Department of Economics and Finance

Applied Statistics and Econometrics

Rationality of Asset Price Bubbles: The Cases of the United States of America and Asia

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To my parents, Mitat and File, who have stimulated me towards achievements for them unreachable

To my brother, Plarent, my life guide

And to Marta, whose support I cannot do without

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Abstract

Rationality has been a major assumption in the economic subjects and it is central when attempting to define an asset price bubble. According to the efficient market theory, we compute prices rationally since our expectations for future stream of dividends are rational: a bubble arises in the moment in which prices deviate from this fundamental value.

The aim of my thesis is to identify the rationality of the asset price bubbles using the Variance Bound Test as a tool and two examples to guide the analysis: the U.S. Housing market and the Asian crisis, with a focus on Thailand and Malaysia. The test consists of comparing the variances of the actual price and the ex-post rational price (calculated backward given the observed dividends). A rational bubble should produce actual prices with a variance lower (or equal) to the variance of ex-post rational prices.

Keywords: Asset Price Bubble, Rational, Irrational, U.S. Mortgage Crisis, 2007, Asian Crisis, 1997, Variance Bound Test, Feedback Loop

INTRODUCTION

<<Why do people still refer to *irrational exuberance* years later? I believe that the words have become a useful name for the kind of social phenomenon that..has happened again and again in history, when markets have been bid up to unusually high and unsustainable levels under the influence of market psychology.>>

Shiller, 2005

The market psychology Shiller refers to is still today an open issue: it denotes the way agents' behave within an exchange context. In fact, markets are the outcome of the interaction between buyers and sellers who, by assumption, behave rationally. However, when they fail to do so, markets do collapse. The particular case I am going to describe and analyze in my thesis is the manifestation of asset price bubbles.

Defining a speculative bubble is the starting point for understanding its occurrence and for acting to prevent it. One of the first things we learn in financial courses is that the price of an asset is given by the present value of future stream of cash flows (also said to be the fundamental value) and that when they deviate from it, according to the efficient market theory, we are no longer making rational expectations: it is widely believed that this is the moment in which a bubble arises since irrationality is all what causes this event to occur. Nevertheless, in making my research I have found contradictory definitions of asset price bubbles: rationality implies that we use all the available information in the market in order to form our expectations and, when a market is hit by widespread

optimism, why would it be irrational to expect a further increase in prices? Certainly, it would be hard to believe that prices increase forever, but still the expectation is made using all the available information at the time.

So, I came across a different definition of price: many authors, such as Gürkaynak (2008), talk about the presence of a bubble element into the equation, claiming that the computation of the price comprises of a fundamental part and a bubble part. In this way, we can still claim the rationality of an asset bubble since it is embedded in the calculation of the rational price.

The real estate bubble of the U.S. in 2007 and the Asian bubble(s) of 1997 are two noteworthy examples of speculative bubbles. The two events have been triggered and enhanced by similar factors.

The loss in confidence in the U.S. stock market after the crash in the mid 1990's shifted the interest of investors and households to the real estate market, fueling demand and supply for houses. Asia, on the other hand was experiencing a great economic growth in the early 1990's, which encouraged a common enthusiasm for the bright era and drove people to buy houses and firms to invest in new projects. The feedback loop had just initiated: as prices increased, enthusiasm and more consumption (through the affection of GDP and thus the perception of wealth) fed back. Even though the starting structural factors are diverse, in both cases the regulation was lax and a high number of bad loans were issued resulting in defaults once the prices started decreasing when people realized that they could not grow up to infinity: U.S. excessive diffusion of subprime mortgages brought already in 2006 to a high number of defaults; Asian banks were expanding credit to firms, which were not investing in efficient projects..

It is interesting to see the role of the respective Central Banks: the Fed was supplying credit prior the Lehman Brother's bankruptcy (2008) through the Term Auction Facility and a reduction in the target federal funds rate; afterwards it undertook unconventional monetary policy, known as Quantitative Easing, which involved the purchase of Mortgage Backed Securities and long-term Treasuries. In Asia, monetary policy tended to be loose and interest rates were low prior the devaluation of the Thailand Baht. Only after a few months of devaluations in the whole region, the monetary authorities decided to undergo a tight monetary policy and increase interest rates.

Many methods had been investigated for the detection of bubbles, however all of them present some weakness. I used Shiller's Variance Bound Test as a tool to evaluate in which of the above described cases there had actually been a bubble driven by rationality. According to the Test, the variance of actual detrended prices should be lower or equal to the variance of the ex-post rational prices. The reason is that the ex-post rational price is a forecast and as such it implicates an error in the computation: in fact it is calculated backward given the observed dividends (rents).

From this test I will make my deductions and conclusions on the dichotomy rationality-irrationality that characterizes asset price bubbles, with a major focus on the U.S., Malaysia and Thailand. The results that I obtain suggest that the so-widely discussed existence of rational asset price bubbles is in fact validated, even though the number of cases I use are limited (U.S. and Malaysia).

CHAPTER I

ASSET PRICE BUBBLE

Around 1634 a new fad invaded the Netherlands: the flourishing colors of tulips attracted a great variety of people, from merchants to farmers, who were willing to mortgage their lands and properties for a bulb. Holland was entering the Golden Age, a fact that encouraged the enthusiasm for those flowers to a point in which the bulbs began trading for thousands of Guilders.
Even though tulip's bulbs were obviously neither listed nor traded in financial markets, this episode is judged as one of the first bubbles in history. However, what a bubble is in reality has always been at the center of economists and financial professional's attention. I am now going to present and understand the different interpretations of a speculative bubble.

1.1 The "Fundamentals" View

Many economists (as Mishkin, 2013) define a bubble as being the result of observed price deviation from the fundamental value, which is a rational expectation of the future stream of dividends.

I will start the analysis of asset bubble by focusing first on the above-mentioned definition. In order to explain the concept, let me consider first the dividend valuation model:

$$P_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t} \quad (1)$$

Where:

- P_0= Price of the stock at time 0
- D_t= Dividend at time t
- r = return required by investors

Equation (1) is expressed in terms of observed values, but we can also use it for expected values of stock prices:

$$P_t^{exp} = \sum_{t=1}^{\infty} \frac{D_{t+1}}{(1+r)^{t+1}} \quad (2)$$

Where:

- P_t^{exp} = Expected stock price at time t
- D_{t+1}= Dividend at time t+1
- r = return required by investors

Equation (2) refers to the fundamental market value of stock prices calculated on future expectations. Normally, it is believed that if the observed stock prices coincide with the fundamental market value, then expectations are rational. However, what does rational really mean?

The roots of the rationality notion applied to financial markets lie in the efficient market hypothesis: the estimation of future stock prices is built using all information available in the market (e.g. past prices, monetary policy, etc...) and it defines the optimal forecast of the stock price itself.

In accordance with the theory, the optimal forecast of the rate of return should be equal to the equilibrium rate of return. Even if we cannot observe the former value, we can derive the latter from the analysis of supply and demand. Now we have the following identity:

$$R^{of} = R^{*}$$

Where:

- R^{of}= optimal forecast rate of return
- R^{*}= equilibrium rate of return

If this identity holds, we are also implying that there is no arbitrage opportunity in the market. To make this point, let us assume that the rate of return is lower than equilibrium; in this case, demand will decrease because the attractiveness of the investment decreases and the rate of return will increase until it reaches the equilibrium. (Mishkin, 2013). From this argument we are saying that rational agents exploit all profit opportunities, leading the market towards equilibrium and thus toward an optimal forecast, which in turn corresponds to the fundamental market value. Furthermore, the observed price volatility should be less than the volatility of the present value of future stream of dividends. If the volatility of our forecast is lower than the real volatility of stock prices, the observed prices are deviating from our fundamental calculus (Lansing, 2007). I will deepen this concept in the last chapter. Thus it may appear that irrationality becomes an issue when observing deviation of prices: given that a rational expectations would create an estimated stock price with a volatility higher than the observed values, if this condition is not fulfilled the reason ought to lie in the irrational behavior of investors.

However, irrationality cannot be intuitively judged as direct consequence of this deviation: it may be that the definition of fundamental itself is wrong (Siegel,2003), which may be caused by misguided expectations and undisclosed information in the market. Thus, the dichotomy rational-irrational is somehow a central issue in defining an asset bubble.

