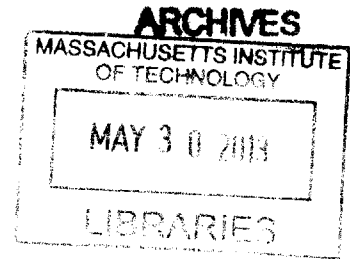


An Overview of Potential Financial Bubbles in the US Financial Markets

By

Marco Antonio V. Sadalla

B.S. Aeronautical Engineering
Instituto Tecnológico de Aeronáutica, 2002



SUBMITTED TO THE MIT SLOAN SCHOOL OF MANAGEMENT IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF BUSINESS ADMINISTRATION
AT THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JUNE 2013

©2013 Marco Antonio V. Sadalla. All rights reserved.

The author hereby grants to MIT permission to reproduce
and to distribute publicly paper and electronic
copies of this thesis document in whole or in part
in any medium now known or hereafter created.

Signature of Author: _____

A handwritten signature in black ink, appearing to be "M. Sadalla", written over a horizontal line.

MIT Sloan School of Management
May 10, 2013

Certified by: _____

A handwritten signature in black ink, appearing to be "Robert C. Merton", written over a horizontal line.

Robert C. Merton
School of Management Distinguished Professor of Finance
Thesis Supervisor

Accepted by: _____

Maura Herson
Director, MBA Program
MIT Sloan School of Management

This page was intentionally left blank

2020-2021

An Overview of Potential Financial Bubbles in the US Financial Markets

By

Marco Antonio V. Sadalla

Submitted to the MIT Sloan School of Management on May 10, 2013
in Partial Fulfillment of the Requirements for the
Degree of Master of Business Administration

Abstract

Financial bubbles have presented a challenge for the financial markets for a long time and caused steep losses for many investors. This thesis has two main goals relating to financial bubbles. The first is to try to determine if it is possible to find out if a financial bubble is forming. To accomplish that, the economic theories that govern bubble formation and burst are analyzed and the models that exist to predict bubble formation are discussed. A new model is suggested and is applied in the US financial markets to determine if any of the asset classes are currently risking the development of a bubble. This analysis suggests that one asset class is likely to be developing a bubble and this thesis further discusses this asset class.

The second objective of this thesis is to suggest alternatives that prudent investors could introduce to protect themselves from some of the worst consequences of bubbles. This thesis will suggest models inspired by completely different industries: the air transportation industry with its high safety standards; the oil industry with its long-term planning; and the socially responsible investment industry, with its self-regulatory structure.

Thesis Supervisor: Robert C. Merton
Title: School of Management Distinguished Professor of Finance

This page was intentionally left blank

Acknowledgments

I am heartily thankful to my advisor, Professor Robert C Merton, whose encouragement and guidance pushed me to think further in innovative ways and enabled me to develop a deep understanding of the subject.

Special thanks to the MIT community, in particular to Professors Eric Jaquier, Stewart Meyers, John Cox , Simon Johnson, Saman Madj and Athanasios Orphanides, whose thoughtful teachings helped me to explore the field of finance. Furthermore I would like to extend my thanks to my colleagues at the MBA program - the network of intellectually curious individuals who frequently discussed with me topics related to finance and bubbles and helped me in many different ways.

Finally I would like to thank my parents for instilling in me the desire to work hard and for sharing with me the values that brought me to MIT.

This page was intentionally left blank

Table of Contents

Abstract	3
Acknowledgments	5
List of Figures	9
List of Tables	9
1 Introduction	11
2 Theory and examples of bubbles	12
2.1 Bubble definition.....	12
2.2 Theories related to the bubble dynamics.....	17
2.2.1 The Efficient Market Hypothesis	18
2.2.2 The Adaptive Market Hypothesis	19
2.2.3 The Three Lenses Framework.....	20
2.2.4 The Theory of Reflexivity.....	22
2.2.5 The Minsk Model of Booms and Busts	22
2.2.6 Economic models biases	27
2.3 Examples of relevant financial bubbles.....	28
2.3.1 Tulip mania in Amsterdam	29
2.3.2 South Sea Company	32
2.3.3 The Great Depression in the US	35
2.3.4 The Japanese Real Estate Bubble	37
2.3.5 The Internet Bubble	39
2.3.6 The 2008 US Housing Bubble	41
2.3.7 Overview of the selected bubbles	46
3 Framework to spot bubbles “ex-ante”	48
3.1 Disclaimer on bubble searching	48
3.2 Economic vs finance models as tools	49
3.3 Bubble “Score” strategy	50
3.3.1 Risk factors	51
3.3.2 Mitigating factors	54
3.3.3 Combining the factors	55

3.4	Timeframe.....	58
3.5	Mathematical overview – JLS Model.....	60
4	Analysis of potential bubbles in the US.....	62
4.1	Remarks about the asset classes not scored with the Bubble Score model.....	65
4.2	Results of the Bubble Score model.....	67
4.3	Results of the JLS Model.....	72
4.4	Remarks about U.S . Treasury bonds.....	73
4.4.1	Market Risk.....	74
4.4.2	Default Risk.....	80
4.4.3	The uncertain nature of bubble prediction.....	80
4.5	Remarks about corporate bonds.....	81
4.6	Remarks about other commonly mentioned potential bubbles.....	83
5	Institutional alternatives to reduce the severity of bubbles.....	85
5.1	Investor-driven alternative – “Anti-bubble Fund Style”.....	86
5.1.1	Put protective strategy.....	88
5.2	Regulatory Alternative – Agency to map risks.....	89
6	Conclusion.....	92
7	References.....	94

List of Figures

Figure 1: Housing Prices Index Evolution and selected news 16

Figure 2: South Sea Company share prices 34

Figure 3: Price / Earnings evolutions..... 40

Figure 4: Real Estate prices evolution in different cities 43

Figure 5: Index levels used on the JLS model 72

Figure 6: Evolution of newly issued 30 Year Treasuries Yields 75

Figure 7: Decomposition of 30 Year treasuries returns in Coupon and “Duration” effect 77

Figure 8: Calculation of 30 Year Treasuries returns implied by Chairman Ben Bernanke forecasts 79

Figure 9: Evolution of Assets of US Corporations..... 82

Figure 10: Evolution of Profits of US Corporations 82

Figure 11: Private Student Loans Gross Cumulative Defaulted Dollars curves by repayment entry vintage by years of seasoning for five non-profit lenders (that account for 85% of the PSL universe)..... 84

List of Tables

Table 1 - Total Mint Output of the South Netherlands, 1598-1789 (in guilders) 30

Table 2: Evolution of US real GDP 42

Table 3: Exposure of Financial Institutions to Housing Risk on the Eve of the Crisis (\$ Billions) 44

Table 4: Lehman Brothers HEL Bond Conditional Forecasts of Losses on Subprime Investments 45

Table 5: Overview of the selected Bubbles 47

Table 6: Calculation of the weights of the risk factors for the bubble score model 56

Table 7: Levels and weights of the factors in the predictive model 57

Table 8: Frequency of Crises in selected developed countries..... 59

Table 9: Asset classes selection..... 63

Table 10: Sources of information for Table 9..... 64

Table 11: Return Evolution Analysis..... 67

Table 12: Returns vs. Historical Returns Analysis..... 68

Table 13: Volume evolution Table 70

Table 14: Overall Bubble risk Factors 71

Table 15: JLS Model results..... 73

Table 16: Evolution of selected financial information for corporations 83

This page was intentionally left blank

1 Introduction

Since the 2008 financial crisis, there has been an increased interest in the concept of “financial bubble”. Newspapers regularly publish news discussing and speculating about potential bubbles developing either in the US or overseas. But what is a financial bubble and is it possible to know if one is forming? Or is it the type of event that is only possible to determine ex-post, once the bubble has busted? The objective of this thesis is to apply the current theories related to financial bubbles to assess the current situation of the US financial markets. Some of the key bubble theories will be reviewed and a model to identify vulnerabilities will be suggested.

A second and equally relevant question is what a well-informed investor should do if he or she knows or suspects that a bubble is forming in any given market. Evidence will be presented that, despite important early warnings given from Alan Greenspan (1) about the Technology Bubble that formed in the late 1990’s, the market largely ignored his warnings. This thesis will address institutional solutions that could help risk-averse investors to protect themselves from bubbling markets.

To accomplish these goals, this thesis is organized into four main sections. The first section will define what constitutes a financial bubble and present some key theories and models that were developed to understand the bubble behavior. Furthermore, the first section will also shed light on some of the relevant bubble examples in the past, such as the Tulip Mania in Amsterdam and the Great Depression, and will also shed light on how the theories that were proposed adhere to the past bubbles. The second section will apply and combine the current theories and models to develop a framework to forecast bubbles. The third section will apply this framework to the key assets in the US financial markets in order to determine the asset classes that are currently most “likely” or more “exposed” to bubble type of events. Finally, the last section of the thesis will propose functional and institutional alternatives that could offset some of the stronger consequences of the bubbles. As this thesis will further address,

current research suggests that it is impossible to completely eliminate the formation of financial bubbles or the economic cycles that accompany them. Therefore this thesis will not try to generate new ways of avoiding bubbles, but instead, will suggest new approaches for prudent investors and other market participants to avoid some of the more severe effects that accompany a financial bubble burst.

2 Theory and examples of bubbles

This section will present a definition of what constitutes a financial bubble and discuss the current theories that explain the behaviors that lead to the formation and burst of financial bubbles.

Furthermore, this section will also present some of the key financial bubbles of history and address how these bubbles adhere to the current bubble theories.

2.1 Bubble definition

"The classic definition of a bubble is people buying on false expectations about future prices, and buying with the hope of selling in the future."

Professor Yoshihisa Nakashima (2)

According to Charles Kindleberger et al. (3) Financial Bubble is the term given to an increase in the price of an asset that cannot be explained by the intrinsic value. There is a variety of definitions of intrinsic value and Jeffrey Hooke (4) defines it as the result of a valuation technique that forecasts the future streams of cash flow of any security and then discounts these streams of cash flows to obtain the present value of the cash flows. Therefore, by definition, in order to apply the 'intrinsic value' technique

to value a security, it is necessary to forecast different financial and operational parameters of the underlying business or asset. The need to forecast makes the intrinsic value of an asset “subjective” since forecasting is by definition a subjective process. There is no real mathematical formulation that provides a correct, unique and error-free estimation. Estimations can and do rely on mathematical frameworks, but they also heavily rely on judgment and the ability of the market participants to understand the available information and to judge the future based on these forecasts.

As a consequence of the subjective nature of the forecasting needed for the calculations of the intrinsic value of an asset, it follows that it is also subjective to determine if a price bubble is forming. This is the reason why every financial bubble in history was difficult to spot properly *ex-ante*.

The Kindleberger framework states that a bubble is a part of a cycle that starts with a traditional, well-functioning and well-priced market that then suffers a shock and deviates from its intrinsic value, also termed the “fundamental’s price”. This shock makes the participants in the market believe that a new trend is emerging, either in efficiency, in profitability, in growth or in any other valuation parameter and that the prices should be calculated with a new forecast for this given parameter and, as a consequence, prices will converge to a new and higher level.

This behavior appears to generate a self-fulfilling prophecy, at least for some period of time. The more people believe in the new trend, more buyers come to the market and these new buyers push prices up. The more prices go up, the more people start to believe that the new valuation model is correct and true and the more they are encouraged to buy. This dynamic evolves until the market runs out of new buyers, and then the sellers dominate the price-making dynamic. At this point, the new valuation is often no longer regarded to be right and the *new* buyers will rely on the old valuation to price the market and push the values to the normal levels, or perhaps even to a lower value in an undershoot.

