted R-squared | 0.871384    | S.D. dependent var    |             | 0.547250  |
| S.E. of regression | 0.196260    | Akaike info criterion |             | -0.330164 |
| Sum squared resid  | 4.121439    | Schwarz criterion     |             | -0.071880 |
| Log likelihood     | 30.47970    | Hannan-Quinn criter.  |             | -0.225293 |
| F-statistic        | 80.26874    | Durbin-Watson stat    |             | 2.003309  |
| Prob(F-statistic)  | 0.000000    |                       |             |           |
| Inverted AR Roots  | .83-.47i    | .83+.47i              |             |           |
| Inverted MA Roots  | .41+.32i    | .41-.32i              |             |           |

The adjusted R-squared of the regression is 0.87, which indicates a reasonable fit. The table reveals that the percentage change in consumer prices is significant at 10% level and has a positive coefficient indicating that a 1% increase in the consumer prices increases house prices by 0.24%. This result supports the expectation that prior to the rapid increase in the house prices, consumer prices and house prices were positively correlated. Personal Income has highly significant and positive coefficient indicating an increase in the income increases house prices since it increases the demand for houses. Other fundamentals do not prove to have significant effects on house prices. Population variable has a negative and

insignificant coefficient which does not give a rational interpretation. Mortgage rate as well has insignificant and wrong signed coefficient since it is expected that an increase in the mortgage rate would decrease the house prices instead of increasing them. Housing starts do not have a coefficient significantly different from zero, thus the influence of this variable on house prices do not exist. The unemployment rate has a low coefficient which is insignificant. Positive and significant AR(1) suggests an increase in house prices mostly depends on the previous periods. AR(2) is significant but has a negative coefficient. Additionally, both of the moving averages are significant, although the first moving average has a negative sign. Thus, the percentage increase depends on both first and second past errors. This shows an important characteristic of the house price changes: one can explain house prices by looking at the previous pattern of the house prices besides income and the percentage increase in the consumer prices.

#### **IV.3.2 Results for the period 2000 – 2006**

The regression for the second sample period has been conducted again using the Newey-West Error corrected regression since the White-test for this sub-period again represented heteroskedasticity (Table A4; Appendix). The performance of the regression for this time period is depicted in Table 2.

**Table 2: Heteroskedasticity and Autocorrelation Consistent OLS for 2000-2006**

Dependent Variable: PERHPI

Method: Least Squares

Sample: 2000M01 2006M12

Included observations: 84

Convergence achieved after 31 iterations

Newey-West HAC Standard Errors &amp; Covariance (lag truncation=3)

Backcast: 1999M11 1999M12

|                    | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| PERCP              | -0.171559   | 0.117465              | -1.460513   | 0.1484    |
| INCOME             | -0.082342   | 0.054533              | -1.509939   | 0.1354    |
| POP                | 18.08159    | 8.530006              | 2.119763    | 0.0374    |
| RNMAR              | -0.139839   | 0.108134              | -1.293200   | 0.2000    |
| START              | -0.000160   | 0.000168              | -0.953437   | 0.3435    |
| UNEMP              | 0.297155    | 0.156899              | 1.893925    | 0.0622    |
| C                  | 1.495635    | 1.953847              | 0.765482    | 0.4465    |
| AR(1)              | 1.388923    | 0.164839              | 8.425929    | 0.0000    |
| AR(2)              | -0.581516   | 0.153438              | -3.789921   | 0.0003    |
| MA(1)              | -0.085163   | 0.176717              | -0.481919   | 0.6313    |
| MA(2)              | 0.315298    | 0.152851              | 2.062775    | 0.0427    |
| R-squared          | 0.893053    | Mean dependent var    |             | 0.963779  |
| Adjusted R-squared | 0.878402    | S.D. dependent var    |             | 0.611518  |
| S.E. of regression | 0.213241    | Akaike info criterion |             | -0.131236 |
| Sum squared resid  | 3.319449    | Schwarz criterion     |             | 0.187085  |
| Log likelihood     | 16.51191    | F-statistic           |             | 60.95796  |
| Durbin-Watson stat | 1.927873    | Prob(F-statistic)     |             | 0.000000  |
| Inverted AR Roots  | .69-.32i    | .69+.32i              |             |           |
| Inverted MA Roots  | .04+.56i    | .04-.56i              |             |           |