1.2 Insights on Rationality and Irrationality

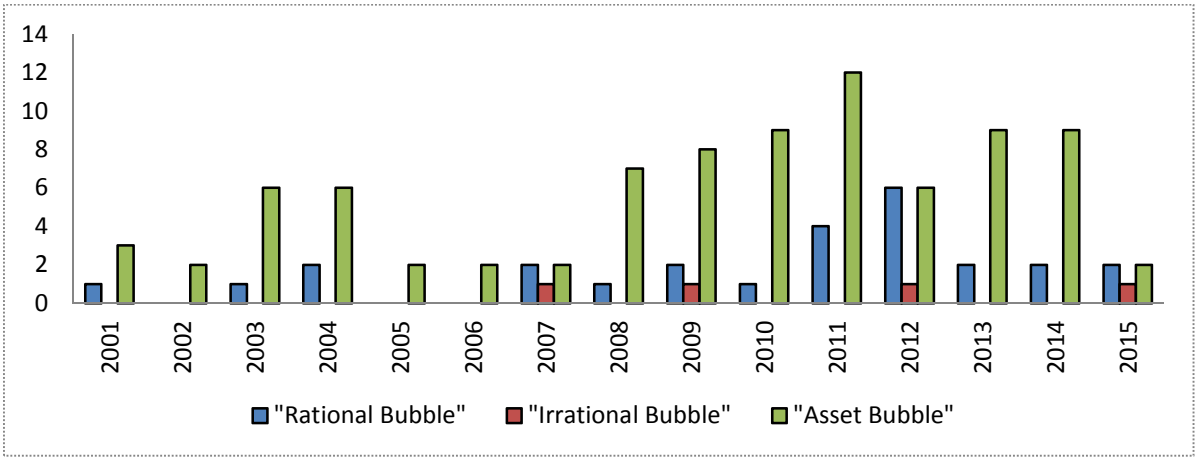
In order to extrapolate some information on the above-mentioned dichotomy, I made a research on Google Scholar on the frequency of the terms "Rational Bubble", "Irrational Bubble" and "Asset Bubble" in the titles of academic papers for each year from 2000 and I graphed the results (Graph 1).

As we can see in Graph 1, irrationality was not the most used word when talking about bubbles from 2000 and on. In fact only in 2007 it started appearing in the titles of working papers. If instead we look at the presence of the term "rational bubble", it seems that rationality is more in evidence than irrationality when economic literature deals with bubbles. It arises natural then to question the validity of the term irrational as an explanation of speculative bubbles.

From these data, it may seem that, while the present value formula suggests an irrational bubble, economists tend more towards a rational explanation. Furthermore, time is a variable that can tend to infinity, thus eventually it will come a point in time in which discounted future cash flows will justify today's price: the price is then evaluated rationally. We should then revise the definition of rationality and irrationality.

Graph 1.

Literature of Bubbles.



Source: Self-Adapted from Google Scholar

Shiller (2005) defines a speculative bubble as generated by irrational exuberance: such a definition attributes the origins of a bubble mainly to psychological factors. Structural factors determine the initial increase in prices, which in turn fuels optimism and finally this optimism leads more and more investors to enter the market by buying stocks with the hope to sell them in the future at a higher price ("feedback loop"[1]). In fact, in these periods of peak, investors believe in an ever-growing market. From a psychological point of view, optimism leads investors to weight more the benefits rather than the costs of the action: this does not seem an irrational behavior, rather a misjudgment. [2] On the other side, there is nothing rational in the belief of an infinite increase of prices; there is no reason anyone could ever believe that prices will grow forever because we all know that there will come a moment in which prices are going to

[1] Shiller,2005

[2] In economics we define rational a behavior which weights costs and benefits and chooses an action with the highest benefits and lowest costs. In this case the decision is deviated due to over-optimism, this is why I talk about misjudgment.

fall, even if it happens slowly. This event is something investors do not see as a possible outcome for their investments during bright times and they are willing to buy even more in order to increase their eventual profits.

We remain with the dilemma of defining an asset bubble as rational or irrational: the irrationality of seeing an ever-lasting bright future ahead is explained by the rationality of weighting costs and benefits with over-optimism.

1.3 Rational Bubble inside the Economic Model

Even if from the fundamentals view a bubble may seem a deviation from the discounted value of future cash flows, there is still another economic view, which starts from the fundamentals' notion, but it also adds a component which discredits the idea that the bubble cannot be rational.

It has been (see for example Gurkaynak, 2008) proposed a model of asset pricing that comprehends a fundamental component (the expected stream of discounted dividends) and a bubble component (B). Thus starting from Equation (2) we have:

$$P_t^{exp} = \sum_{t=1}^{\infty} \frac{D_{t+1}^{exp}}{(1+r)^{t+1}} + B \qquad (3)$$

Where:

- P_t^{exp}= Expected stock price at time t
- D_{t+1}^{exp}= Expected dividend at time t+1
- r = return required by investors

- B= Bubble component

Given the introduction of a bubble component in Equation (2), a bubble event is not an irrational evaluation of stock prices anymore: we cannot observe this bubble component but the price can very well be greater than the simple present value of future dividends, and thus it can deviate from the fundamental market value for reasons behind irrationality.

So far, we have seen different perspectives on the notion of a bubble, all of which are validly reasoned; however, it still seems controversial to give a unique and universal definition of asset price bubble. I will now outline two main historical manifestations of bubbles: the Asian stock price crash in 1997 (with a focus on Thailand and Malaysia) and the U.S. housing bubble of 2007.

CHAPTER II

HISTORICAL EVIDENCE: SUBPRIME AND ASIAN CRISIS

The Asian (1997) and the Global (2007) financial crises are two clear examples of the failure of financial markets. The factors that have contributed to the creation of a bubble are akin and in both cases they have generated a widespread optimism which triggered the so-called feedback loop (Shiller,2005). Let me explore each of them more closely.

2.1 The U.S. Subprime Mortgage Crisis

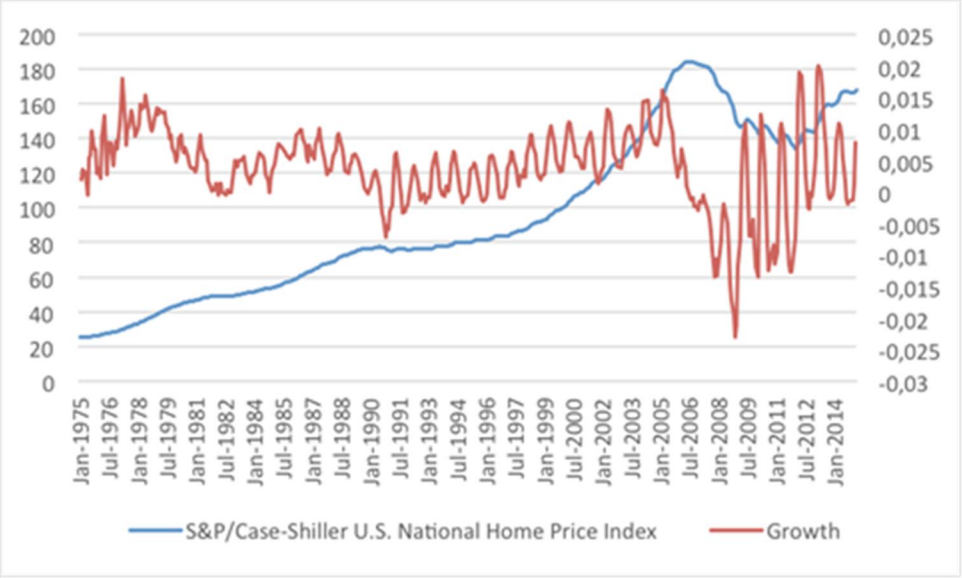
The global financial crisis had its origins from the market failure that arose in the housing market.

The filing of bankruptcy under Chapter 11 of the Lehman Brothers was a manifestation of the underlying problems that had been affecting the U.S. housing market for years. A crisis, whether it is caused by a bubble burst or not, is never sudden since it takes some time before the economy shows the consequences of a flaw in the market (Shiller, 2005). Thus, tracing the primary sources that led to the real estate bubble and consequently to the global crisis is not an easy task: many are the factors that affected the market simultaneously.

As shown in Graph 2, home prices have been growing steadily until the third quarter of 2005 at an average rate of 0.53%[3]: afterwards both level and growth dropped sharply reaching an average growth rate of -0,02% for the next 10 years. Also, the decline started in 2007, roughly one year before the bankruptcy of Lehman Brothers. Let me try to trace back the factors that influenced such boost and consequent drop of prices.

Graph 2.

S&P/Case-Shiller U.S. National Home Price Index and Growth



Note: Adapted with personal elaboration from http://us.spindices.com/indices/real-estate/sp-case-shiller-us-national-home-price-index

From 1994 to 2000 the stock market in the U.S. increased rapidly (see Figure 1). Both this increase and the subsequent slowdown had two effects on the housing market: on one side, the stock bubble of the 1990's fueled the demand for houses (more wealth is actualized in more consumption); on the other side the decrease in the market after a long

[3] After gathering the data from the S&P/Case-Shiller US Home Prices Index, I calculated the average rate of growth of prices for the periods of interest.

period of high generated a loss of confidence and as a consequence, investors shifted their attention to what they considered a more secure investment: the housing market (Baker,2008).