Examples of extreme valuations include: the purchase of a tulip bulb (which is the reproductive organ of a tulip, that hopefully will generate a tulip within 6 months) for the price of 5 years of common labor income. Another example is to price the land of the Imperial Temple in Tokyo at the same price as the entire state of California. Those are extremes prices and valuations reached close to the burst phase of the cycle. These examples will be further discussed in the 'Examples of relevant financial bubbles' section of this thesis.

Carmen M. Reinhart and Kenneth S. Rogoff (3) call this dynamic the "this time is different". According to their research, market players are aware of past crises and bubbles and the severe loss incurred from them, but still their cognitive biases, such as greed and fear lead them to behave in a way that is inconsistent with past experience.

Another key factor that increases the mispricing is abundant and cheap credit. Vikram Mansharamani (5) states that low interest rates and high leverage play a key role in fostering this dynamic, allowing the market agents to further increase the valuations of future streams of cash flow, given the low interest rates. Furthermore, cheap credit leads to the amplification of the mispricing, both in terms of values and also in terms of anticipating the time of the occurrence of its peak. As it will be argued in the following sections, high leverage played a key role in many of the largest financial bubbles, such as the Tulip Mania in Amsterdam.

Finally, according to Andrew Lo (6), financial crises that end in bubble type of events, are consequences of human behavior and cannot be completely avoided by any legislation or regulation. They can only be understood. That is already a powerful tool to help society to avoid some of the worst consequences of the bubbles.

There are some opponents of the bubble concept, who often voice their opinions during the boom stage of the cycle. Often some market participants make the case that bubbles cannot exist and that the

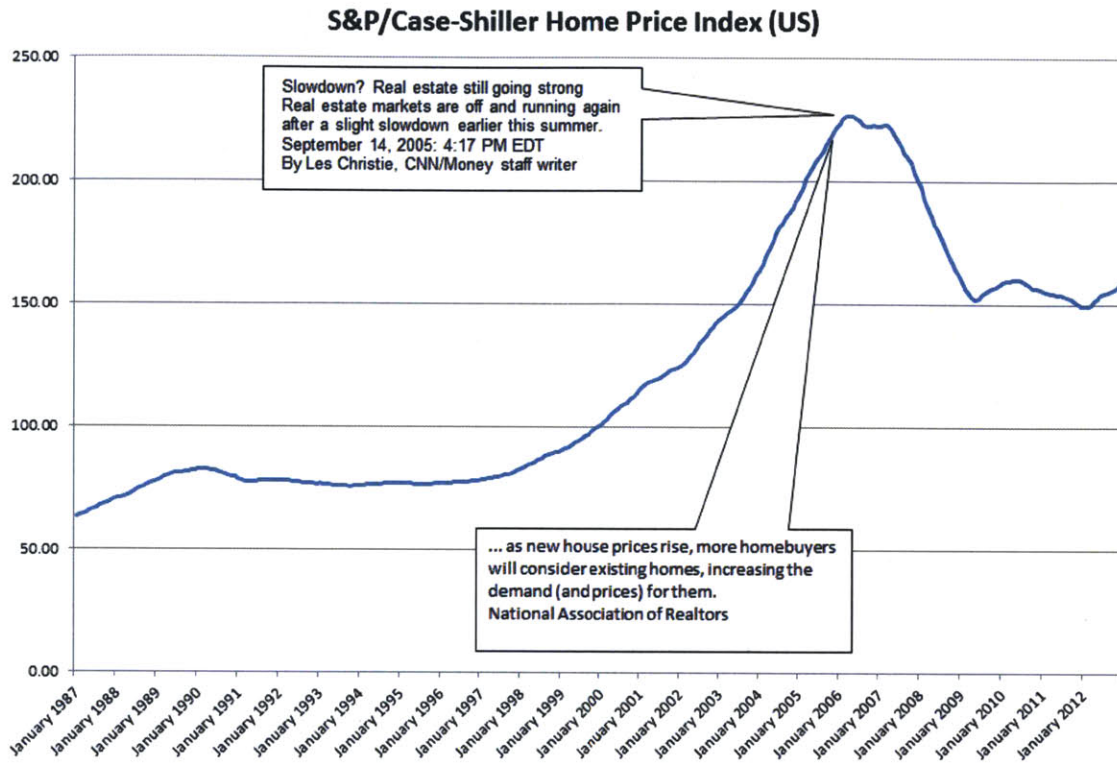
market is completely efficient and that prices are always correct and reflect all available data. Historical examples will be offered in the “historical examples” section, showing important cases in history in which the markets were strongly mispriced. Some of the opposition to the bubble concept is related to the agents that benefit from bubbles. For example, the recent real estate bubble in the US is now regarded as a very well established and a very serious case of financial bubble. However, that was not the case even in the months preceding the burst. The following statement from a CNN article exemplifies this situation.

...“New home prices will be immediately impacted because of increased construction costs,” says NAR economist Lawrence Yun, “and that will filter down to existing home prices as well.” That’s because as new house prices rise, more homebuyers will consider existing homes, increasing the demand (and prices) for them....

*National Association of Realtors, September 14, 2005, obtained from the
CNN.com website (7)*

This statement was issued at the peak of the real estate boom, when real estate prices were at an all-time high. The graph below presents the evolution of the real estate prices in the US.

Figure 1: Housing Prices Index Evolution and selected news



Source: Standard and Poor's.

It is clear that some market agents can benefit from bubbles, at least for a period of time. In this case the National Association of Realtors and all other realtors profit from a high level of real estate transactions. The realtors are frequently compensated with a commission, and therefore have an incentive to stimulate the maximum number of deals. Years after the bust it is easy to realize that the realtors were only interested in further expanding the market activity as long as they possibly could. Citigroup's chief executive, Charles O. Prince, provided a statement to the New York Times that clearly exemplifies this behavior:

... "As long as the music is playing, you've got to get up and dance," he told The Financial Times on Monday, adding, "We're still dancing."

CNN.com, July 10, 2007 (8)

The proponents of the non-existence of financial bubbles often rely on Paul Samuelson's (9) hypothesis of efficient markets, which states that all information available should be reflected in the price of a security. This thesis will analyze some of the key assumptions of Samuelson's hypothesis and will demonstrate that often markets fail to fulfill all the assumptions. Some key historical examples will be offered as evidence of the existence of bubble and also used to analyze the recurring patterns on the bubbles.

The next section will discuss the current theories related with the bubble dynamics and also will discuss one theory that tries to explain and model the entire bubble cycle. The thesis's goal with the review of these theories is both to understand the bubble dynamic and also to look for recurring patterns that can be used to forecast building bubbles.

2.2 Theories related to the bubble dynamics

The key assumption that drives the proper pricing of assets, or instead their mispricing, is the ability of the market players to use the available information with judgment and rationality to find a proper value to any given asset or security. Some theories and hypotheses help to understand the way that the market participants determine the proper prices for the assets and securities and therefore can cast light to the dynamics that govern the mispricing as well. These theories will be explained in the next section, starting with the well-known Efficient Market Hypothesis.

2.2.1 The Efficient Market Hypothesis

One important hypothesis regarding price discovery, the Efficient Market Hypothesis, developed by Paul Samuelson (9) states that the market agents use all information available to form a security price and also that this price embodies all information available. This hypothesis applies to tradable instruments that are publicly available. The requirements for the Efficient Market Hypothesis are that the participants of the market are on average correct, and that information is immediately incorporated in the market. Two consequences if the Hypothesis holds true for a given market is that both prices are correct and also that it is impossible to forecast the future price of a security, just based on past data.

These two consequences might be misinterpreted by market participants and help to start or build a bubble. Since some of the requirements of the hypothesis might not hold true for a particular given market, it is risky to assume that it holds, and it is not possible to use the Hypothesis to justify correct prices, under these circumstances. Particularly the requirement that market participants are on average correct is very strong, and it is probably the requirement that are not met on many of the bubble type of events. As discussed in the previous section, the market participants must use forecasting techniques to obtain the intrinsic value of a security. A wrong prediction of any parameter can lead to a wrong intrinsic value and therefore the wrong price. If all the market participants commit the same estimation or forecasting error, then, the Efficient Market Hypothesis requirement that market participants are on average correct is not met.

If the Efficient Market Hypothesis does not hold for some markets, at least during a particular time frame, the unwarranted belief that it is impossible to predict the future behavior of the price, and also

the equally unwarranted belief that the current price is correct, might give false confidence to investors to buy assets that might be overpriced. This confidence might lead to further buying of a given asset or security and then to further increase the mispricing, thus fueling the bubble.

If the Efficient Market Hypothesis held completely, all the time, there would be no boom and bust behaviors in the markets at all. Prices would always perfectly reflect the real and correct valuations and bubbles would never form in the first place. The mere existence of Booms and Busts, such as the ones described in the “examples” section of this thesis, is evidence that markets are not completely efficient, at least during some period of time.

2.2.2 The Adaptive Market Hypothesis

Andrew Lo (10) presents a different hypothesis to explain price formation, the Adaptive Market Hypothesis. It argues that market players’ cognitive bias might drive their behavior away from the behavior expected by the Efficient Market Hypothesis. The hypothesis suggests markets in which the participants are more worried about “survival” or their relative importance compared to others. In this scenario, risk aversion changes over time and the “success” of some (probably early-adopters) generates an incentive to other players to increase their risk tolerance or risk exposure.

The adaptive market hypothesis suggests that market players are mostly worried about survival. The expected returns are not the key goals, but instead their abilities to survive under any circumstance. One of the implications of Lo’s hypothesis is that market participants are worried about “following the herd”. It is very easy for a money manager to explain that he lost money (or underperformed some target), when the entire market is going down. On the other hand, it is very hard for the same money

manager to explain losses (or performances below the target) when the market is booming. In this sense, there is strong incentive for market participants to “surf” the waves and “dance” to the music. Citigroup’s chief executive, Charles O. Prince, previously quoted statement clearly exemplifies this behavior:

...“As long as the music is playing, you’ve got to get up and dance,” he told The Financial Times on Monday, adding, “We’re still dancing.”

CNN.com, July 10, 2007 (8)

Carroll’s Three Lenses Framework provides a deeper insight into how professional money manager firms could be influenced by the behavioral bias that are pillars of the Adaptive Market Hypothesis and offers a better understanding of the behaviors that lead to the bubble formation.

2.2.3 The Three Lenses Framework

According to John Carroll (11), the behavior of individuals within organizations could be better explained by the analysis of three different lenses. Each lens determines the course of action that the individual is expected or stimulated to behave and the real action of each individual is a combination of the three different stimuli. The first lens focuses on the structure and efficiency of operations. The Strategic Design Lens views an organization in a way that fits perfectly with the idea of efficient markets, proposing that the financial institutions, and their employees, should always behave in the most

efficient way to achieve their objective and functions, based on its mission, resources and available information.

However, two other lenses complete the framework and combined provide a better understanding of an organization. The Political Lens maps and identifies the behaviors of the individuals that are oriented toward their own individual or group goals and not to the institution goals and functions. Such a view can be and often is conflicting with the Strategic Design Lens. To complete the framework, the Cultural Lens tends to map and predict the individual's behavior and also organizational actions based on the culture of the organization.

The political goal of an individual to maximize its own compensation might conflict with an organization goal of maximizing returns, restricted to a given limit of risk. Furthermore, the cultural bias of a given share of the finance industry that "The good ones beat the markets" might also lead to a risk taking behavior that might be inconsistent with the mission of the organization.