In this regression adjusted R-squared is 0.88, which represents same level of goodness of fit with the first sub-sample regression. As was expected, the positive and significant coefficient of the percentage change of the CPI is replaced by a negative and insignificant coefficient in this period. This shows that the behavior of the house price increase cannot be explained with the increase in the consumer prices. Additionally the positive coefficient of income becomes insignificant and negative. Thus this variable falls short in explaining the pattern of the house prices. In this regression, population has a significant effect, 5%, on the change of the house prices

indicating that an increase in the population increases the house prices. However the other variables cannot explain the change in the house prices. Mortgage Rate has negative and insignificant coefficient; the coefficient of Housing Starts is insignificant and close to zero. The unemployment rate, however, has a significant coefficient at 10% level but has a positive sign, which does not make sense in explaining house prices. Furthermore, it is found that AR(1) and AR(2) are significant, suggesting that an increase in the house prices cannot be explained by any fundamentals ( except population), but its previous realizations.

Thus, the empirical analysis represented in this part proves the hypothesis that the increase in consumer prices cannot explain the increase in the house prices after 2000, after the housing bubble started. The positive and significant coefficient of CPI for the first sub-period becomes negative and insignificant in the second period. Furthermore, it has been found that the following independent variables do not have the expected influence house price increases; unemployment rate, mortgage rate, and housing starts. Consumer prices and income per capita influence the housing price increase before the bubble; population influences the increase in the house prices after the bubble. The influence of income has also been encountered in the study done by Case and Shiller (2003). However, they have found that only income explains the trend in the house prices, whereas in this study the influence of the consumer prices has also been apparent. Since Case and Shiller (2003) do not include CPI in their analysis the findings regarding CPI cannot be compared<sup>9</sup>.

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<sup>9</sup> In order to see the relationship between the change in the house prices and consumer prices, a regression has been conducted with using only inflation rate as the independent variable explaining the percentage change in the house prices. That analysis shares the same conclusion with the regression conducted in this thesis that the positive coefficient of inflation rate in the first sub-period becomes negative and insignificant in the second sub-period.

## **CHAPTER V**

### **POLICY IMPLICATIONS**

Based on the empirical results, one can derive a number of policy implications to attempt to accommodate the negative effects of the mortgage crisis. To begin with, the market turbulence has caused investors to lose their confidence in financial markets. Additionally, banks have increased inter-bank rates, because they fear the exposure to risks on the sub-prime mortgage market. In order to change these developments, one has to reestablish the confidence of investors. Although this is an uncontrollable factor, the Fed attempts to regain trust by liquidity injections and interest rate reductions. Additionally, one would be able to regain trust by enhancing the transparency of financial institutions.

To alleviate the individuals who are negatively affected by the current crisis, a program of loan restructuring has been designed. However, some critics have argued that this would worsen the crisis by artificially propping up the home prices. If foreclosures occur without intervention, the market would recover faster, since decreasing house prices make them affordable to buyers. If instead the adjustable mortgage rates are shifted to prime mortgage rates -which are much lower than

ARMs-, then the interest payments will become more affordable to sub-prime borrowers. According to the Federal Reserve Bank of Boston, half of the sub-prime borrowers have the adequate credit scoring for a prime mortgage loan. Thus, shifting the qualified borrowers to prime rates will reduce the amount of foreclosures (Calbreath; 2007).

The current mortgage crisis has also provided policy insights that could be employed to limit the effects of any future mortgage crisis. First, in dealing with the burst of the housing bubble, one could design better forms of social insurance that allow one to manage real risks more effectively. Second, financial regulators should protect customers by imposing rules to prevent abusive practices. These arise through the intricate contracts that misinform potential customers of the payment conditions of the mortgages. Additionally, many borrowers relied on their brokers who were earning higher commission rates from sub-prime contracts (Calbreath, 2007). Financial regulators could also support potential customers through counseling and financial education for potential borrowers (Bernanke, 2007). Other protections include greater mortgage disclosures of payments over the lifetime of a loan and a greater prohibition of deceptive advertising (Sahadi, 2007).