This was one of the initial factors that pushed up house prices. It was followed by the feedback loop initially mentioned. In fact, this increase in prices was then embedded in expectations and optimism started spreading among investors: no-one was considering that eventually the market would drop and even those who did were driven to continue investing by the perception of other's successes (Shiller, 2005).

As more homebuyers entered the market, the demand for houses increased and along with it the supply side.

In order to better demonstrate such an increase in housing construction, I plotted in Figure 2 both sales and construction of household houses in the U.S. We can see from the graph that not only construction increased (New Residential Construction line) in order to cope with higher demand but most remarkably sales and construction moved almost perfectly together until roughly 2006Q4: as a new house was completed it was almost immediately sold.

Such a fact is also deduced by looking at the iShares US Home Construction (ITB) Exchange-Traded Fund (ETF): since it comprises equity from the construction sector, its aim is to track the performance of this market segment. We notice that the ITB index level was quite high already at its initiation date (May 2006), with a drop during 2006Q3 and, after a catch up, a final drop in 2007Q2 (see Figure 3). Clearly, this is in line with the implications we deducted from Figure 1with the difference that the drop displayed in Figure 2 occurred with a lag of one year.

It is now reasonable to assess the reasons of such a drop.

A high demand for houses gave the opportunity to households that had "tarnished credit histories and little savings available for down payments" (Mayer et al, 2009) to be able to obtain subprime loans. They had incentive to do so for two reasons: mortgage interest rates were decreasing along with the decrease of federal funds rates (see Figure 4), which occurred simultaneously with the loss in confidence in the stock market of 2001; moreover, the standards for underwriting mortgages loosened (Shane,2008), as shown by the peak reached from mid-2004 to 2007 by the Total Mortgage Credit Availability Index (see Figure 5) and by the fact that subprime mortgages "nearly doubled from 1.1 million in 2003 to 1.9 million in 2005" (Mayer et al., 2009).

Finally, the increase in the number of homebuyers who were applying for a mortgage loan was further facilitated by the wrong incentives spread across investment bankers and also rating agencies: the former received profits based on their short-term performance and thus they had reason to increase their profits in any way; rating agencies instead were directly hired by banks, which could easily engage another agency if the rating was not fulfilling their expectations (Baker,2008). Also, the spread of complicated financial instruments, such as CDO's (Collateralized Debt Obligations), CDS's (Credit Default Swaps) and SIV (Structured Investment Vehicles) made it harder to give a reliable rating (Baker,2008).

According to Shiller (2005), as more people entered the market the more prices increased and this fueled an optimism which led prices to increase even further.

However, prices cannot grow up to infinity and in 2007 they began dropping with a negative average growth rate from the positive average of 2006 (see Graph 2).

As prices were decreasing, households began defaulting on their mortgage, also because they could not refinance through other mortgages (Mayer et al, 2009) and consequently the mortgage backed securities value plunged. Homebuyers exited the market and supply of houses increased given the high number of foreclosures (Baker, 2008): home prices dropped significantly and the real estate bubble burst.

2.2 The Asian Crisis (1997): The case of Thailand and Malaysia

On July 2nd 1997 the Bank of Thailand announced a devaluation of the Thai baht against the U.S. Dollar (Mydans, 1997): it was just the beginning of the currency crisis that soon would have spread to the neighbour countries.

Roughly ten years before the U.S. housing boom of 2007, Asia was experiencing an increase in prices both in the stock market and in the property market (Berg, 1999).

The roots of the rise in price levels and of the financial crisis that derived from it were established both at the macroeconomic and financial level. Given the high number of countries involved, for simplicity I will focus on two countries: Thailand (since it is the country where it all started) and Malaysia (since the housing market has experienced important visible shocks).

The SET (Stock Exchange of Thailand) Index surged from roughly 1993 to 1994 (see Graph 3), with its peak in 1993. In fact the market grew by 10% only in the two last quarters of 1993, compared to a 1.3% growth in the four years before

1993.

Graph 3.

Stock Exchange Thailand (1990-2000)

Note: Adapted from Bloomberg

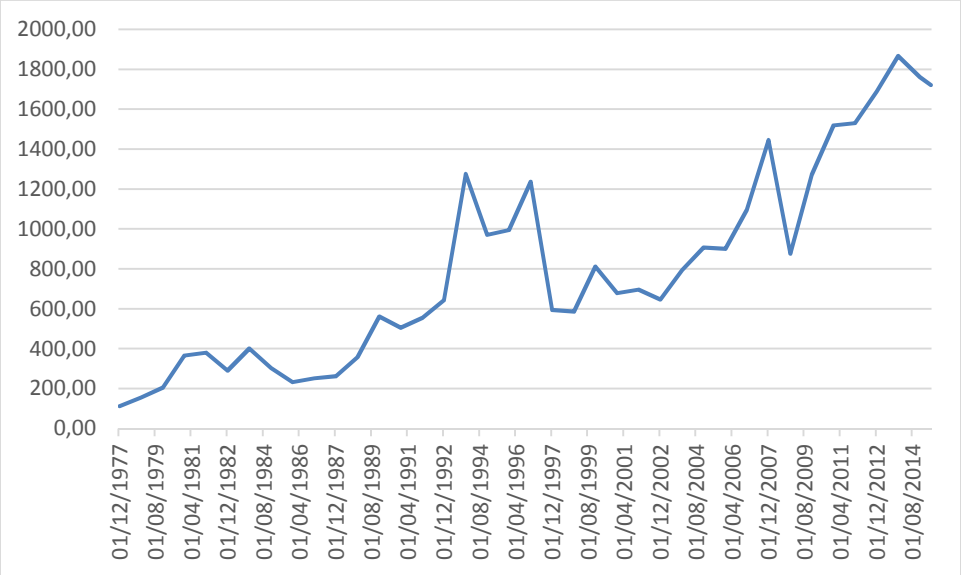
On the other side, Malaysia had a surge in prices of almost 70% from 1992 to 1993 and the market dropped by roughly the same amount from 1996 to 1997 [4](see Graph 4).

Also, as shown in Graph 5, Malaysia suffered another major shock in the housing market: house prices climbed at an average rate of 11% from 1990 to 1996 and fell by 73% only in the year from 1998 to 1999.

[4] The country was hit by a significant drop (50%) in the market also in 2008, but there is reason to believe that it was the effect of the global crisis.

Graph 4.

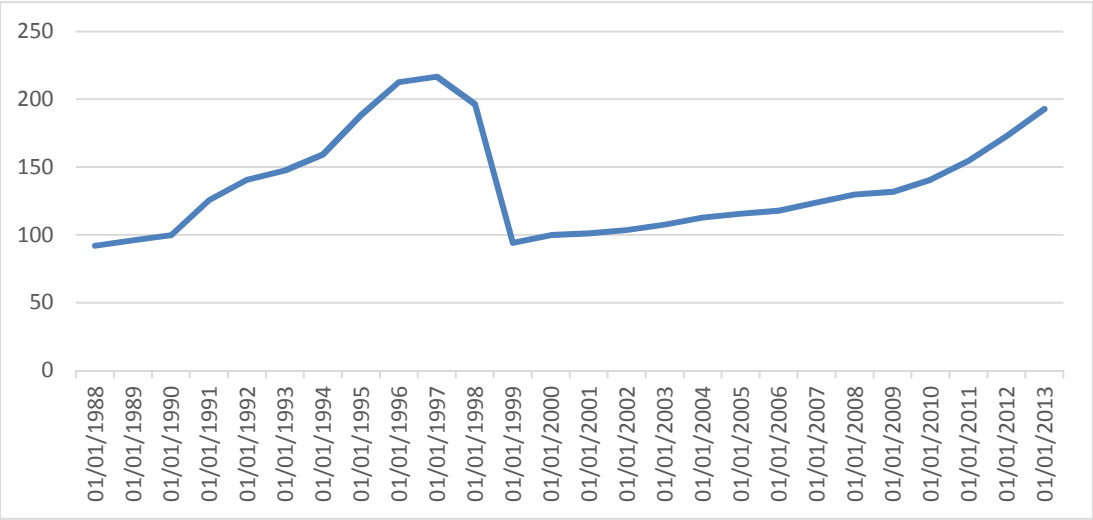
FTSE Bursa Malaysia KLCI Index - Kuala Lumpur Composite Index (FBMKLCI)



Note: Adapted from Bloomberg

Graph 5.