Combining the Adaptive Market Hypothesis and also the Three Lenses Framework, it is possible to identify a series of stimuli to market participants that lead to bubble fueling. The market participants aim to continue to exist as their main goal according to the AMH. At least for the large institutions that manage money, there is an incentive to be in the "top quartile" of performance to attract more resources, instead of losing resources. This gives managers an incentive to take more risks than their best judgment would recommend, buying positions in markets that they might even believe are overpriced. The only explanation for this is that they do not have the right incentive to be contrarian to the market or at least to be neutral to the booming market that often precedes the bubbles. This incentive is key to the protection of risk adverse investors that want protection from bubbles. The last section of this thesis will address protective alternatives for risk adverse investors and once again address the money managers' incentive issue.

2.2.4 The Theory of Reflexivity

George Soros (12) argues that markets are not independent of the agents that study the markets. According to this theory, the study of the market by itself, including the research and the development of valuations, influences the behavior of the investors and other market participants. As a consequence, according to Soros, it is impossible to determine if a movement in the market is a response to the reality of the market or a response to some of the studies that were conducted regarding the market.

This theory further provides insight into how bubbles evolve. Some market participants in any given market, (such as real estate) might have the incentive to forecast the asset prices in an upward trend, stimulating further inflow of resources into such market. One example is the National Realtors Association, previously quoted on this thesis, which forecasted continued growth of real estate prices, even in the prices peak of 2005. Sell-side researchers are also frequently accused of targeting their recommendations according to the overall interests of the security firm that they work.

These actions from markets participants might lead to an inflow of resources that actually push prices up, not in a real way, but instead in a speculative and mispriced way.

2.2.5 The Minsk Model of Booms and Busts

Kindleberger argues that the Hyman Minsk (13) model is the most adequate model to explain the boom and bust behavior. The model identifies four distinct stages or phases that govern the booms and busts. The first stage is the stable market, in which pricings do not deviate from the fundamentals. According

to Minsk, if the interest rates stay low for too long during a stable market, it fosters the development of the mispricing, which is the second stage. That is the “mania”, a stage in which there is a large capital infusion into a market which propels the prices to new levels that are far from the fundamentals. This stage is often (but not always) accompanied by an intense expansion in credit, that further drives prices away from the fundamentals. The next stage is the “pop”, in which rationality returns to the markets and that leads to a selloff of the assets. This stage is often very short and one in which an intense panic develops, forcing prices to quickly return to the more appropriate levels, or to the values implied by the “fundamentals”. The recovery period is an often long lasting period, of deleverage and in which the prices of the assets are often depressed below the fundamentals. The next sections will discuss each of these stages in more detail.

Formation

Minsk model proposes that the markets are essentially instable and that bubbles tend to form naturally under low interest rate environments. The very stability of prices in the periods with low interest rates by itself is a factor that can trigger a boom and bust cycle. According to Mansharamani (5), investors become eager to get new and more profitable investment opportunities and become prone to “good news” that changes the dynamics of the markets and drive up the prices of a given asset.

The turning point that drives the market away from the equilibrium to the new stage is the shock. The shock is a displacement in the markets that makes the participants believe that the dynamics of the market will be different in the future. It influences the expectations related the value of any given asset class – that might be the profitability, the growth of sales, the reduction of costs or a combination of

these. These new circumstances in the market are often unlike any other seen before and therefore pose a significant challenge for the market participants to properly price the effects of these shocks. One key example of shock is the “invention of the internet”, which, combined with the great improvement in information technology and communication provided a cost reduction to all companies, as well as a new sector to the economy. That was certainly a relevant event that should influence the prices of all assets in the markets in the proportion of the true benefits generated. According to this line of reasoning the market was correct to incorporate a change in the price. But what the market sometimes fails to do is price this “new eras” in the proper way, leading the way for a bubble. The expansion stage of the cycle addresses how the market participants incorporate these new prices into the market.

Expansion

In the expansion stage, according to the Minsk model, the market participants start to experience an increase in the price of a given asset. The early entrants in the market obtain the first profits. The “rationality” of the market is justified with strong backing from the shock. According to Kindleberger defense of Minsk’s model, it is possible to identify “high logic “among the traders during this stage. The rationality is justified by the “changes in the fundamentals” induced by the shock. It is hard, however to properly distinguish whether the new valuation is used to guide the price trajectory or if the valuation is just used as an excuse for market participants to trade at the new prices.

According to Kindleberger, there is also a cognitive bias at the same time – all participants in this market have experienced profits up to this point. Therefore there is a high incentive for all players, both investors and advisors alike, to recommend the participation in this market.

This dynamic by itself is not destabilizing. One could argue that it could only accelerate the convergence of prices to the new level induced by the shock, and not beyond. In this sense, the shock would be a real positive economic gain experienced by the market. Sometimes that is case, but in other instances, however, some of the cognitive bias presented before – both in the Adaptive Market Hypothesis and also in the Three Lenses Framework, stimulate the market participants to continue to invest and to take a bullish view on the market for as long as they possibly can.

At this point, according to Kindleberger, the means became the end. Investors are buying because prices are increasing and prices are increasing because investors are buying. The investors no longer want to get the revenues or benefits from owning the asset, but instead drive their decision to buy solely on the false expectation to sell it later for a profit.

That is the stage in which the market as a whole no longer behaves rationally and that it is headed to the next stage which is the bust of the bubble.

During the expansion stage, the market might experience a great increase in indebtedness. Many of the market participants might borrow at low rates to invest in the booming assets. This trade seems as good trade for the investor: during the expansion stage, the market frequently still experience low interest rates and low investment yields in many of the asset classes. The prospect to borrow at a low interest rate and invest in a short-term high return investment seems highly attractive to many investors.

These highly levered investors will pose a key problem in the final stage of the cycle – the bust or the bubble popping.

The critical moment – the Bubble “explosion”

It is during the explosion that a cycle can be effectively detected. Up to the previous stage, different opinions could provide support both for an upward trend in price as a secular and lasting dislocation as well as other opinions could suggest an unsustainable price trajectory. It is only the intense market reaction in the bust that confirms that prices trajectory was unsustainable.

According to Minsk, the heavily indebted investors play a key role in the Bubble explosion. Firstly, they are exposed to both to revenues and also to costs in their “trade”. Their cost arises from the cost to service the debt incurred to buy the securities. Their revenues can only come from the yield on their asset (such as rent, dividends or coupons) plus the price change component. During the expansion, they are benefited from the positive variation in prices, leading to profits. Now, as new investors cease to enter the market, the price variation tends to be close to zero in the first instance and, later on, negative.

Many events can lead to the critical transition from the growth in prices to a stability trajectory or a distress one. The distress period, is a period of financial hazard. In this period, frequently many firms face the risk of not being able to service or roll their debts. The distress might start from a bad harvest, a sharp increase in commodities prices or by a perception in the market that there is an overall overleverage. Usually under distress situations, banks and other firms tend to reduce credit, particularly to subprime borrowers and to increase the interest rates.

This change in the lending pattern has a particularly severe impact to the heavily indebted investors. As the price variations cease to be positive, and price variations are for some period of time close to zero or negative, these investors no longer profit from the market, since the yields on the assets are not enough

to service their debt. Their incentive is now changed, and they now have the incentive to sell and exit the market. This puts an extra selling pressure that further depresses prices, in a process called by Mansharamani “Asset deflation”.

Once some players start to sell, then there is a downward pressure in the market. This pressure might influence other players to sell, particularly those who invested in the market solely because of the upward trend in prices. This is a behavior that will drive prices back to their proper fundamentals in a somehow slow fashion, as was experienced in the Japanese Real Estate market in the 80’s. This would characterize the “slow” end of a bubble.

There can also be a “crash” in the market – a situation in which a big or relevant institution fails or goes bankrupt and therefore the market agents enter into Panic mode and start to sell their risk assets and search for low risk, government securities. This is the “fast” end for a bubble.

The next section will present a mathematical overview that aims to identify bubble behaviors by analyzing the prices patterns in a market.

2.2.6 Economic models biases

Some of the economic models discussed present issues that might make the bubble prediction even more challenging. The first and most important issue is the survivorship bias. Now, that the world is dominated by capitalist countries and where the US is the leading power, it is easy to misleading think that it was easy to forecast prices for stocks as compared to the growth of US economy or the world. However, during the times of some of the crashes that will be presented in the next section, investors

did not have a lot of the information that now seems “embedded” in our common knowledge. For example, it is clear now that capitalism won over communism, but that was not a clear assumption during the 1930, and S&P 500, or any other stock indexes, should reflect this information or this risk. Another example would be the comparison of US and Argentina GDP in 1900 which were the same, but both countries experienced extremely different GDP evolutions, something that should be priced in the stocks. The economic models often fail to include these adjustments which are probably the gaps that make them vulnerable to criticism. However, the greater challenge probably comes from the downside estimations, since risks can come from many sources. Financial bubbles, on the other hand, emerge from unsustainable high valuations and the high valuations tend to be the ones in which the economic models presents fewer biases.

2.3 Examples of relevant financial bubbles

"I can calculate the movement of the stars, but not the madness of men"

Sir Isaac Newton (14), after losing money in his investment in the South Sea Company

The framework proposed by Minsk and expanded and detailed by Kindleberger et al. presents a guideline to understand the evolution of a financial cycle that ends with a burst in a bubble behavior. The following sections will review some of the key bubbles in history and will particularly address how each of the following crises combines with the Mink framework. Some key elements that will be part of

the analysis are: the shock that drives the system away from the equilibrium, the credit propeller that fuels the boom and also, if any, the crash situation.

This section will draw information from some key bibliographical references. Particularly the following sources are the pillars of the discussion: “Boombustology: Spotting Financial Bubbles Before They Burst” by Vikram Mansharamani (5), “Famous First Bubbles – The fundamentals of Early Manias” by Peter M. Garber (15) and also Doug French’s “The Dutch monetary environment during Tulipmania” on The quarterly Journal of Austrian Economics (16)

2.3.1 Tulip mania in Amsterdam

To better understand the Tulip Mania that took place in Amsterdam in 1637, it is necessary to understand both the situation of the country and the nature of the underlying asset of the speculative run – the tulip.

After achieving its independence from Spain in 1581, Netherlands experienced a very stable and prosperous period, sometimes referred to as “The Dutch Golden Age.” The reduction of the military cost, after the independence, combined with a strong overseas trading activity led the country to experience a period of great wealth creation. According to Garber (15), the Dutch trading position was so prominent that they enjoyed almost monopolies in the trade routes to the East Indies and Japan. Furthermore they also made several land conquests overseas, founding the city of New York in America and conquering a part of Brazil.

Garber also suggests that Netherlands enjoyed the position of the top financial power in Europe during the early 1600’s, something that provided the country with vast resources and also power.

The table below illustrates the expansionist monetary environment experienced in the Netherlands during the 1630's.

Table 1 - Total Mint Output of the South Netherlands, 1598-1789 (in guilders)

Year	Gold	Silver	Copper	Total
1628–29	153,010	2,643,732	4,109	2,800,851
1630–32	364,414	8,838,411	6,679	9,209,503
1633–35	476,996	16,554,079		17,031,075
1636–68	2,917,826	20,172,257		23,090,083
1639–41	2,950,150	8,102,988		11,053,138
1642–44	2,763,979	1,215,645	47,834	4,027,458

Source: Jan A Van Houtte and Leon Van Buyten (1977, p. 100), as quoted by Doug French in the "The Dutch Monetary Environment During Tulipmania" (15)

As a consequence, the country started to invest in improving its infrastructure and many of the new wealthy families started to improve their real estate and to buy arts. There was also greater demand for flowers in general.