## **CHAPTER VI**

### **CONCLUSION**

Although the debate on the housing price bubble has shifted to another debate concerning increasing regulation in financial markets, it is crucial to analyze the causes of the financial crisis and how the house prices started to show bubble symptoms. To this aim, the progress of the crisis has been outlined by dividing the periods of the crisis as the way it is described by Allen and Gale (2000). During the first phase, Fed's low interest rate policy led to increased credits and demand on real estates which led to the increase in house prices. The indicators have pointed that house prices cannot be explained by any other parameters than people's expectations. A considerable portion of the increase in house prices can be explained by psychology as Shiller (2000) pointed out. In the second phase positive effects of bubble and the burst of the bubble has been explained. Third phase has showed the crash in the financial market because of the tightening in the lending. Focusing on the bubble literature, the regression model by Case and Shiller (2003) has been ameliorated and employed. The monthly data for the period 1990-2006 is divided into two periods, before and after housing bubble, to indicate the break of the relation between house price increase and consumer price increase. The results have suggested that for the first period -besides income and the past realizations of the

lagged dependent variable and error terms- the inflation rate has a positive and significant effect on the house price increase. The second period analysis has showed the break in this relationship and led one to conclude that except population, none of the fundamentals can explain the sudden growth rate in the house prices.. Consequently, the results of the thesis confirm the findings by Case and Shiller (2003) and Case, Quigley and Shiller (2001) that the increase in the US housing prices was indeed a real estate price bubble which busted in the first months of 2007, leading to a mortgage crisis and credit crunch, whereof the effects are still spreading throughout the world.



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## APPENDIX 1

**Table A1: Representative Regression Results**

Dependent Variable: PERHPI  
Method: Least Squares  
Sample: 1990M01 2006M12  
Included observations: 204

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.  |
|--------------------|-------------|-----------------------|-------------|--------|
| PERCP              | -0.066498   | 0.167767              | -0.396372   | 0.6923 |
| INCOME             | 0.005257    | 0.018073              | 0.290876    | 0.7715 |
| POP                | 8.105672    | 3.609613              | 2.245579    | 0.0258 |
| RNMAR              | -0.135618   | 0.070531              | -1.922806   | 0.0559 |
| START              | 0.001183    | 0.000321              | 3.683080    | 0.0003 |
| UNEMP              | -0.108831   | 0.052828              | -2.060090   | 0.0407 |
| C                  | -0.656625   | 1.224834              | -0.536093   | 0.5925 |
| R-squared          | 0.450764    | Mean dependent var    | 0.490568    |        |
| Adjusted R-squared | 0.434036    | S.D. dependent var    | 0.695587    |        |
| S.E. of regression | 0.523294    | Akaike info criterion | 1.576365    |        |
| Sum squared resid  | 53.94585    | Schwarz criterion     | 1.690222    |        |
| Log likelihood     | -153.7893   | F-statistic           | 26.94667    |        |
| Durbin-Watson stat | 0.302800    | Prob(F-statistic)     | 0.000000    |        |

**Table A2: Chow Breakpoint Test**

Chow Breakpoint Test: 2000M01

|                      |          |             |          |
|----------------------|----------|-------------|----------|
| F-statistic          | 16.90083 | Probability | 0.000000 |
| Log likelihood ratio | 99.24161 | Probability | 0.000000 |

**Table A3: Correlogram of Squared Residuals**

Sample: 1990M01 2006M12

Included observations: 204

| Autocorrelation | Partial Correlation | AC | PAC    | Q-Stat | Prob   |       |
|-----------------|---------------------|----|--------|--------|--------|-------|
| . *****         | . *****             | 1  | 0.670  | 0.670  | 92.807 | 0.000 |
| . ***           | * .                 | 2  | 0.368  | -0.145 | 121.01 | 0.000 |
| . *             | * .                 | 3  | 0.127  | -0.107 | 124.39 | 0.000 |
| . .             | . .                 | 4  | -0.012 | -0.024 | 124.42 | 0.000 |
| * .             | . .                 | 5  | -0.059 | 0.013  | 125.16 | 0.000 |
| . .             | . .                 | 6  | -0.040 | 0.034  | 125.50 | 0.000 |
| * .             | * .                 | 7  | -0.073 | -0.117 | 126.66 | 0.000 |
| * .             | . .                 | 8  | -0.087 | -0.008 | 128.29 | 0.000 |
| . .             | . *                 | 9  | -0.043 | 0.081  | 128.69 | 0.000 |
| . .             | * .                 | 10 | -0.043 | -0.075 | 129.09 | 0.000 |
| . .             | . .                 | 11 | -0.047 | -0.026 | 129.57 | 0.000 |
| . .             | . .                 | 12 | -0.041 | 0.002  | 129.94 | 0.000 |