Malaysia House Price Index



Note: Adapted from Bloomberg

These facts were already subtly revealing the distress the economy was suffering. As a matter of fact, Corsetti et al. (1999) show that the countries that

suffered the most remarkable currency depreciation (compared to the U.S. dollar) were those with the highest current account deficits, such as Thailand and Malaysia. However, it is important to analyse the sustainability of such deficits. In fact we should look at which side of the current account (savings or investments) was the principal cause. Also, the openness of each country plays an important role (Berg, 1999) because it helps assessing their ability to repay the debt.

As it concerns the saving side, Corsetti et al (1999) show that the rate of savings in the period prior the crisis was high and most specifically, public savings did not decrease so that the imbalance in the current account was not generated by a decline in savings rather by an increase in investments.

In fact, during the 1990's Asian countries had a surge in investments (Berg, 1999).

In the years precedent the crisis most Malaysia and Thailand had been experiencing a growth in GDP (see Figure 6), as most of the Asian countries: even though some less than others, many had been considered economic miracles (e.g. the Asian Tigers). As GDP increased, so did the perception of the public that the country was accruing more and more wealth and the confidence attained drove people and firms toward new investments. Moreover, this growth had an impact on foreign investors as well since more availability of capital is motive for a proliferation of investments: capital inflows in Thailand were already increasing in 1994, while in Malaysia they only increased until the beginning of the 1990's (see Figure 7). Another important source was credit from the financial sector (see Figure 8): both Malaysia and Thailand were undergoing an escalation of lending. The problem of the lending boom lied in the quality of credit. Similarly to what in the real estate market in the U.S., banks were issuing credit

for investments which had a questioning profitability. As a matter of fact, once the bubble burst and the crisis hit, the number of non-performing loans as a percentage of total loans increased almost fivefold from 1997 to 1998 in Malaysia, while in Thailand the rise from 1995 to 1998 was almost six fold (see Chart 1).

Moreover, another macroeconomic source of the crisis was the trade shock they experienced which pushed down the number of exports from 1996 to 1997 (see Figure 9). This occurred because of the competitive pressure of the Chinese rising economy and the slow recovery of the Japanese economy (Corsetti, Pesenti, & Roubini, 1999).

In the next chapter I will empirically evaluate the asset bubbles of U.S., Thailand and Malaysia in order to give a more concrete ground to the analysis I made so far and an assessment of the rationality I talked about in the first chapter.

CHAPTER III

EMPIRICAL ANALYSIS

Before engaging in the empirical analysis of the previously described events, I will briefly review the monetary policy implemented before and after the burst and the manifestation of the bubble.

3.1 Monetary Policy Responses to the Housing Bubble

<< We as central bankers need not be concerned if a collapsing financial asset bubble does not threaten to impair the real economy, its production, jobs, and price stability. >>

Alan Greenspan, 1996

Alan Greenspan, Chairman of the Federal Reserve from 1987 to 2006, in his famous speech held at the end of 1996 questions the role of monetary policy in preventing asset bubbles, given that the cause is "irrational exuberance" (Greenspan, 1996) and its burst may also have little effect on the economy as a whole. However, as we have seen, this is a questionable statement (especially in the case of Asia): the economic stability of a country is also linked to its financial stability.

In the following paragraphs I will outline the policy measures of the three countries investigated above.

3.1.1 The U.S. Housing Bubble

When the housing market crashed, the Federal Reserve planned an immediate meeting with the FOMC on Tuesday 16th 2008 in order to inhale stimulus for a recovery: they turned to the large-scale asset purchase (LSAP), referred to as quantitative easing, or QE (Fed's Press Release, 2009). This policy decision comprised the purchase of long-term Treasuries and Mortgage-Backed Securities (MBS) which, through the portfolio balance channel, would have reduced the available supply of those securities (thus increasing price) and as a consequence reduced their yields.

As an evidence, Kozicki et al. (2011) show that in fact the yield on 10-year Treasuries dropped, as did the Mortgage Backed Security rate, and also the GDP growth reached significant values when the announcement was made. Another type of unconventional monetary policy the Fed undertook was credit facility, aimed at purchasing assets from the private sector with the intention to decrease interest rates and increase liquidity (Kozicki et al., 2011). In fact credit facilities "have made a positive contribution to the functioning of the targeted markets" (Kozicki et al, 2011).

As we can see, those measure had a role in helping the economy to recover from the burst of a bubble.

Thornton (2012) outlines two major policy strategies prior the Lehman Brother's bankruptcy: the reduction in the target federal funds rate which occurred from 2007 to 2008 and the supply of credit through the TAF (Term Auction Facility).

As we can see from Figure 4, the federal funds rate decreased from 5.02% to 1.92% from 2007 to 2008: the Federal Open Market Committee decided to decrease the federal funds rate target by 325 bpt throughout the year (Thornton,2012). The goal of such a policy instrument was "to foster price stability and sustainable economic growth" (FRB, 2007).

However, a decrease in federal funds rate could fuel the credit boom: banks have more incentive to borrow from the Fed since the cost of borrowing is lower, the availability of credit (along with bad credit as well) will increase and the enhanced optimism would bring more participants to the market, pushing prices up. The same reasoning may apply for the TAF: supplying credit increases the perception of wealth to the public, which encourages feedback loop which puts a further up pressure on prices.

This was not the case of the U.S. housing market crash since in those years house prices were in their declining path (see Graph 2). Detecting an asset price bubble is a fundamental ingredient to the efficiency of monetary policy in containing prices. The research on this topic has always been wide, but has also produced contradictory results, leading to no general accepted solution.

3.1.2 The Asian Region

In the years prior the crisis, the monetary authorities of the Asian countries decided to keep their interest rates low, even though their currencies had already been facing some tension, and to preserve on loose monetary policy (Corsetti, Pesenti, & Roubini, 1999). However, engaging in such measures would have meant stimulating the increase in prices even more. In fact, a loose monetary policy expands the supply of money giving a signal of prosperity to the public: as a result investments and loan applications are expanded. As a matter of fact, as we have already discussed, credit and investment increased.

Furthermore, the government of the countries in question also spread the news of a bail-out plan: they were ready to sustain the companies which were facing financial difficulties and were about to file bankruptcy (Corsetti, Pesenti, & Roubini, 1999). Those measures were contradictory and could not be implemented together. Indeed, guaranteed government intervention and extensive supply of money in the market are two elements that in the long-run can only bring to the malfunctioning of the financial market as well as the whole economy.

In fact, what happened after was exactly a series of devaluations that started in Thailand in the summer of 1997 and spread to the whole region. The currencies kept depreciating for the whole summer.
Only when the stream of depreciations was substantial, the monetary authorities decided to implement tight monetary policy and increase interest rates. Such an intervention was aimed at restoring what had been the initial (bad) credit boom (Corsetti, Pesenti, & Roubini, 1999).

On the other side, having supply contracted in a crisis period had meant also an increase in bankruptcies because people and firms began to default on their loans.

In the following paragraph I will engage in an empirical analysis of the rationality of the three cases described.

3.2 Empirical Results

I have based my evaluations on Shiller's Variance Bound Test in order to see whether the housing bubble, the rise in prices in the SET and the bubble of the stock market in Malaysia were driven by rationality. This is certainly a simplified analysis of asset price bubbles. As a matter of fact, there are many other tests, such as West's two-step tests "that explicitly put a bubble in the alternative hypothesis" (Gürkaynak, 2008) and whose technical aspect goes beyond my reach.

I made the calculations in each of the three cases following Shiller's (1980) approach: after collecting data on the prices and dividends (or rents), I eliminated the trend from both of them. Before moving on, I would like to make a remark: I thought it would be more reliable to gather data until the peak of the bubble; I did so for the U.S., using data from 1994 to 2007, but for Malaysia and Thailand the only data retrievable were from 1993 and, since the peak was in 1997, I could not use a dataset comprised of only four observations, so I decided to include all the data up to 2015.

The trend factor was calculated by regressing the logarithm of respectively the price levels and the dividend (rent) levels on time:

$$Price = \beta_0 + \beta_1 Time \quad (4)$$

And

$$Dividend\ (Rent) = \beta_0 + \beta_1 Time \quad (5)$$

The results I obtained from those regressions are significant both at the 1% lev el of confidence in the case of the U.S. housing market (see Chart 2) and the stock mark et in Malaysia (see Chart 4). As it concerns the stock exchange of Thailand, the coefficie nt on time of Equation (4) is not significant, while the coefficient on time of Equation (5) is significant at the 5% level (see Chart 3). I will deepen this aspect as I go on with the analysis.

In order to calculate the detrended prices (p) I divided the observed prices of all the thre e countries by the respective factor proportional to the trend (Shiller, 1980), obtaining th e values in Chart 5 for the U.S. and Chart 6 for Thailand and Malaysia.