The tulip is a particular type of flower. Firstly it is not original from Western Europe and was only introduced in Holland in 1563. The flower has a reproductive cycle that naturally makes it difficult to quickly increase the supply. Tulips can be grown mostly by two ways: by planting the seeds or by a cultivation of bulbs. According to Mansharamani, the process to plant seeds can take from 7-12 years to generate new tulips, therefore making it a reproductive technique that is unable to increase supply of

tulips in the short term. The alternative way to grow tulips is with the bulbs. The bulb is an underground structure that can yield a low rate of reproduction and that needs proper care. This characteristic restrains severely the availability of tulips, at least in the short run. Furthermore, the tulip bulbs have to be kept in the ground for most of the year and they could only be uprooted and traded in the spring and summer.

Tulips exist in more than 100 natural species and at least 6 varieties had great commercial value in the early 1600's. This phenomenon made some particular, unique, kinds of tulips more expensive than others.

The combination of the high demand for tulips (and other flowers) with the constrained supply of tulips pushed prices to higher levels. As the prices increased, more and more people started to consider tulips as an investment, instead of just a flower for decorative purposes, and started to buy tulips only to resell in the future for a higher price. This stage is already a stage in which the means and the end of the investment are changed and that leads to the development of a bubble.

Furthermore, there was a strong credit component in the mania. Since the tulip bulbs could only be traded during the spring and summer months, traders developed a "futures contract." Those contracts established that the buyers would buy the bulb and only receive them in March; however, the buyer only had to pay an upfront value of 10% of the sale price. It was basically a structure in which it was possible to buy on margin, with great leverage.

In November of 1636, in the top of the speculation period, tulip bulbs were traded for the prices of decades of common job pay, what would be equivalent today of up to USD 450,000 for a single flower. After the system ran out of bigger fools, during a traditional auction held in Amsterdam, in which no buyers showed up, panic ensued and prices collapsed.

The components of the Minsk Model which were present in this event:

Shock: The Independence of Holland and the great inflow of gold and silver from its international trading activities.

Speculation: The constrained supply of tulips forced their prices to increase in response to the increase in the demand, creating gain opportunity for short-term investors. This brought investors to the market that were not considering the benefits of owning the tulips, but were only worried about the increase in their value.

Fueling Credit: The cyclical nature of growing tulips fostered the development of the futures sale contract, that in practice had the same effects as an increase in credit availability.

Crash event: Panic quickly ensued after an unsuccessful auction.

2.3.2 South Sea Company

The South Sea Company was an English company founded in 1711, with the official purpose to trade with Spanish America. The company had a legal monopoly of the trade with Spanish America, even though that proved to be far less valuable than expected. The war between England and Spain never allowed the South Sea Company to conduct any trade beyond occasional slave and textile shipments, and the company never truly benefited from its monopoly.

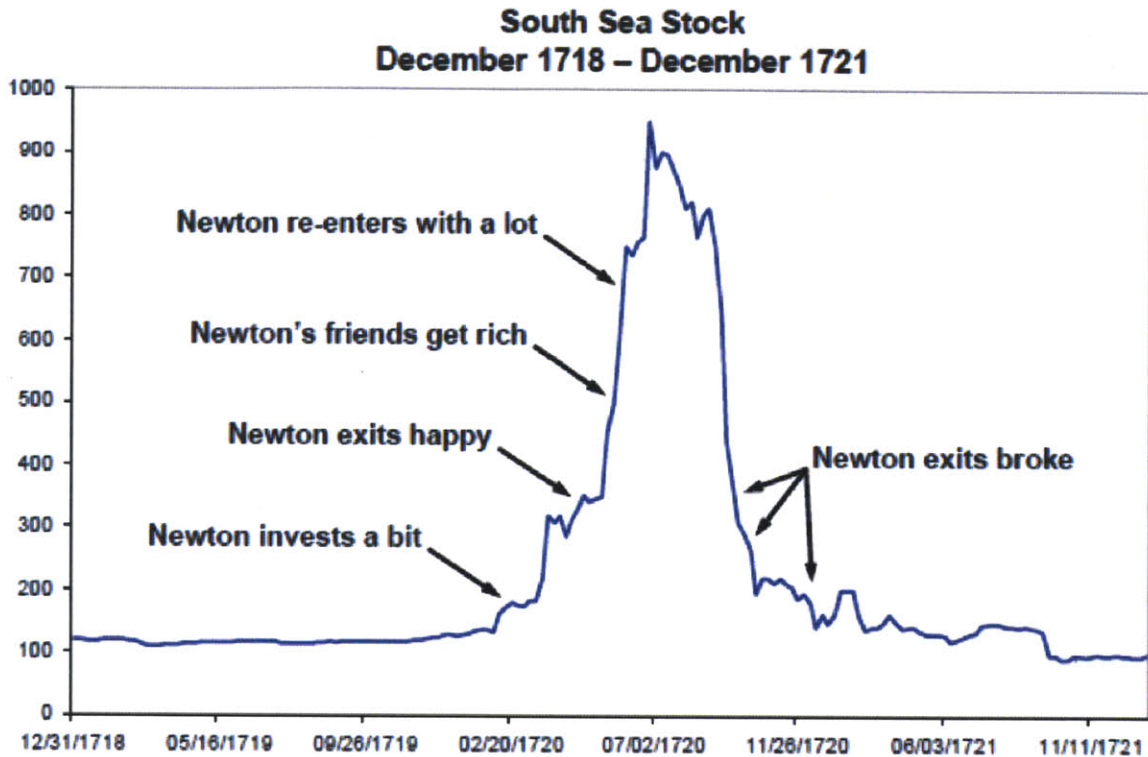
However, according to Temin et al. (17), the South Sea Company had a very important function. It helped the Government of England to reshape its sovereign debt. English long-term bonds and annuities

were trading at a discount, since investors were pricing the perceived default risk. The South Sea Company, in its first meaningful business operation, according to Temin et al., bought Government debt in exchange for stocks in 1719. With this exchange, the company received the interest from the government; the bondholders saw their securities price increasing. It seemed like a good trade for every participant, except for the fact that the total risk of the system was not reduced, but only redistributed. The risk premium of the government bonds and annuities should have been reflected on the South Sea Company books and therefore on the pricing of the stocks, but that connection was blurred by the speculation. The company eventually obtained a license to buy all the outstanding sovereign debt of England, which further fueled the speculation on its stocks.

The dynamics evolved in a way that pricing the shares of the company was based on the expectation of a trading with South America, something that never happened, and was fueled by an accounting distortion in the accounting of the recently acquired sovereign debt.

Not surprisingly, in 1720, the stock crashed and share prices dropped 70%. The figure below presents the evolution of the prices of the South Sea Company shares as well as the investments of Sir Isaac Newton.

Figure 2: South Sea Company share prices



Marc Faber, Editor and Publisher of "The Gloom, Boom & Doom Report."

The components of the Mink Model present in this event:

Shock: The monopoly of the trade rights with South America was an innovative asset that the market was unaware how to properly price.

Speculation: The company issued a sizable amount of stocks, but these were exchanged for sovereign debt, and therefore a small fraction ended up in free float. With that, the availability of the stocks was low. Furthermore the Company lent money freely, taking its own shares as collateral. It also reduced the supply of shares.

Fueling Credit: The strategy to lend against its own shares increased the leverage that investors could achieve, further fueling the bubble.

Crash event: Panic quickly ensued after books were disclosed in 1720.

2.3.3 The Great Depression in the US

After winning WW1, the US experienced a period of significant growth and prosperity. The increase in industrialization and manufacturing was improving the productivity; the recently invented automobile was a new and high selling product. The highways under construction were connecting the country and making trade and travel easier and less expensive.

According to Mansharamani, the invention of the radio, the airplane and several other new technologies allowed room for the development of new business. Simultaneously, the Federal Reserve reduced their rates to low levels, incentivizing lending activities. The very establishment of the Federal Reserve System in 1913, was also a key milestone that many considered that would prevent speculation and bubbles to ever occur again.

This combination of elements fueled the national sentiment, and led to the mindset that Reinhart et al. call "this time is different." However the change of means and end invaded many of the markets.

According to Mansharamani, regular people with little to no knowledge about the stock market started to invest in stocks. People started to invest not because they wanted to get the risk exposure or the dividends from the stock market, but only because they saw other people making short-term profits.

Another example of speculation took place in Miami and Southern Florida. The combination of automobiles and roads allowed a far greater number of people to travel, and the region became much more attractive. The market evolved into a system in which the purchase of a real estate property only required a 10% upfront payment. The remaining value would be split into installments starting 30 days from the purchase. According to Mansharamani, at some point during the speculative run, 90% of all purchases were targeted to be resold within the next 30 days.

Of course, the combination of speculation and high leverage fell apart when the greater fools refused to show up. In the well-known events of October 1929, the US stock market fell rapidly and the construction market faced a strong downturn.

The components of the Mink Model present in this event:

Shock: The discovery of new technologies, combined with the victory in WW1, fueled the national sentiment in the US and pushed real estate and stock prices to new levels.

Speculation: Run in different markets, including stocks and also real estate.

Fueling Credit: Low interest rates set by the FED and the development of real-estate “upfront” contracts

Crash event: No “key” event. Panic ensued after the New York Stock Exchange session of Oct 29th 1929.

2.3.4 The Japanese Real Estate Bubble

Economically, Japan presented a great recovery in the years following WW2. The country benefited from the support received by Western powers, particularly from the US, and re-built its infrastructure. In the early 1980's, according to Mansharamani, Japan was frequently regarded as able to surpass the US and to become the largest economy in the world.

This impressive growth fueled the society's confidence and as a consequence the construction business prospered and the real estate prices increased dramatically. The Japanese banks, highly capitalized during this period and among the largest in the world, increased lending activities, particularly in the mortgage market.

Furthermore, the Bank of Japan reduced the interest rates to 2.5% in January 1986, further incentivizing the lending activities. According to Kindleberger et al., money seemed to be free at that time, which is a common characteristic to the starting stage of a cycle that leads to a bubble.

As the lending market increased greatly, so did the prices. Japan experienced some of the highest valuations recorded in history for its land and property. According to Christopher Wood (18), the US is geographically 25 times larger than Japan and had twice the population at that time, but still, according to market prices, at that time all Japanese real estate combined totaled about four times the price of US Real Estate.

These impressive land and real estate valuations were also reflected in company balance sheets. Since the companies owned buildings and factories, the increase in their property values began to positively influence the prices of the stock market, pushing these prices to extremes. To illustrate such extremes, according to Mansharamani, the Japanese National Telephone Company traded for a total market

capitalization that exceeded the entire market capitalization of all French and Swiss publicly traded companies. Some sectors of the Nikkei index traded at P/E of 100 to 300. Considering that current P/E's for the US is about 20, and historical averages tend to be lower than 20, it is fair to assume that the prices of Japanese stock were extremely overpriced.

The trend in prices started to reverse as the Bank of Japan increased its short-term rates up to 6.0% in 1989. Furthermore, the Bank of Japan limited the amount that each bank could lend in new mortgages. These two actions made it less attractive, if even possible, for new players to enter the real estate market targeting short-term capital gains. The buyers that remained in the market were those really interested in the benefit from the asset, rather than on the short-term gains. As a consequence, the demand for real estate greatly reduced and so did the prices of real estate.

In the stock market, the tailwind, provided by real estate reversed. This pushed stock share prices down as well in a combined process that has lasted 20 years.

The components of the Mink Model present in this event:

Shock: The recent strong growth of Japan to developed world income levels as well as the low interest rates inflated the country's confidence.

Speculation: Many investors became aware of the increasing prices in real estate and invested expecting to obtain capital gains. Furthermore, this behavior and dynamic spilled over and influenced the stock market.