**Table A3: White Heteroskedasticity Test for Period 1990-1999**

|               |          |             |          |
|---------------|----------|-------------|----------|
| F-statistic   | 2.199152 | Probability | 0.003026 |
| Obs*R-squared | 46.90476 | Probability | 0.010148 |

Dependent Variable: RESID^2

Sample: 1990M03 1999M12

Included observations: 118

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.  |
|--------------------|-------------|-----------------------|-------------|--------|
| C                  | -1.356748   | 13.92173              | -0.097455   | 0.9226 |
| PERCP              | -3.916091   | 2.403387              | -1.629405   | 0.1067 |
| PERCP^2            | 0.289478    | 0.197908              | 1.462687    | 0.1470 |
| PERCP*INCOME       | 0.085446    | 0.054293              | 1.573800    | 0.1190 |
| PERCP*POP          | -3.850133   | 3.384482              | -1.137584   | 0.2583 |
| PERCP*RNMAR        | 0.192425    | 0.088308              | 2.179010    | 0.0319 |
| PERCP*START        | 0.000195    | 0.000416              | 0.469543    | 0.6398 |
| PERCP*UNEMP        | 0.108928    | 0.113552              | 0.959275    | 0.3400 |
| INCOME             | -0.190831   | 0.682603              | -0.279563   | 0.7805 |
| INCOME^2           | 0.004439    | 0.009082              | 0.488763    | 0.6262 |
| INCOME*POP         | -0.049382   | 0.653461              | -0.075570   | 0.9399 |
| INCOME*RNMAR       | 0.002708    | 0.020857              | 0.129832    | 0.8970 |
| INCOME*START       | -6.11E-05   | 0.000108              | -0.565252   | 0.5733 |
| INCOME*UNEMP       | 0.009634    | 0.029794              | 0.323334    | 0.7472 |
| POP                | -23.57301   | 26.07665              | -0.903989   | 0.3684 |
| POP^2              | -48.35282   | 40.35480              | -1.198193   | 0.2340 |
| POP*RNMAR          | 2.237869    | 1.114500              | 2.007957    | 0.0476 |
| POP*START          | 0.009342    | 0.006332              | 1.475543    | 0.1436 |
| POP*UNEMP          | 0.967470    | 1.274543              | 0.759072    | 0.4498 |
| RNMAR              | 0.484340    | 0.952459              | 0.508515    | 0.6123 |
| RNMAR^2            | -0.021683   | 0.023021              | -0.941872   | 0.3488 |
| RNMAR*START        | -0.000211   | 0.000171              | -1.232798   | 0.2209 |
| RNMAR*UNEMP        | -0.037987   | 0.043013              | -0.883146   | 0.3795 |
| START              | 0.003472    | 0.003925              | 0.884565    | 0.3787 |
| START^2            | -1.32E-07   | 4.66E-07              | -0.283291   | 0.7776 |
| START*UNEMP        | -0.000248   | 0.000184              | -1.346376   | 0.1816 |
| UNEMP              | 0.365511    | 1.226055              | 0.298119    | 0.7663 |
| UNEMP^2            | -0.006355   | 0.026513              | -0.239678   | 0.8111 |
| R-squared          | 0.397498    | Mean dependent var    | 0.034829    |        |
| Adjusted R-squared | 0.216747    | S.D. dependent var    | 0.043630    |        |
| S.E. of regression | 0.038613    | Akaike info criterion | -3.466753   |        |
| Sum squared resid  | 0.134187    | Schwarz criterion     | -2.809302   |        |
| Log likelihood     | 232.5384    | F-statistic           | 2.199152    |        |
| Durbin-Watson stat | 1.973482    | Prob(F-statistic)     | 0.003026    |        |

**Table A4: White Heteroskedasticity Test for Period 2000-2006**

|               |          |             |          |
|---------------|----------|-------------|----------|
| F-statistic   | 1.747401 | Probability | 0.039377 |
| Obs*R-squared | 38.40970 | Probability | 0.071612 |