The next step required the computation of the ex-post rational prices (p*)[5]: I calculated the latter backward using the observed values of dividends (rents) until time T in order to evaluate what would have been a rational price at time *t.* I found, thus, the terminal value at time T (average of the detrended prices of the sample[6]) and from it I proceeded backward from the last period (2015 for Thailand and Malayisia and 2007Q1 for U.S.) to calculate the detrended ex-post rational prices:

[5] Results are shown in Chart 5 and 6.

[6] I choose 2006 since that year prices started to decline and it would have been more relevant to evaluate only the period in which observed prices were increasing.

$$p_t^* = \gamma(p_{t+1}^* + R_t) \quad (6)$$

Where:

- γ "is the real discount factor for detrended series" (Shiller,1980) , given by (1+g)/(1+r), with g being the growth factor and r the discount factor[7]
- p_{t+1}^* is the ex-post rational price at time t+1, with the last value the Terminal value
- R_t is the detrended rent

As I described in the first chapter, $p*$ is the optimal forecast of what would hav e been the value of the ex-post rational price (Shiller,1981). However, there will be a for ecast error (ε), which will be given by the difference of expected and observed dividend (rental) prices and thus also by the difference of observed prices and ex-post rational pri ces.

Thus

$$Var(p) = Var(p*) + Var(\varepsilon) \quad (7)$$

From Equation (7), "a rational forecast should be less variable than the object being fore casted" (Lansing, 2007) and thus:

$$Var(p) \leq Var(p*) \quad (8)$$

[7] The discount factor r was calculated as the mean value of detrended dividends divided by the mean value of detrended observed prices. The growth g was the coefficient found with equation 4 and 5.

Equation (8) represents the Variance Bound Test. I then calculated the respective Varian ces for each case, as represented below.

For the U.S. real estate market:

$Var(p)$ =62,670,774

$Var(p*)$ = 769,749,137

For the Stock Exchange Thailand:

$Var(p)$ = 128,439.5

$Var(p*)$ = 10,395.5

For Malaysia stock market:

$Var(p)$ = 42,361.92

$Var(p*)$ = 48,863.24

As we can see, the Variance of p is actually less than the variance of p* in the c ases of the U.S. and Malaysia. Instead, for Thailand it is the variance of the ex-post ratio nal prices which is lower than the variance of the observed detrended prices.

These findings suggests that the housing bubble of 2007/2008 and the bubble o f the Malaysian market were in fact rational: rationality implies that people's expectatio n embody all the available information at the time and in fact if prices start to increase d ue to structural factors, the public and investors will perceive it as continuing to increase also in the next period and so on. The difference in the variances in the case of the U.S. h ousing bubble is greater than in the case of Malaysia: the effect of the structural factors was possibly more enhanced and also the increase in the market was continuous without

important up and downs (see Graph 2). Malaysia did not have the linear increasing trend we see for the U.S., in fact it is characterized by more fluctuations, and even substantial ones (see Graph 4). The case for the housing market for Malaysia could resemble the cas e of the U.S. housing market (see Graph 5) however I could not analyse it since I could n ot retrieve data on rental levels.

Thailand, instead, presents the opposite situation: the variance of the ex-post ra tional price is lower than the variance of the actual prices. I would abstain from interpret ing this output since I attained p and p* using the coefficients on time of Equation (4) an d (5), whose significance was very low and not reliable.

The Variance Bound Test has been criticised for its incapacity to detect a bubb le and it has been argued that it is a mere test of the validity of the discounted cash flows as a method for calculating prices (Gurkayanak,2008). Nevertheless, I considered it a go od starting point, since it gives some useful insights on the definition of asset price bubb le: it is fundamental to be able to identify the phenomenon, before being able to explore it in more depth.

CONCLUSIONS

Irrationality has always been identified as being a distinct feature of asset price bubbles and the authenticity of such a belief has been hardly put into question. If we explore the phenomenon of asset price bubbles more in depth, we come across a rarely used method to price assets: prices are generated by the sum of the fundamental value and a bubble component. Given that a price is rational when it fulfils this equation, there is no reason to see a simple departure from the fundamental value as the consequence of irrational behaviour, after all we are still computing prices based on our optimal forecasts of the future.

The U.S. and the Asian cases have demonstrated to be two useful illustrations of the above definition of asset bubble. In fact, the cases of the housing bubble, in 2007, and the Asian region (particularly Malaysia) in 1997, seem to have behaved in accordance with the Variance Bound Test: the volatility of the actual detrended prices was in fact lower than the volatility of the prices that would have been rationally estimated at the time. The outcome is justified by the fact that the ex-post rational price is a forecast and as such is accompanied by a computational error which will make it deviate from the actual prices.

From such a result, we can deduce that what had been widely considered irrational speculative bubbles, were instead a rational manifestation of the phenomenon.

The two examples analysed did fulfil my intention to demonstrate that a speculative bubble can be the product of rational behaviour and not, as the public widely believes, the consequence of agent's unreasonable choices. In fact, psychological factors do have a significant role in markets: investors are influenced by other investor's behaviour and households are persuaded by illusionary prosperity. Those circumstances are not the ground for irrational behaviour, but lay the basis for misinterpretation instead. Nevertheless, the historical cases of asset price bubbles are many and it may very well be that some of them do not satisfy the rational equation described.

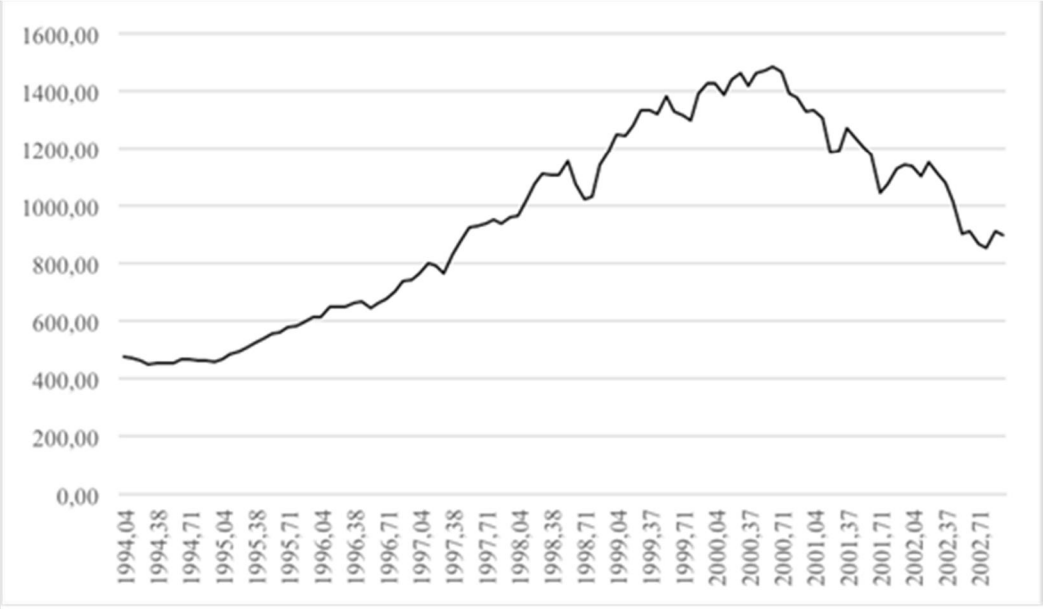
I must say that the model I used is simple and straightforward: Gürkaynak (2008) has reviewed the problems related to the model and one of them lies in the use of the mean price as the terminal value. Furthermore, he specifies that "variance bounds tests are used to evaluate the present value model, and are not specific to testing for bubbles" (Gürkaynak,2008). As a matter of fact, for not falling into erroneous usage of the model, I implemented it as a simple device for rationality testing.

The ambiguity of the definition of an asset price bubble remains still an open dispute and further clarification of the definition of the phenomenon is required in order to be able to face and prevent future occurrences with a more efficient approach.

APPENDIX

Figure 1.