Fueling Credit: The low rates the Bank of Japan set up to 1986 were a key part of the fueling credit. Furthermore, the estate tax code in Japan would heavily tax capital gains originating from the increase in property prices, unless some offsetting protective action was taken. One of these offsetting actions, according to Mansharamani, was to buy real estate with high leverage, since the mortgage was

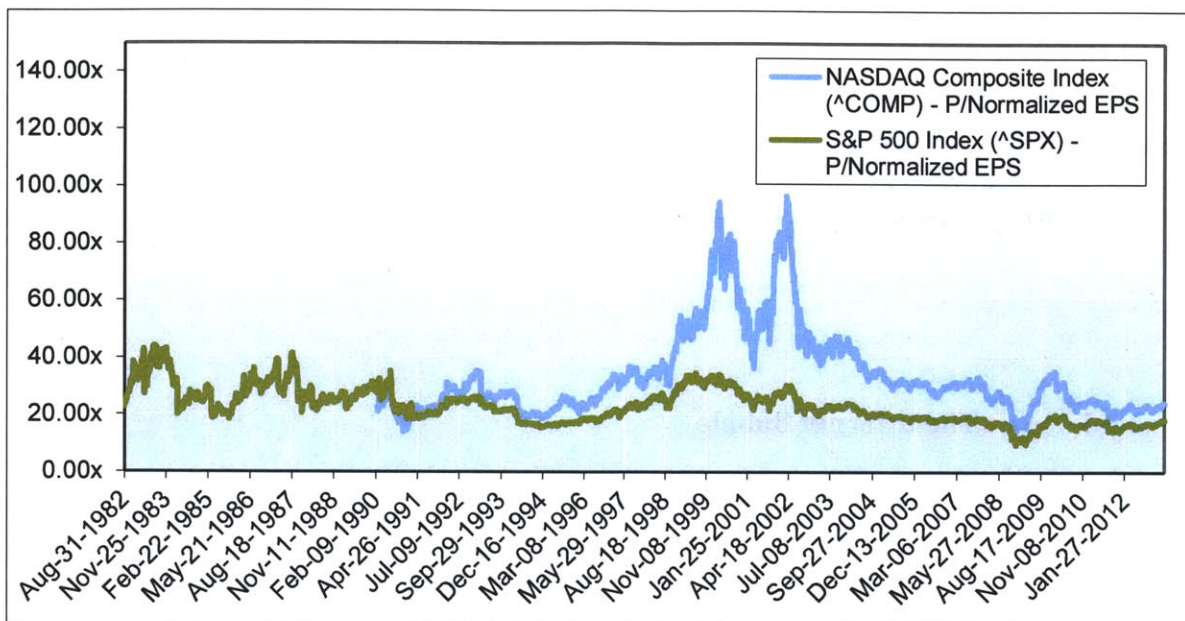
“deductible” in the estate tax. As a consequence, some investors bought highly priced real estate only for tax reasons.

Crash event: Slow retraction ensued, starting with the increase in Bank of Japan short-term rates and the institution of limitations of bank loan growth in 1989.

2.3.5 The Internet Bubble

The widespread introduction of personal computing and the advancements in communication technology created a new industry in the US. This new industry, often called the Information Technology industry, improved the economic outlook of the State of California and also of the US. This phenomenon, combined with the new belief that the capitalism had won over communism in a sustainable way set the foundations of the internet bubble. NASDAQ was the platform on which many of the new companies, such as Microsoft and Oracle, were listed. The figure below presents the evolution of the Price / Normalized Earnings from the NASDAQ Index compared to the S&P 500 Index.

Figure 3: Price / Earnings evolutions



Source: S&P / Capital IQ

It is possible to note that investors valued the entire NASDAQ index at 90 times Earnings, in a valuation level never seen in the history of publicly traded equity. However, the “this time is different” mindset made high growth expectations in this new market to justify such valuations.

Alan Greenspan, chairman of the Federal Reserve at the time, noticed these extraordinary valuations at which some of the technology stocks were trading. On December 5, 1996, the date in which the NADAAQ was priced at 1300 points, Greenspan (1) made the now famous “irrational exuberance” warning about the lack of “rational” foundation for the NASDAQ prices. Despite of his warning, the NASDAQ index rose all the way to 5048 points, or to 90 x P/E, to then burst. This case exemplifies the extent to which the players believed in the new “trend” in the industry, since the market participants largely ignored Greenspan’s warning. Now the NASDAQ presents a P/E of about 20, still higher than the 16 exhibited by the S&P 500 index, but within the long-term historical trends for equities.

Shock: The end of communism and the victory of capitalism combined with the invention of the Personal Computer and the Internet.

Speculation: Market participants started to invest based on the previous gains of other investors, and prices and valuations reached all-time peaks.

Fueling Credit: The leverage was relatively low.

Crash event: Market participants adjusted their views on IT stocks after the Federal Reserve increased the FED fund rates several times, reaching a peak of 6.5% yearly.

2.3.6 The 2008 US Housing Bubble

...These loans are made on the basis of the value of the property, not the ability of the borrower to repay ...

Senator Christopher Dodd, U.S. Senate Banking Committee, March 22 2007 (19)

During the year of 2008, the US financial markets experienced some of the most volatile times since the great depression. Relevant financial institutions failed, a significant number of families experienced the foreclosure processes, and the S&P 500 Index lost 56% of its value (from 1561 points on December 9th, 2007 to 676 points on March 3rd, 2009) and the economy entered into a recession.

The table below exemplifies the effect of the crisis on the gross domestic product of the US, in real terms.

Table 2: Evolution of US real GDP

Year	GDP (Billion of 2005 Chained USD)	Growth (%)
2000	11,325	
2001	11,370	0.40%
2002	11,591	1.94%
2003	12,039	3.87%
2004	12,387	2.90%
2005	12,736	2.81%
2006	13,038	2.38%
2007	13,326	2.21%
2008	12,884	-3.32%
2009	12,873	-0.08%
2010	13,181	2.39%
2011	13,441	1.97%
2012	13,657	1.61%

Source: U.S. Department of Commerce: Bureau of Economic Analysis, obtained from the Federal Reserve Bank of St Louis Website.

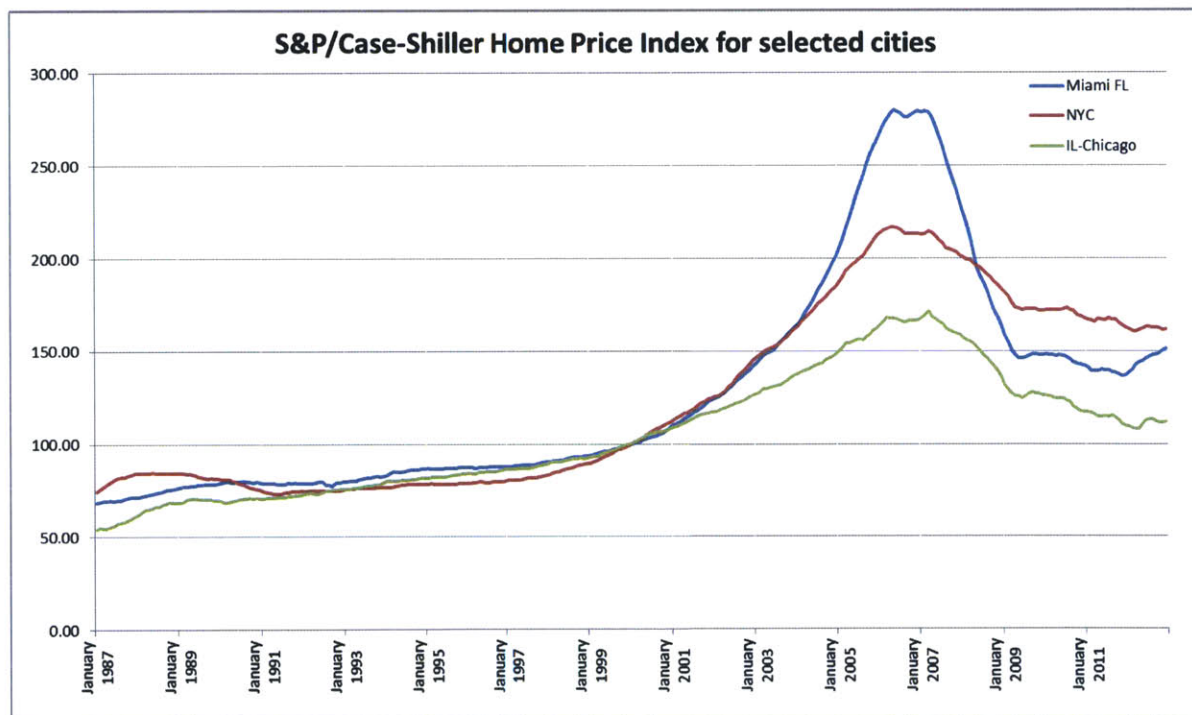
Several experts voiced their opinions regarding the causes of such a major downturn in the economy. These opinions were sometimes conflicting and, most of the time, tended to blame the big institutions and the insiders for their greed. Few of the explanations focused on the real bubble concept, which is the purchase of an asset based on the false expectations of price appreciation and in the expectation to sell in the future. This thesis will present evidence suggesting that the bubble dynamic was the key driver of the recent crisis, instead of any other reason.

Paul Krugman (20) pointed out that the overall speculation on the rising housing prices and also the financial innovation were responsible for fueling the bubble. The new structure of derivative products such as Collateralized Debt Obligations (CDOs) and Mortgage-backed securities (MBSs) were, according to him, too difficult to properly price and gave the wrong incentives to the market participants.

Furthermore, Krugman added that the new low standards of credit were also a key factor that made many of the loans either impossible or at least improbable to be properly repaid.

The figure below shows the prices in different cities of the US. It is possible to notice that home price variations were sharply different in the three regions quoted, with Florida presenting the largest variation. That variation is arguably difficult to explain by any “market-wide” argument such as the ones proposed by Krugman. If the financial innovations were to blame, they should be present in all states. If the incorrect standards of loans were to blame, they could also be expected in the entire country. In this sense, the concept of bubble as defined in this thesis seems to better explain these events.

Figure 4: Real Estate prices evolution in different cities



Source: Standard and Poor's

As new buyers were expecting price increases on the houses, based on past increases and also on the profits that other investors had experienced, these investors entered into the housing market on false expectations of increasing prices and with expectation of selling in the future. In that sense, the market

as whole took a bet on housing prices. Based on that assumption, it is easy to justify a concentration in Florida. In Florida, because of good weather and other attractive conditions, houses hold for speculative reasons could serve a secondary function of a vacation home. That suggests the explanation why Florida became a favorite destination of real estate “bets” from the market players. This behavior would be similar to the one displayed during the Great Depression, in which Miami was a key place for the speculation, as discussed previously. In other words, Florida real estate can be considered as high Beta real estate, since there is a tendency for prices to go up faster than average in the upturns and also to go down faster than the average in the downturns.