Dependent Variable: RESID^2

Sample: 2000M01 2006M12

Included observations: 84

| Variable     | Coefficient | Std. Error | t-Statistic | Prob.  |
|--------------|-------------|------------|-------------|--------|
| C            | 5.431773    | 72.71647   | 0.074698    | 0.9407 |
| PERCP        | -9.224197   | 11.91504   | -0.774164   | 0.4421 |
| PERCP^2      | 0.842215    | 0.783053   | 1.075553    | 0.2867 |
| PERCP*INCOME | -0.013582   | 0.124206   | -0.109348   | 0.9133 |
| PERCP*POP    | 6.296606    | 33.39568   | 0.188546    | 0.8511 |
| PERCP*RNMAR  | 0.695337    | 0.892876   | 0.778760    | 0.4394 |
| PERCP*START  | 0.000342    | 0.001239   | 0.275591    | 0.7839 |
| PERCP*UNEMP  | 0.875210    | 0.724916   | 1.207325    | 0.2324 |
| INCOME       | 0.333150    | 2.360522   | 0.141134    | 0.8883 |
| INCOME^2     | -0.009806   | 0.028531   | -0.343710   | 0.7324 |
| INCOME*POP   | -0.501822   | 5.277661   | -0.095084   | 0.9246 |
| INCOME*RNMAR | 0.012501    | 0.128860   | 0.097010    | 0.9231 |
| INCOME*START | -0.000132   | 0.000229   | -0.574626   | 0.5678 |
| INCOME*UNEMP | 0.091310    | 0.130342   | 0.700542    | 0.4865 |
| POP          | 250.0187    | 304.3254   | 0.821551    | 0.4148 |
| POP^2        | -3013.414   | 873.8816   | -3.448309   | 0.0011 |
| POP*RNMAR    | 35.16994    | 21.78616   | 1.614325    | 0.1121 |
| POP*START    | -0.030385   | 0.050111   | -0.606347   | 0.5467 |
| POP*UNEMP    | 15.42516    | 15.96818   | 0.965994    | 0.3382 |
| RNMAR        | -7.681548   | 8.864404   | -0.866561   | 0.3899 |
| RNMAR^2      | 0.250664    | 0.332914   | 0.752940    | 0.4546 |
| RNMAR*START  | -0.000311   | 0.001075   | -0.289391   | 0.7734 |
| RNMAR*UNEMP  | 0.413501    | 0.474883   | 0.870743    | 0.3876 |
| START        | 0.017949    | 0.017592   | 1.020329    | 0.3120 |
| START^2      | -1.29E-06   | 1.78E-06   | -0.724742   | 0.4716 |
| START*UNEMP  | -0.001011   | 0.001013   | -0.998715   | 0.3222 |
| UNEMP        | -5.234676   | 7.561370   | -0.692292   | 0.4916 |
| UNEMP^2      | 0.073662    | 0.266263   | 0.276650    | 0.7831 |

|                    |          |                       |          |
|--------------------|----------|-----------------------|----------|
| R-squared          | 0.457258 | Mean dependent var    | 0.211374 |
| Adjusted R-squared | 0.195579 | S.D. dependent var    | 0.315290 |
| S.E. of regression | 0.282782 | Akaike info criterion | 0.572923 |
| Sum squared resid  | 4.478088 | Schwarz criterion     | 1.383195 |
| Log likelihood     | 3.937227 | F-statistic           | 1.747401 |
| Durbin-Watson stat | 1.477210 | Prob(F-statistic)     | 0.039377 |

## APPENDIX 2

In this appendix, a different empirical analysis is conducted in search for the bubble symptoms for the house prices. Departing from the regression conducted in the empirical part; instead of using the levels of personal income, population and housing starts, the percentage changes are used. The regression is done for the whole period Jan 1990 – Dec 2006. A dummy variable is used which is equal to 1 for the bubble period starting from January 2000. Additionally, to capture the different effects of the bubble, the interaction terms of bubble dummy with all variables are used. The regression results are presented in Table A5.