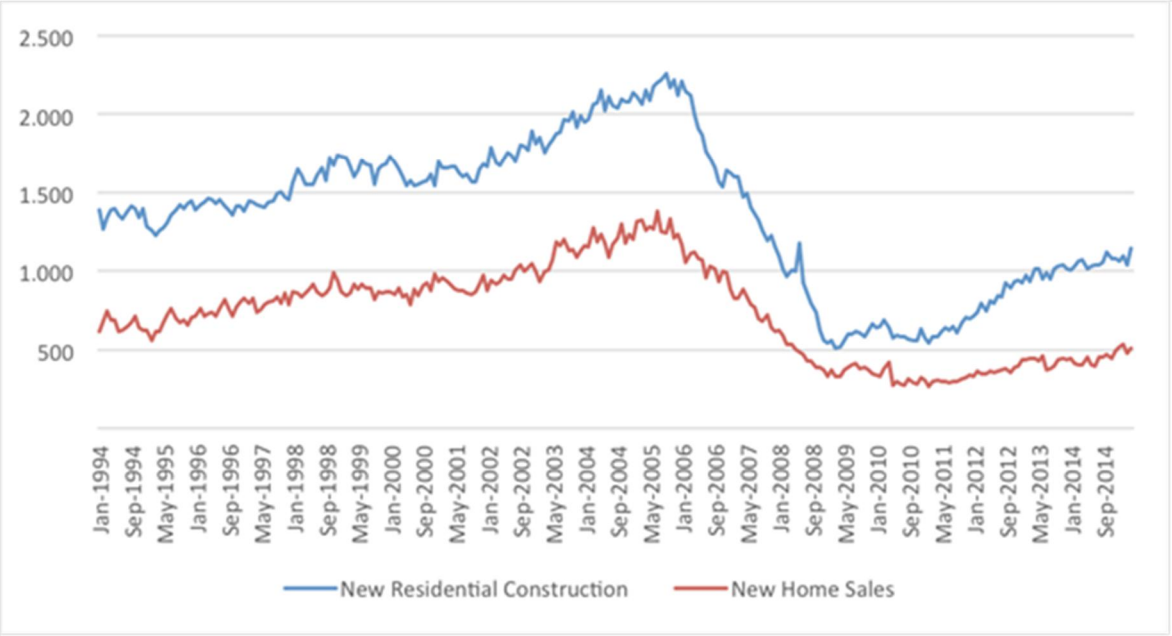
S&P Composite Index



Note: Adapted from http://us.spindices.com/indices/equity/sp-composite-1500

Figure 2.

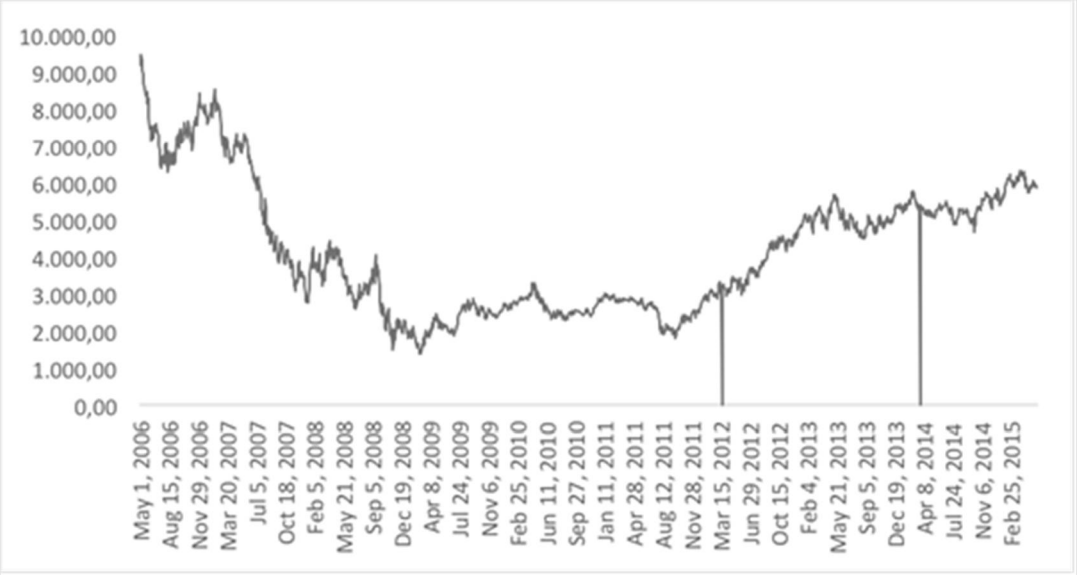
New Residential Construction vs. New Home Sales



Note: Adapted from http://www.census.gov/econ/currentdata

Figure 3.

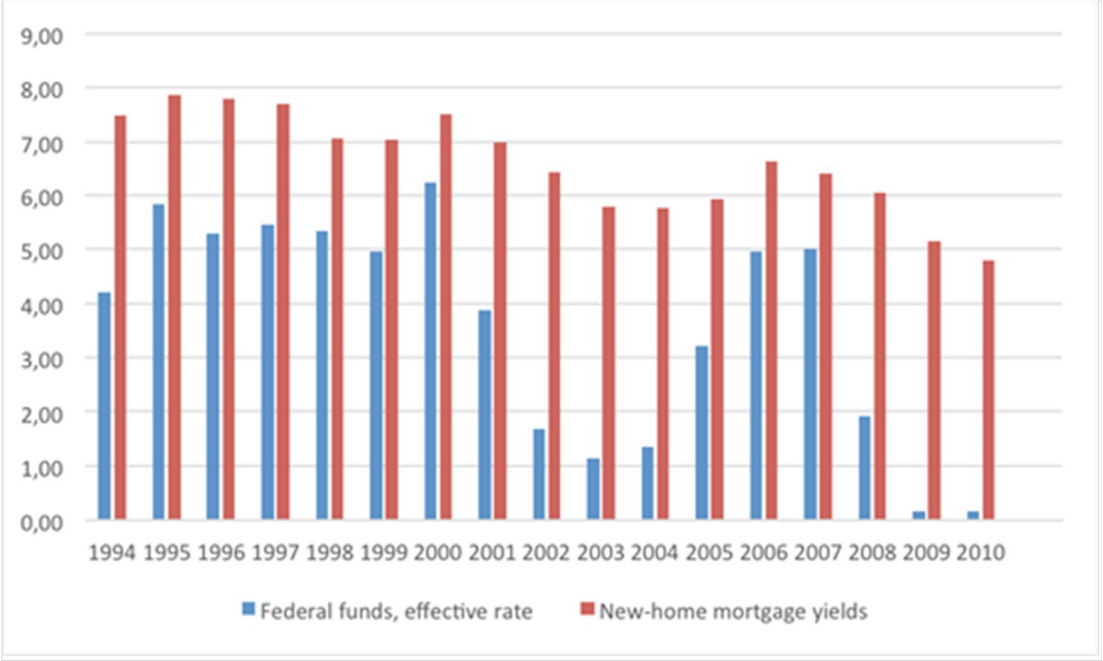
ITB (US Home Construction ETF) Index Level



Note: Adapted from http://www.ishares.com/us/products/239512/ishares-us-home-construction-etf

Figure 4.

Federal Funds Rates vs Mortgage rates in the U.S.



Note: Adapted from

http://www.census.gov/compendia/statab/cats/banking_finance_insurance/money_stock_interest_rates_bond_yields.html

Figure 5.

Total Mortgage Credit Avalaibility Index.

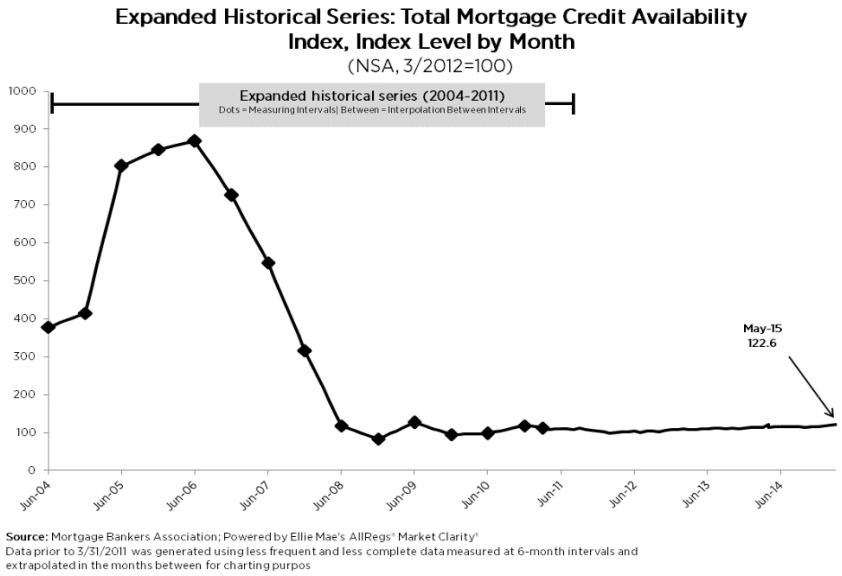
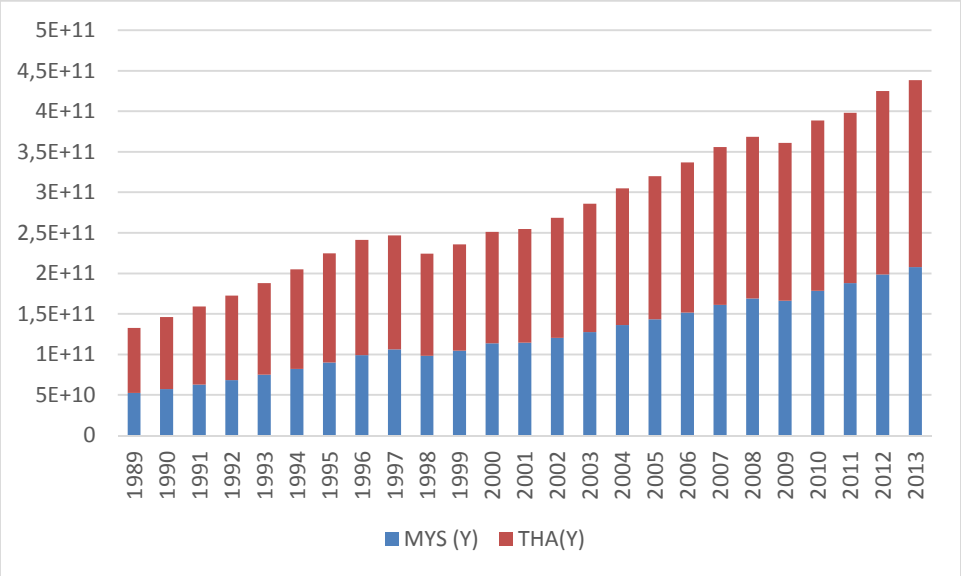


Figure 6.