Christopher L. Foote and Paul S. Willen (21) from the Federal Reserve Bank of Boston support this theory. According to them the actual level of mortgage innovation during the 10 years preceding the crisis was relatively small. Another fact that they present is that the “insiders” of the industry were among the players that were hit the hardest, with big banks such as Bear Sterns and Lehman Brothers failing during the crisis. The table below presents the net risk exposure for some types of market participants:

Table 3: Exposure of Financial Institutions to Housing Risk on the Eve of the Crisis (\$ Billions)

Entity	Loans	HELOC +2nds	Agency MBS	Non-Agency AAAs	CDOs (resi. subs)	Residential subs	Total Exposure
US banks/Thriffs	2,020	869	852	383	90	0	4,212
GSEs/FHLB	444	0	741	308	0	0	1,493
Broker/Dealers	0	0	49	100	130	24	303
REITs	0	0	82	10	0	0	92
Hedge Funds	0	0	50	51	0	24	126
Money Managers	0	0	494	225	0	24	743
Insurance Cos.	0	0	856	125	65	24	1,070
Overseas	0	0	689	413	45	24	1,172
Financial Guarantors	0	62	0	0	100	0	162
Others	461	185	550	21	45	0	1,262
Total	2,925	1,116	4,362	1,636	476	121	10,680

Source: Figure 4 from “Residential Credit Losses—Going into Extra Innings?” Lehman Brothers U.S. Securitized Products, April 11, 2008 and, as quoted in Christopher L. Foote and Paul S. Willen (21)

Furthermore Foote and Willen, argue that players, particularly the banks, including the ones that failed, were well aware of the risks they were taking. They had the clear understanding that several of the products traded on the market, such as the CDO's, MBS's and the double CDO's had a strong sensitivity to housing prices. In another words, they knew they were betting on housing prices. The table below exemplifies this:

Table 4: Lehman Brothers HEL Bond Conditional Forecasts of Losses on Subprime Investments

Name	Scenario	Probability	Cum Loss
(1) Aggressive	11% HPA over the life of the pool	15%	1.4%
(2)	8% HPA for life	15%	3.2%
(3) Base	HPA slows to 5% by end-2005	50%	5.6%
(4) Pessimistic	0% HPA for the next 3 years 5% thereafter	15%	11.1%
(5) Meltdown	-5% for the next 3 years, 5% thereafter	5%	17.1%

Source: "HEL Bond Profile across HPA Scenarios" from Lehman Brothers: "U.S. ABS Weekly Outlook," August 15, 2005, as quoted by Christopher L. Foote and Paul S. Willen (21)

The previous table presents some noteworthy facts. First, it comes from Lehman Brothers research department and Lehman Brother is one of the banks that endured the most losses during the crisis. The table presents a selection of housing price variations that ranged from 11% yearly increase to -5% yearly variations for three years and then 5% increase thereafter. Most scenarios implied growth in the real estate prices, despite their already high levels in 2005. Furthermore the table clearly presents the probabilities of the scenarios and it indicates that reductions in prices were considered to be only 5% likely to occur. Furthermore, Lehman Brother's research department was well aware of the severity of the losses that would be incurred if the prices actually went down, since expected losses would more than triple compared to the base scenario. In sum this table provides evidence, that at least for this particular market participant, the risks were known, but the expectations were of an upward trend in prices, exactly as it happens in a bubble environment.

The components of Mink Model present in this event:

Shock: The belief that the last crisis (Internet Bubble) was not particularly strong combined with the low interest rate environment made the market participants reassess their price forecasts for real estate.

Speculation: Most market participants, including banks, broker-dealers and also families were bullish on the future of housing prices, leading to an increase in exposure to real estate assets.

Fueling Credit: A large fraction of all real estate, the underlying asset of the crisis, was financed by mortgages. These mortgages were issued with low down-payments and high leverage.

Crash event: Panic ensued after Lehman Brothers failed.

2.3.7 Overview of the selected bubbles

Several of the crises discussed present different variations of the same key elements: the shock, the speculative run, the fueling credit and finally, the burst. The next table presents an overview of the selected crisis.

Table 5: Overview of the selected Bubbles

Crisis	Place	Time	Shock ?	Speculation Underlying Asset	Fueling Credit	Crash Event
Tulip Mania	Amsterdam	1636	✔ The Independence of Holland and the great inflow of gold and silver from its international trading activities	✔ Tulip - flower with great constrained supply	✔ Future contracts on margin leveraged the Tulip exposure of the market participants	✔ Regular Tulip auction with not enough buyers
South Sea Company	London	1720	✔ Legal Monopoly over trading with Spanish America	✔ South Sea Company Stocks	✔ The company lent money with their stocks as collateral	✔ Panic quickly ensued after books were disclosed in 1720
Great Depression in the US	US	1929	✔ The discovery of new technologies, combined with the victory in WW1	✔ Different markets, including stocks and also real estate	✔ Low interest rates set by the FED and the development of real-state "upfront" contracts	● N / A
Japanese Real State Bubble	Japan	1989	✔ Recovery of WW2	✔ Real Estate and Stock Markets	✔ Mortgages with low interest rates	● N / A
The Internet Bubble	US	2000	✔ The discovery of new technologies	✔ Tech stocks	● N / A	● N / A
The Housing Bubble	US	2008	✔ Low interest rates from the recovery of 2000 Internet Bubble	✔ Real Estate and Stock Markets, particularly financial sector	✔ Mortgages with low interest rates	✔ Lehman Brother's Bankruptcy

Source: Thesis writer compilation

The next section of this thesis will focus on using these key elements and other inputs from the theory to build a model to forecast bubbles. It is not possible to precisely predict a bubble, but instead the goal of the next section will be to assess which asset class, if any, in the US markets presents the elements that make it susceptible to bubble type of events.

3 Framework to search for bubbles “ex-ante”

3.1 Disclaimer on bubble searching

To search for a bubble before it bursts is a very controversial proposition. Firstly, by definition, the market “believes” intensely in the prices of the securities they are trading during the expansion phase of the cycle. This trust and belief can be observed by the trading activity and the value of the long positions that multiple market participants establish. These positions effectively expose these participants both to the upsides, and to the downsides, demonstrating their bullishness on the underlying asset.

According to Reinhart et al, this is the “This time is different” mindset of the market players that impair their abilities to envision the limits of growth and the risks of the investments. Furthermore, some of the market players are expecting only short-term gains. As discussed before, the means and the end are reversed in this situation. Thus, many current players have a strong incentive to push market prices up. In order for that to happen, there is a need for fresh new buyers or, as described by Kindleberger, for “Greater fools”. This brings a great incentive for the current market participants to forecast even further increases in prices. Not because they truly believe in that, but instead because they need the “Greater fool” to show up.

Probably one of the best examples of how it is difficult to spot bubbles “ex-ante” can be found in the tech bubble prediction made by Alan Greenspan. As chairman of the Federal Reserve, Greenspan had significant resources, both in terms of data and analysis capability. All of these resources combined with his experience led to the famous “Rational Exuberance” speech in 1996 (1). Even though this speech clearly indicated his concern about the overvaluation of the stock market, or in the framework presented in this thesis, the expansion phase of the cycle, the market seems to have ignored his

warning. Since the day of the speech, December 5, 1996 to the peak of the NASDAQ index on March 10, 2000, the NASDAQ increased from 1300 points to 5048, or a 388% increase, to then burst to lower levels that have not recovered since (at least until the time of the writing of this theses).

As a consequence of these factors and the historical evidence, there is a strong expectation that any kind of bubble prediction that this research leads to (as well as any other, regardless of how well posed) will face strong opposition, particularly from the current participants of the affected market.

3.2 Economic vs finance models as tools

The previous sections started to state about how difficult it might be to search for a bubble before it burst, since there are many forecast variables that are subjective and necessary to determine the value of a security. It deserves a further regard about an explanation about an important distinction between “Economic” models such as the Hyman Mink model discussed previously and “Finance” models such as the Efficient Market Hypothesis. The financial models are intensely focused on risk and on the principle of no arbitrage. They are often based on the mechanic that similar securities should be similarly priced and, if and when they are not, an arbitrageur can initiate a trade that will profit from this situation and at the same time close the gap. On the other hand the “Economic” models in general are based on the assumption that the risk-free rate is the greater guide of the economy and behavior of economic agents. The assumption of the Economic models is that lower interest rates will foster investment and risk taking by the economic agents and that will influence the economy in a cyclical way. The Hyman Minsk model that will play a key role in the forecasting of bubbles has deeply embedded assumptions about risk-free rate as a key driver to start a cycle. Finance models, on the other hand, such as the well-know

CAPM offer an explanation that the willingness for individuals to invest might be inversely proportional to the sum of the risk-free plus a risk premium. And this sum might not change with perfect correlation with risk-free rates. Rather the opposite, in some situations, as in which there is an increase in risk aversion, investors might demand higher returns for risky investments, even if the risk-free rate decreases. Another important distinction is that finance models have risk in their core. The most important variable is risk and the pricing of risk, and all prices are properly adjusted for the risks embedded.

Economic models are useful to understand business cycles and to get information about the potential bubble formation. Finance models present a great edge to understand the best way to protect an investor once a bubble has been spotted. The nature of risk sharing and non-arbitrage implicit in the finance models will be useful in the next section, to help build defensive strategies for prudent investors to avoid some of the negative effects of bubbles.

3.3 Bubble “Score” strategy

This bubble searching approach is inspired by the Credit Score strategies. In such strategies, companies such as Experian or Equifax start by gathering a pool of information from a given person or company and with that information these companies create a score to predict the ability and the willingness of a given individual or company to re-pay a loan.

These strategies analyze a large pool of data from past loans, both successful and also defaulted loans, as well as information from the borrowers at the time of the issuance of the loans. Based on regression and other statistical analyses of such loans, these strategies identify key factors that make a borrower

more likely to be a good payer and which ones make him less likely to do so. After that, these multiple factors are combined to determine a “credit” score that embeds all the information, both the positive and also negative.

Similarly, the proposed Bubble “Score” strategy will try to search for bubbles in the US economy by combining qualitative and quantitative information regarding the financial cycle that leads to a bubble. The framework presented in the former sections of this thesis, permits the identification of some key factors that are frequently associated with bubbles, some factors that are somewhat frequently associated with bubbles and other that are somewhat negatively correlated with the bubbles.

The process to determine this model will start by identifying the relevant factors and then will evolve to assess the situation of each of these factors for each of the relevant asset classes in the US financial markets. Finally the resulting information will be combined in a bubble score that will indicate the likeliness of the existence of a bubble in a given asset class in the US.

3.3.1 Risk factors

1. **Significant “change” in the industry** – one of the key factors relates to the change in the mindset. Some big and important change in a given industry or market must have happened in order to temporarily justify new levels of valuation, above what would be expected with the “regular” mindset. One example would be the “gain of productivity” that sparked the IT bubble in 2000.
2. **Prices increase** – As discussed in the “Minsky Model” section, markets in the expansionary phase of the cycle experiences price increases. Some of these increases are due to legitimate

improvements in the efficiency of the industry and some of it due to the overtrading or the change in the “goal” and “means” mindset. In either ways, it is necessary to have a price increase in order to generate a proper expansion that would fuel a bubble. For the purpose of this thesis, the metric “total return” will be used instead of prices. There is a tight relationship between the two variables and total returns tend to be a variable more comparable among different asset classes.

3. **Prices above historical average** – Price increase is an important factor, but also top record prices constitute an important factor to properly identify a bubble. If the market had already experienced some level of prices, then market participants might still have enough information to properly assess risks and prices. It is only when the prices reaches new levels that it becomes difficult to assess what is due to real increase in performance and what is due to “overtrading”. For the purpose of this thesis, the metric “total return” will be used instead of prices. Even though the two variables are interconnected, total returns are easier to compare among different timelines. For example, a given corporate bond issuance may only have a maturity of 5 years, and even during this 5 years the prices might change for different reasons, and it is hard to compare this bond to a historical trend. However, the total returns of any given corporate bond could be compared to other similar bonds, both in the current markets, and also in terms of historical returns.
4. **Volume increase** – The behavioral dynamic of investing in an asset class because of its recent increases in price is an important factor in the bubble dynamic. Inexperienced buyers often join a market due to the previous success histories of other players. These players often search for short-term gains with little knowledge of the market and the risks associated. Furthermore,

professional money managers also tend to increase exposures to upward trending markets further boosting trading volume.

5. **Low interest rates** - As discussed in the Minsky model, low interest rates is an important component of any speculation or mania. Many players get less “risk averse” when the cost of borrowing is lower. The low interest rate could be for the entire market or for one specific asset class such as for margin accounts or mortgages.