The adjusted R-squared of the regression is 0.91 which gives a reasonable goodness of fit. Percentage change in consumer prices has a positive coefficient, however it is not significant. On the other hand, the coefficient for the percentage change in income is significant at 1% and negative representing that the increase in income decreases the house prices. This interpretation, however does not represent the reality. Thus the coefficient has a wrong sign. Percentage change in the population is positive but does not have a significant influence. Mortgage rates have negative coefficient, meaning an increase in the mortgage rates decreases the house prices. However, the coefficient does not have a significant impact. The change in



the housing starts as well does not influence house prices significantly. Unemployment rate on the other hand, has a negative and significant coefficient indicating that an increase in the unemployment rate negatively affects the increase in the houseprices. The significant dummy variable for the bubble indicates that during bubble period, the increase in the house prices were almost 3.24 times faster than the corresponding increase prior to the bubble period which reflects the irrational increase in the house prices. The interaction terms indicate the effects of the fundamentals during bubble period compared to their influence prior to the bubble period. The interaction of the dummy with CPI reflects an almost insignificant, negative coefficient. This indicates that compared to the “normal” period, the increase of the consumer prices decreases the house prices. Interaction term with income represents a 5% significant and positive coefficient indicating a percent increase in income during bubble period positively influences the house prices compared to the previous period. The coefficient for the interaction term with population is 5% significant and positive. If we try to interpret the coefficient; a 1 % increase in population increases house prices by 16% which is not a rational influence. The interaction of dummy with mortgage rates and housing starts do not have significant influence on house prices. The significance of AR(1) and MA(1) indicate that previous realizations of the house prices predict the initial value of the variable.

Consequently the analysis in the appendix also provides the proof for the existence of bubble, indicating the structural break and the irrational influences of the fundamentals during the bubble period. Once again the break in the relationship between the house prices and consumer prices is encountered.

**Table A5. Heteroskedasticity and Autocorrelation Consistent OLS for 1990-2006**

Dependent Variable: PERHPI

Method: Least Squares

Sample (adjusted): 1990M04 2006M12

Included observations: 201 after adjustments

Convergence achieved after 27 iterations

Newey-West HAC Standard Errors & Covariance (lag truncation=4)

Backcast: 1990M02 1990M03

| Variable           | Coefficient | Std. Error            | t-Statistic | Prob.     |
|--------------------|-------------|-----------------------|-------------|-----------|
| PERCP              | 0.103588    | 0.114949              | 0.901170    | 0.3687    |
| PERINCOME          | -4.243786   | 1.057873              | -4.011621   | 0.0001    |
| PERPOP             | 0.715122    | 3.774976              | 0.189437    | 0.8500    |
| RNMAR              | -0.042564   | 0.075267              | -0.565501   | 0.5724    |
| PERSTART           | 0.047250    | 0.150350              | 0.314268    | 0.7537    |
| UNEMP              | -0.205254   | 0.074688              | -2.748163   | 0.0066    |
| DUM                | 3.245467    | 1.649927              | 1.967037    | 0.0507    |
| C                  | -1.597680   | 1.437895              | -1.111124   | 0.2680    |
| CPIDUM             | -0.265024   | 0.158204              | -1.675206   | 0.0956    |
| INCOMEDUM          | 3.757652    | 1.499341              | 2.506202    | 0.0131    |
| POPDUM             | 16.12386    | 8.170906              | 1.973326    | 0.0500    |
| RNMARDUM           | -0.084118   | 0.124027              | -0.678224   | 0.4985    |
| STARTDUM           | -0.259662   | 0.220527              | -1.177465   | 0.2405    |
| UNEMPDUM           | 0.580981    | 0.142021              | 4.090799    | 0.0001    |
| AR(1)              | 1.336385    | 0.125723              | 10.62963    | 0.0000    |
| AR(2)              | -0.554663   | 0.116477              | -4.762003   | 0.0000    |
| MA(1)              | -0.074764   | 0.135375              | -0.552274   | 0.5814    |
| MA(2)              | 0.323968    | 0.087405              | 3.706534    | 0.0003    |
| R-squared          | 0.916917    | Mean dependent var    |             | 0.499886  |
| Adjusted R-squared | 0.909199    | S.D. dependent var    |             | 0.696518  |
| S.E. of regression | 0.209883    | Akaike info criterion |             | -0.199244 |
| Sum squared resid  | 8.061340    | Schwarz criterion     |             | 0.096575  |
| Log likelihood     | 38.02398    | F-statistic           |             | 118.8008  |
| Durbin-Watson stat | 1.984522    | Prob(F-statistic)     |             | 0.000000  |
| Inverted AR Roots  | .67-.33i    | .67+.33i              |             |           |
| Inverted MA Roots  | .04+.57i    | .04-.57i              |             |           |