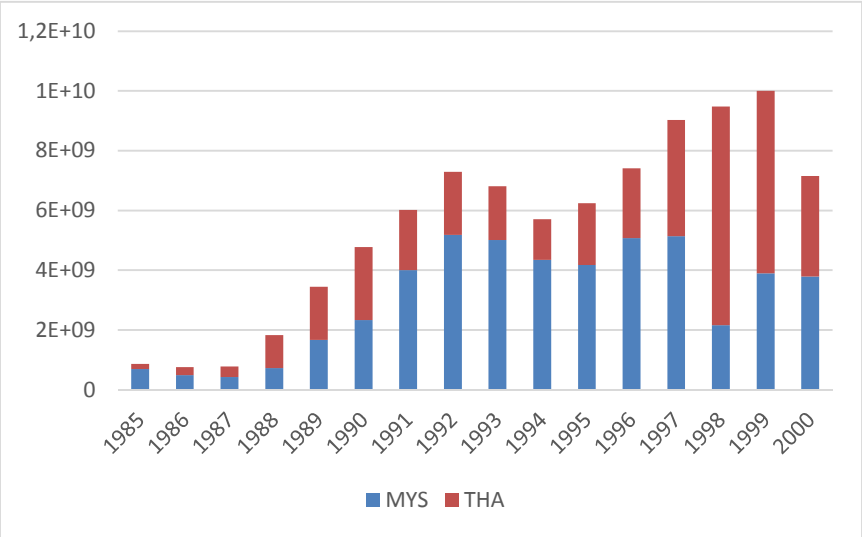
Gross Domestic Product for Thailand and Malaysia



Note: Adapted from http://data.worldbank.org/indicator/NY.GDP.MKTP.KD

Figure 7.

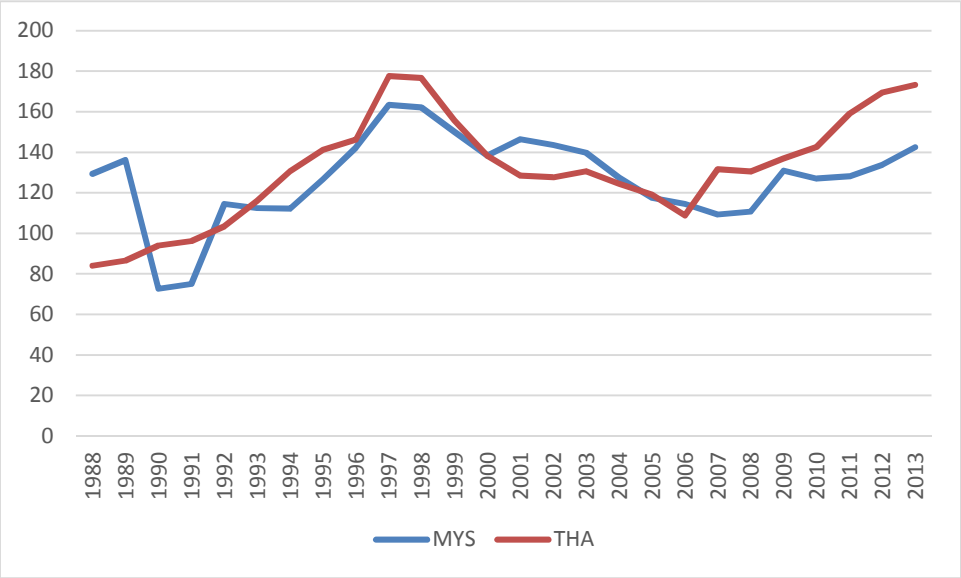
Foreign direct investment, net inflows (% of GDP)



Note: Adapted from http://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD

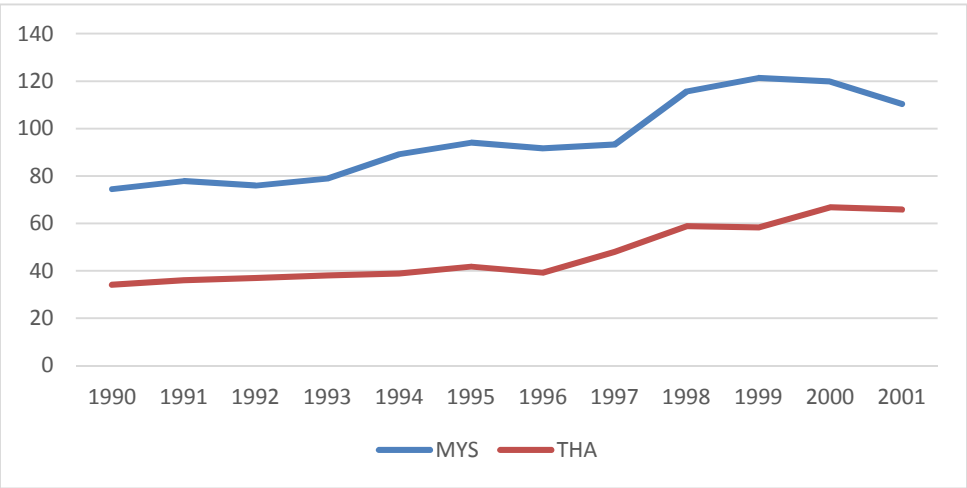
Figure 8.

Domestic credit provided by financial sector (% of GDP)



Note: Adapted from http://data.worldbank.org/indicator/FS.AST.DOMS.GD.ZS

Figure 9.
Exports of goods and services (% of GDP)



Note: Adapted from http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS

Chart 1.

Nonperforming Loans as Percentage of Total Loans

Date	*MYS*	*THA*
1994	8.1	7.5
1995	5.5	7.7
1996	3.9	n.a
1997	4.1	n.a
1998	18.6	42.9
1999	16.6	38.6

Note: Adapted from World Bank and Bank of International Settlement (1997 Annual Report)

Chart 2.

Regression Results for the Trend on the U.S. Housing Market

	Dependent Variable	
	LogPrice	*LogRent*
Time	0.018344**	0.007979**
Constant	11.6158**	8.740**
Observations	53	53
R^2	0.9541	0.9964

**Significant at the 1% level

Note: Regression Output self-Conducted

Chart 3.
Regression Results for the Trend in Thailand Stock Exchange

	Dependent Variable	
	LogPrice	*LogDividend*
Time	0.02562	0.05570*
Constant	6.3142**	2.36007**
Observations	23	23
R^2	0.09334	0.1642

**Significant at the 1% level
*Significant at the 5% level

Note: Regression Output self-Conducted

Chart 4.

Regression Results for the Trend in Malaysia Market

	Dependent Variable	
	LogPrice	*LogDividend*
Time	0.035944**	0.0877**
Constant	6.529184**	2.2674**
Observations	23	23
R^2	0.4299	0.8817

**Significant at the 1% level
*Significant at the 5% level

Note: Regression Output self-Conducted

Chart 5.