6. **High leverage** – As it was pointed out in the Minsky model, during the expansion phase of the cycle, the existence of leverage increases significantly the likeliness of overshooting the prices. As it happened in the Florida speculation run in the 1920’s, or in the Tulip Mania in Amsterdam, the payment of an upfront down payment was important in stimulating a higher risk-taking behavior, particularly for the market participants who were interested in short-term gains and not in the real cash flow streams from the underlying assets.

7. **FED chairman warning** – Another important factor is the evaluation of the market characteristics by a very senior regulator, whose function demands him to make the necessary efforts to make sure that the markets function properly. The “crash” that comes after a bubble impairs the ability of the financial markets to function properly. Capital does not get allocated properly, credit is halted, and of course the economy suffers some serious consequences. As a result, the indications of overpricing in any market by the FED chairman should be considered as one the risk factors.

8. **De-regulation** – According to Reinhart et al., the reduction of regulation in the financial sector is a factor commonly present in banking crises around the world. The change in the regulation induces a change in the risk pattern of some of the investments and assets and these new risk levels are, according to Reinhart et al, initially not fully comprehended by the market participants. This situation leads to an overtrading bias that could fuel a bubble. Furthermore, this could be also understood as a change in the industry as well (the first factor discussed).

3.3.2 Mitigating factors

1. **More regulation** – According to Reinhart et al. the increase in the regulation often have the impact to limit the speculative runs on some of the key asset classes. If the increase in regulation comes early enough it can avoid a bubble. In another cases, if the regulation arrives too late, it could be the “trigger” factor to burst a bubble. The Japanese real estate bubble exemplifies a situation in which the Bank of Japan regulation to limit the bank’s growth of mortgages has “stopped” the increase in real estate prices. This effectively triggered the bubble burst. In either way, whether the increase in legislation prevents the bubble or bursts it, it is a mitigating factor. In the situation that the legislation prevents the crisis it is clearly a mitigating factor. In the situation it bursts the bubble, it makes a new bubble formation less likely in the short term.
2. **No or little leverage** – the leverage factor is important part of the cycle. For the same reasons that high leverage presents an important risk factor, the lack of leverage is a mitigating factor.

With low leverage, usually the investors are better prepared to endure prices reductions and this make them less likely to start a “fire sale” when prices drop. In turn, this combination reduces the bubble risk.

3. **Downward prices or recovery from a crisis** – any asset class that is experiencing a long lasting price reduction trend will probably not be a very attractive market for short-term investors. Particularly the change in goal and means that defines the expansion phase of the cycle does not take place in the downward price environment. If the asset is recovering from a crisis, then these downward prices are even more pronounced and the protective effect is even stronger.

3.3.3 Combining the factors

The next step to complete the model is to determine the adequate weights to combine the factors and create the bubble score model. This is a procedure that would be better achieved by using a regression model and determining the weights that maximizes the ability of the model to properly map the risks of bubble development, using the available data. However the data necessary to perform such optimization is not available. The relevant bubbles in history are limited, occur in different types of markets, which reduces data compatibility and, furthermore, many bubbles occurred in the distant past, making data availability even lower. The strategy to be applied, instead, will focus on determining the weights by a combination of two approaches. The first approach will be to analyze the importance that the Minsk model gives to the factor and generate weights based this importance. The second approach will be to analyze the presence of the mentioned factors in the small sample of bubbles discussed in the section “Examples of financial bubbles”. The final weight will be the combination of both approaches.

Table 6: Calculation of the weights of the risk factors for the bubble score model

Factor	Minsk model emphasis ?	Weight obtained from approach 1	Factor Materially present during:						Weight obtained from approach 2	Overall Factor weight in the bubble score model
			Tulip Mania ?	South Sea Company bubble	Great Depression in the US	Japanese Real Estate Bubble	Internet Bubble	2008 Housing Bubble		
Significant change in industry	Very important	2	✓	✓	✓	✓	✓	✓	2	4
Prices increase	Relevant	1	✓	✓	✓	✓	✓	✓	2	3
Prices (or returns) above historical levels	Relevant	1	✓	✓	✓	✓	✓	✓	2	3
Volume increase	Relevant	1	✓	✓	✓	✓	✓	✓	2	3
Low interest rates	Relevant	1	✓	✓	—	✓	✓	✓	1	2
High leverage	Relevant	1	✓	✓	✓	✓	—	✓	1	2
Regulation level	Relevant	1	—	✓	—	—	—	✓	1	2
Official warning	N / A	0	n / a	n / a	n / a	n / a	✓	✓	2	2

Source: Thesis writer analysis

The information regarding “Official Warning” is related to the warnings that Alan Greenspan, as the president of the FED issued regarding some of the recent booming markets. Those were important warnings, which if properly considered by any investor in his investment strategy, could have helped this particular investor to protect himself from some of downturns following the bubble bursts.

This factor could be considered as not present in many or the earlier bubbles, however that would be to misinterpret the nature of this warning. The level of knowledge and analysis capability that the FED now commands is unparalleled in history. To compare the presence of an Official Warning in earlier manias, such as the Tulip Mania, would be impossible, since simply there wasn’t a comparable institution at the

time. Even for the great depression in the US, the FED was then only a recently founded institution with less than 20 years of history and far fewer capabilities than it now possesses. Therefore this factor was considered to be unavailable for some of the earlier manias.

The table below presents the different levels or states in which the factors can be for a given security. The table also presents the number of points that the asset class will gain by each level of the factor. More points indicate a higher probability of a bubble behavior to be forming in the given asset class.

Table 7: Levels and weights of the factors in the predictive model

Factor	Factor weight in the bubble score model	Factor Levels and value		
Significant change in industry	4	Yes (4)	No (0)	
Prices increase	3	Yes (3)	No (0)	
Prices (or returns) above historical levels	3	Yes - more then 2x Historical (3)	Yes (1.5)	No (0)
Volume increase	3	Yes (3)	No (0)	
Low interest rates	2	Yes (2)	No (0)	
High leverage	2	Yes (2)	No (0)	
Regulation level	2	Increase (-2)	Same (0)	Reduced (2)
High official warning	2	Yes (2)	No (0)	

Source: Thesis writer analysis

3.4 Timeframe

According to Lo (6), it is impossible to precisely determine the time that a crisis or a bubble will occur and therefore it is not the goal of this thesis to precisely time the crisis. However, previous research conducted on the subject might prove useful to provide a guideline on the time between bubbles.

The research conducted by Reinhart et al, helps to shed light on the frequency of the bubble phenomena. This research collected data of a series of world data from different banking crisis in an organized and statistically significant way. It is not exactly the same information as the number of financial bubbles. Sometimes, as in the 1929 real estate bubble or in the 2008 real estate bubble, both the bubble and the banking crisis can occur at the same time. In other situations, the bubble can occur without the banking crisis, as it was the case in the Internet Bubble. Furthermore it is also possible to have a banking crisis without a bubble, such as the long lasting Savings and Loans Crisis.

According to Bordo et al (22), banking crises tend to occur in synchrony with the boom and boost cycle of real estate. This indicated that the frequency of banking crisis might be a potential indicator of the expected frequency of boom and boost cycles in the economy.

The table below summarizes the frequency of banking crisis identified by Reinhart et al.

Table 8: Frequency of Crises in selected developed countries

Country	Number of Banking Crisis since 1800	Share of years in Banking Crisis since 1800 (%)	Number of Banking Crisis since 1945	Mean Time between crises (1800-now) (years)	Mean Time between crises (1945-now) (years)
France	15	11.5	1	12.6	66.0
USA	13	13.0	2	14.3	32.0
UK	12	9.2	4	16.1	15.0
Italy	11	8.7	1	17.7	66.0
Germany	8	6.2	2	25.0	32.0
Spain	8	8.1	2	24.5	32.0
Japan	8	8.1	2	24.5	32.0
Sweden	5	4.8	1	40.6	66.0
Average	10	8.7	1.9	21.9	42.6

Source: This Time Is Different: Eight Centuries of Financial Folly (3)

According to this information, one crisis occurs in the selected pool of countries every 21.9 years, in average. This suggests that current markets in the US are relatively protected from bubbles in the short term, since the last real estate bubble busted in 2008, or only 5 years ago. This statistics provide no guarantees, but instead an indication.

Furthermore, data also suggests that in any given year, there is an 8.7% chance to experience a banking crisis.

3.5 Mathematical overview – JLS Model

The alternative bubble forecasting approach is based on Didier Sornette (23) (24) (25) suggested mathematical model. The JLS (Johansen, Ledoit and Sornette) model is based on mathematical assumptions regarding the individual traders in the market. It assumes that each trader's decision to buy or sell any given security is influenced by two factors: the trader individual opinions and analysis of the markets and the opinions of other traders he is related to. According to the JLS model, all traders in the world are organized in a network, and each individual trader has only a few contacts with whom he or she interacts. Each individual trader weights these two inputs, his own opinions and the opinion of the traders of his or her network, differently to make his or her trading decision. His own opinion is independent of other trader's opinions and fosters a diversity of opinions in the market. This diversity of opinions leads to the existence of both buyers and sellers of the same security, or what Sornette calls "disorder." The other factor which influences the trader's behavior is the opinion of other traders in his network. This is a stimulus that tends to influence traders to have a uniform opinion, or what Sornette calls "order" on the market. The JLS model is based on the conflict of these two factors. The crisis or the crash occurs when order prevails and all traders take the same side, which tends to be the selling side. Under this model, there is no need of any big event to "burst" a bubble, something that explains both the 1929 crash and also the Internet Bubble, events that were not preceded by any particular bad news in the market.

Sornette suggests that the tendency of traders to imitate their peers vary over time and is the key driver of crashes. When the tendency of the trader to imitate other traders becomes sufficiently larger than his tendency to follow his own opinions, it creates a mechanism of local coordination and traders start to take the same position in the market. When the imitating tendency is even larger, this local coordination

can grow, and a large number of traders, or the entire market, can become aligned. According to Sornette, this happens during the crashes and is a behavior similar to some physical systems. Sornette also suggests that one of the conclusions of the model is that prices should rise faster close to the crash moment, since traders will need an additional compensation for the extra risk they are incurring.

The mathematical model is based on a stochastic dynamic of interacting particles, fairly common in the fields of biology and physics. The key equation of the JLS model is presented below.

$$p(t) = A_1 + B_1(t_c - t)^\beta + C_1(t_c - t)^\beta \cos[\omega_1 \log(t_c - t) + \phi_1]$$

Where:

$p(t)$ is the price of the security

A_1, B_1, C_1, ϕ_1 are parameters

t_c is the time of the expected crash

and ω_1 is the frequency of the oscillations

The model can be used to forecast the time of upcoming crashes. In order to accomplish this goal, the price equation has to be fitted to the price time series of a given security and the square errors minimized. According to the proponents of the model, the lower the square error the higher the likelihood that a crash will occur in the time forecasted by the model.

Yan (23) applies the JLS model to generate a crash indicator and a trading strategy. According to his back-testing, the trading strategy generated with the JLS model can yield positive alpha, beyond any statistical doubt, providing support for the model's ability to forecast crashes.

But the JLS model is not without controversy. Chang (26) argues that it is not possible to properly validate the JLS model and other authors argue that the JLS model, even if based on sound financial and mathematical foundation, is prone to implementation problems. One such problem is over fitting or

data mining. Since the core of the model depends on the fitting of the JLS equation with the real prices, there are different ways that such fitting could be done and the results of the model could be misinterpreted as simple data mining. This argument is also supported by the number of degrees of freedom in the model (a total of seven) and most importantly by the fact that the time window of the fit is not determined by the theory. In this sense, data organized into hundreds of different time windows could be selected and used as inputs to the model. After the model has generated its results, the best performing time windows could be selected, generating an adverse selection bias. Therefore, it could be difficult to distinguish between the real results of the model and the “selection bias” of the operator. Given this criticism, the JLS model will be used only as support tool in this thesis.