Detrended Observed Prices (p) and Ex-Post Rational Prices (p) for the U.S. Housing Bubble*

Year	**P**	**p***
1994.125	124572.1	214897.4
1994.375	123021.8	213955.5
1994.625	121511.3	213027.8
1994.875	120098.7	212057.7
1995.125	118859	211081
1995.375	117803.4	210085.7
1995.625	116841	209079.4
1995.875	115871.7	208054.2
1996.125	114850.1	207005.8
1996.375	113764	205938
1996.625	112667.5	204846.6
1996.875	111622.8	203727.4
1997.125	110670.1	202584
1997.375	109827.8	201416
1997.625	109090.9	200215.6
1997.875	108416.4	198978.7
1998.125	107763.2	197708.4
1998.375	107105.1	196407.9
1998.625	106459.7	195069.6

1998.875	105839.4	193682.1
1999.125	105271.2	192251.9
1999.375	104789.9	190792.6
1999.625	104413	189303.7
1999.875	104144.5	187777.7
2000.125	103993.2	186193.2
2000.375	103932	184556.2
2000.625	104602.7	182883
2000.875	104260.1	181170.7
2001.125	103706.8	179412.4
2001.375	105051.3	177603.2
2001.625	105756.6	175730.2
2001.875	104533	173792.4
2002.125	104238.1	171779.8
2002.375	106063.9	169702.3
2002.625	107493.5	167567
2002.875	107633.3	165379.8
2003.125	107282	163141.6
2003.375	108378.9	160857.4
2003.625	109791.7	158549.3
2003.875	110862.8	156204.2
2004.125	111930	153809
2004.375	114946.3	151372.1
2004.625	117044.7	148879.4
2004.875	118248.9	146338.3
2005.125	120513	143756
2005.375	123624.8	141117.9
2005.625	125811.2	138430.8
2005.875	126200.2	135691.1
2006.125	125077	132894.1
2006.375	123680.4	130024.5
2006.625	120317.4	127059.9
2006.875	117129.3	123998.8
2007.125	137652.2	120850.7

Chart 6.

Detrended Observed Prices (p) and Ex-Post Rational Prices (p) for Malaysia and Thailand*

Date	pMYS	p*MYS	pTHAI	p*THAI
31/12/1993	1231.075	1434.393	1640.812	1010.833
30/12/1994	904.9903	1395.493	1292.989	980.2503
29/12/1995	895.1452	1355.22	1187.204	946.3686
31/12/1996	1074.9	1315.754	751.5414	914.4729
31/12/1997	498.2359	1277.527	328.4092	879.7883
31/12/1998	474.2271	1238.093	305.7027	853.1036
31/12/1999	634.4396	1204.31	403.7101	847.8642
29/12/2000	512.3917	1172.763	219.8706	843.6828
31/12/2001	506.5869	1140.002	241.9808	838.1092
31/12/2002	454.0478	1108.431	276.8027	830.9767
31/12/2003	538.4025	1078.052	584.5887	821.8287
31/12/2004	594.0157	1046.404	493.178	810.0637
30/12/2005	568.5797	1013.325	513.7002	796.5776
29/12/2006	668.6844	979.0224	477.0852	780.7724
31/12/2007	850.8594	947.5015	587.1387	763.7875
31/12/2008	498.3359	913.3531	300.1858	750.1258
31/12/2009	698.3371	879.748	477.799	733.4828
31/12/2010	804.4688	852.9997	655.0022	720.7168
30/12/2011	782.6023	822.9797	634.0395	704.1092
31/12/2012	833.5367	795.2413	839.2431	686.83
31/12/2013	889.423	767.6378	763.4772	670.8785
31/12/2014	809.9529	741.2382	858.4471	654.1213
15/06/2015	764.5003	716.8582	839.3615	637.9247

BIBLIOGRAPHY

Baker, D. (2008). The housing bubble and the financial crisis. *Real-world economics review*, *46*, 73-81

Bank for International Settlement (1998). *68th Annual Report, 1st April 1997–31st March 1998.*[Chart]

Berg, M. A. (1999). *The Asia crisis: Causes, policy responses and outcomes* (No. 99-138). International Monetary Fund.

Bloomberg (2015). *Malaysia House Price Index* [Graph]. Retrieved from Bloomberg

Bloomberg (2015). *Stock Exchange Thailand* [Graph]. Retrieved from Bloomberg.

Bloomberg (2015).*FTSE Bursa Malaysia KLCI Index - Kuala Lumpur Composite Index (FBMKLCI).* [Graph] Retrieved from Bloomberg.

Chari, V. V., Christiano, L., & Kehoe, P. J. (2008). Facts and Myths about the Financial Crisis of 2008. *Federal Reserve Bank of Minneapolis Working Paper*, *666*.

Corsetti, G., Pesenti, P., & Roubini, N. (1999). What caused the Asian currency and financial crisis? *Japan and the world economy*, *11*(3), 305-373.

Davis, M. A., Lehnert, A., & Martin, R. F. (2008). The Rent-price Ratio for the Aggregate Stock of Owner-occupied Housing. *Review of Income and Wealth*,*54*(2), 279-28.

Evans, R. (2008). Who is to blame for the crisis? Supply and demand approach Retrieved 01-06-15, from http://www.econosseur.com/2008/10/who-is-to-blame-for-the-crisis-supply-and-demand-approach.html

FRB: Press Release (2007). *Home,News and Events: 2007 Monetary Policy Releases.* Retrieved on 06-06-15 from: http://www.federalreserve.gov/newsevents/press/monetary/20070918a.htm

FRB: Press Release (2009). *Home,News and Events: 2009 Monetary Policy Releases.* Retrieved on 12-0613 from: http://www.federalreserve.gov/newsevents/press/monetary/20090128a.htm

FRB: Speech, Greenspan (1996). The Challenge of Central banking in a democratic society. *speech at Annual Dinner and Francis Boyer Lecture of The American Enterprise Institute for Public Policy Research, Washington, D.C.* Retrieved on 24-04-2015, from http://www.federalreserve.gov/boarddocs/speeches/1996/19961205.htm

Gürkaynak, R. S. (2008). Econometric tests of asset price bubbles: Taking stock*. *Journal of Economic Surveys*, *22*(1), 166-186.

iShares (2015). *iShares US Home Construction ETF.*[Figure]. Retrieved from http://www.ishares.com/us/products/239512/ishares-us-home-construction-etf

Kozicki, S., Santor, E., & Suchanek, L. (2011). Unconventional monetary policy: the international experience with central bank asset purchases. *Bank of Canada review*, *2011*(Spring), 13-25.

Lansing, K. J. (2007). Asset price bubbles. *FRBSF Economic Letter*.

Mayer, C., Pence, K., & Sherlund, S. M. (2009). The rise in mortgage defaults. *The Journal of Economic Perspectives*, *23*(1), 27-50.

Mishkin, Frederic S. (2013). "The Economics of Money, Banking, and Financial Markets". *Pearson Global Tenth Edition.*

Mortgage Bankers Association (2015). Mortgage Credit Availability Index [Figure]. Retrieved on 09-06-2015, from https://www.mba.org/news-research-and-resources/forecasts-data-and-reports/single-family-research/mortgage-credit-availability-index

Mydans, S. (1997,July 3). The Thai Gamble: Devaluing Currency to Revive Economy. *The New York Times.*

R. J. Shiller (1981). Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends? *American Economic Review* 71, 421–36.

S&P Dow Jones Indices (2015). *S&P Case/Shiller National Home Price Index* [Graph]. Retrieved from http://us.spindices.com/indices/real-estate/sp-case-shiller-us-national-home-price-index

Shane, M. (2008). The Past, Present, and Future of Subprime Mortgages. *The Federal Reserve Board, Finance and Economics Discussion Series*, (2008-63),

Shiller R. J. (2005). *Irrational exuberance*. Princeton University Press

Siegel, J. J. (2003). What is an asset price bubble? An operational definition. *European financial management*, *9*(1), 11-24.

Thornton, D. L. (2012). The Federal Reserve's response to the financial crisis: what it did and what it should have done. *FRB of St. Louis Working Paper 2012-050A*

United States Census Bureau (2015). *Money Market Interest Rates and Mortgage Rates.* [Figure]. Retrieved from http://www.census.gov/compendia/statab/cats/banking_finance_insurance/money_stock_interest_rates_bond_yields.html

United States Census Bureau (2015). *New Residential Construction* and *New Home Sales* [Figure]. Retrieved from http://www.census.gov/econ/currentdata

World Bank (2015). *Bank nonperforming loans to total gross loans (%)* [Chart]. Retrieved from http://data.worldbank.org/indicator/FB.AST.NPER.ZS

World Bank (2015). *Domestic credit provided by financial sector (% of GDP.* [Figure]. Retrieved from *http://data.worldbank.org/indicator/FS.AST.DOMS.GD.ZS*

World Bank (2015). *Exports of goods and services (% of GDP)* [Figure]. Retrieved from *http://data.worldbank.org/indicator/NE.EXP.GNFS.ZS*

World Bank (2015). *Foreign direct investment, net inflows (% of GDP)* [Figure]. Retrieved from *http://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD*

World Bank (2015). *GDP (constant 2005 US$).* [Figure]. Retrieved from *http://data.worldbank.org/indicator/NY.GDP.MKTP.KD*