4 Analysis of potential bubbles in the US

This section of this thesis will focus on assessing how the different asset classes in the US are exposed to financial bubbles. The first step in this procedure is to determine the greater pool of assets to evaluate.

The overall market was selected based on two sources. The first was based on Antti Ilmanen (27) suggested key asset classes and the second was based on the Federal Reserve Bank of New York (28) reported key consumer debt types. The combination of these two sources was considered to be the overall market to be analyzed, in order to determine which assets classes should be scored by the new bubble score model.

One of the characteristics that an asset class must possess in order to be relevant for this bubble study is to present a significant market capitalization. Asset classes with small market capitalization are on average a small share of the overall investor’s portfolio, therefore their relative underperformance does not tend to negatively impact an investor’s portfolio in a meaningful way. The second characteristic that

an asset class must present is liquidity. The definition of bubble discussed previously implies that markets are valuing an asset improperly to obtain short-term goals. However, if any given asset does not possess a strong secondary market, it becomes hard, if not impossible, for an investor to establish a short-term trading position.

The table below presents the overall asset classes analyzed and the selected asset classes based on the two desirable characteristics discussed.

Table 9: Asset classes selection

Asset Class	Subclass	Subclass 2	Market Cap (outstanding) Value (\$ BB)	Selected for Analysis?	Comments	Source
Stocks	Tech		3,456	Yes	S&P 500 Sector index	S&P (1)
	Financials		4,235	Yes	S&P 500 Sector index	S&P (1)
	All Stocks		16,856	Yes	Russell 3000 components	S&P (1)
Bonds	Treasuries	Up to 1 Y	2,889	Yes		Department of Treasury - Office of Debt Management (1)
		> 1 and < 10 Years	7,348	Yes		
		>= 10 Years	1,331	Yes		
		Sub Total	11,568	Yes		
	Corporate	Investment Grade	9,088	Yes		SIFMA (1)
	Municipals	High Yield	3,714	Yes		SIFMA (1)
	Subtotal Bonds		24,370			
Mortgages			12,949	Yes		Federal Reserve Z1 Report - table L2 (1)
Alternatives	Hedge Funds		2,130	No	Low liquidity	Hedge Fund research Inc, as quoted by the WSJ (1)
	Private Equity		2,000	No	Low liquidity	TheCityUK (1)
	REIT's		603	No	Low market cap	SIFMA (1)
	Venture Capital		199	No	Low liquidity and low market cap	National Venture Capital Association (1)
	Subtotal Alternatives		2,802			
Money Markets			2,461	No	Recent government guarantee Low liquidity / Concentration of government ownership	SIFMA (1)
Other Credit	Student Loans		966	No	Low liquidity / Concentration of government ownership	FRBNY (1)
	Auto Loans		783	No	Low market cap	FRBNY (1)
	Credit Card		679	No	Low market cap	FRBNY (1)
	Other		351	No	Low market cap	Federal Reserve Z1 Report - table L2 (1)
	Subtotal Consumer credit		2,779			
Total Market Capitalization of Analyzed Assets			62,217			
Total Market Capitalization of Selected Assets			54,175	87.1%		

(1) Sources of information further detailed in the next table.

The next table provides an overview of the sources of the information present in Table 9.

Table 10: Sources of information for Table 9

Asset Class	Subclass	Source
Stocks	Tech	Bloomberg, using S&P IT Index
	Financials	Bloomberg, using S&P Financials Index
	All Stocks	Bloomberg, using Russell 3000 Index
Bonds	Treasuries	Department of Treasury - Office of Debt Management Quarterly report. http://www.treasury.gov/resource-center/data-chart-center/quarterly-refunding/Documents/TBAC_Discussion_Charts_Feb_2013.pdf
	Corporate	Securities Industry and Financial Markets Association, Statistical Data on Bonds Outstanding http://www.sifma.org/research/statistics.aspx
	Municipals	
	Subtotal Bonds	
Mortgages		Federal Reserve Z1 Report - table L2
Alternatives	Hedge Funds	Hedge Fund research Inc, as quoted by the WSJ (http://online.wsj.com/article/SB10001424052702304331204577354043852093400.html?mg=id-wsj)
	Private Equity	TheCityUK Research Centre: Financial Market Series - Private Equity July 2012
	REIT's	Securities Industry and Financial Markets Association, Statistical Data on Bonds National Venture Capital Association Yearbook 2013 (http://www.nvca.org/index.php?option=com_content&view=article&id=257&Itemid=103)
	Venture Capital	
Subtotal Alternatives		
Money Markets		Securities Industry and Financial Markets Association, Statistical Data on Bonds Outstanding http://www.sifma.org/research/statistics.aspx
Other Credit	Student Loans	Quarterly Report on Household Debt and Credit, February 2013, Federal Reserve Bank of New York, Research and Statistics Group
	Auto Loans	
	Credit Card	
	Other	Federal Reserve Z1 Report - table L2 (1)
	Subtotal Consumer credit	

Once the starting pool of assets is selected as presented in Table 9, the next step is to actually analyze these asset classes using the Bubble Score model, which will be done in section 4.2. Before, however, the next session will briefly discuss the asset classes that were not selected to be scored with the new bubble score model.

4.1 Remarks about the asset classes not scored with the Bubble Score model

Some of the asset classes from the starting pool of asset classes were not selected to be scored with the bubble scoring model, based on two criteria. These asset classes account for only 13% of the market capitalization of the original pool of asset classes and they either did not provide a significant market capitalization or did not prove to be liquid instruments. Before moving to the next section that effectively scores the asset classes, this thesis will briefly discuss the asset classes that were not selected.

The largest of the non-selected asset classes was the Money Markets Funds with \$ 2.5 T of assets under management. These are funds that play a role in the asset allocation for short-term investments. A traditional money market fund owns different short-term obligations (such as Commercial Paper) from different issuers, always with short duration and maturity. In the recent US financial crisis, money markets suffered a severe downturn as some of their liquid assets began to default. As a consequence, the owners of these fund's shares not only lost some of their money, but also lost liquidity, since it could take years to get recovery from the defaulted instruments. However, this asset class was promptly supported by the government. The quote below from a news agency at the time (29) exemplifies this support:

Sept. 19 2008 (Bloomberg) -- The U.S. will insure money-market funds against losses for the next year as it seeks to prevent a run on \$3.35 trillion of assets that average investors and institutions rely on as a safe alternative to bank deposits.

Bloomberg news service (29)

If these funds suffer another strong downturn, it is possible to expect the government once again to step in to support the industry. As a consequence, this asset class is not prone to developing bubble behavior. The second largest asset class that was not selected was the Hedge Funds with \$ 2.1 T of assets under management. These funds have grown in volume in the last years and tend to have a diversified pool of strategies of investments. One of the characteristics of these funds is that investors are usually qualified, sophisticated and well aware of the risks incurred in the investment. Another key point that makes Hedge Funds less prone to the formation of bubbles is their low liquidity. Many funds have a lock-up period and the assets under management cannot be withdrawn on short notice. In this sense the bubble behavior is not stimulated. The same occurs for the third largest asset class that was not selected – the Private Equity Funds with \$ 2.0 T of AUM. These funds tend to have an even longer lock-up period, sometimes ranging from 5-10 years and investors have little liquidity during this period. As a consequence the short-term bubble behavior is avoided.

The other asset classes not selected each have a market capitalization of less than \$ 1.0 T.

4.2 Results of the Bubble Score model

The first analysis will focus on the total return evolution. An asset class will be marked with a bubble flag if it presents a constantly increasing total return for the three years considered. The time frame of three years was selected since the bubble dynamic is intrinsically short termed. Particularly according to Carroll's framework and also Lo's hypothesis of adaptive markets, investors will become less risk averse once they realize that other investors are profiting from a given market. This will be mapped as the three year's returns.

Table 11: Return Evolution Analysis

Asset Class	Subclass	Subclass 2	Total Return of assets (% yearly)			Growing Total Returns bubble flag ?
			2010	2011	2012	
Stocks	Tech		10.09%	2.48%	14.72%	●
	Financials		12.06%	-16.91%	28.68%	●
	All Stocks		16.65%	1.01%	16.29%	●
Bonds	Treasuries	Up to 1 Y	0.11%	0.07%	0.03%	●
		> 1 and < 10 Years	4.70%	6.46%	1.50%	●
		>= 10 Years	14.68%	22.69%	2.83%	●
		Sub Total				
	Corporate	Investment Grade	9.20%	9.53%	10.37%	●
		High Yield	11.26%	6.53%	11.20%	●
Municipals		4.29%	4.59%	4.29%	●	
	Subtotal					
Mortgages			5.50%	3.29%	4.39%	●

Sources of information: Bloomberg, Thomson Reuters.

The results presented in the previous Table indicate that none of the asset classes analyzed presented a constantly growing total return over the three years period and therefore none of them were marked to have a total return flag.

The next table presents the comparison of the total returns of the last three versus the average of the historical long-term total returns. An above historical flag will be marked for any asset class that presents either three years above the historical total returns or at least one year of returns that exceeds the historical levels by 200 basis points

Table 12: Returns vs. Historical Returns Analysis

Asset Class	Subclass	Subclass 2	Historical total return "Reference"	Return on the year - Historical Return (% yearly)			Above Historical Returns Bubble flag ?	
				2010	2011	2012		
Stocks	Tech		10.58%	-0.49%	-8.10%	4.14%	●	
	Financials		6.50%	5.56%	-23.41%	22.18%	✓	
	All Stocks		7.08%	9.57%	-6.07%	9.21%	●	
Bonds	Treasuries	Up to 1 Y	4.43%	-4.31%	-4.35%	-4.40%	●	
		> 1 and < 10 Years	6.68%	-1.97%	-0.22%	-5.18%	●	
		>= 10 Years	8.10%	6.58%	14.59%	-5.27%	✓	
	Sub Total							
	Corporate	Investment Grade		7.00%	2.20%	2.53%	3.37%	✓
		High Yield		8.70%	2.56%	-2.17%	2.50%	✓
Municipals			5.24%	-0.95%	-0.65%	-0.95%	●	
Subtotal								
Mortgages			7.10%	-1.60%	-3.81%	-2.71%	●	

Sources of information: Bloomberg (realized returns), Thomson Reuters (realized returns), Antti Ilmanen (27) (historical returns).

The results presented in the previous Table indicate that Financial Stocks, Long maturity Treasury Bonds and Corporate Bonds were marked to have a total return flag.

The next table assesses the evolution of the outstanding value of the assets classes. An asset class will be considered with a flag bubble if it consistently grew in total market capitalization in the last three years.

Table 13: Volume evolution Table

Asset Class	Subclass	Subclass 2	Market Capitalization (USD B)				Market Capitalization Growth			Volume evolution bubble flag ?
			2009	2010	2011	2012	2009-2010	2010-2011	2011-2012	
Stocks	Tech		2,974.7	3,123.7	3,100.6	3,456.0	149.0	(23.1)	355.4	●
	Financials		3,579.4	4,082.1	3,619.2	4,235.0	502.7	(462.9)	615.8	●
	All Stocks		14,877.0	15,916.1	15,977.3	16,855.6	1,039.1	61.2	878.4	✓
Bonds	Treasuries	Up to 1 Y	2,702	2,563	2,620	2,889	(139)	57	269	●
		> 1 and < 10 Years	4,385	5,946	6,791	7,348	1,561	846	557	✓
		>= 10 Years	695	853	1,017	1,331	158	164	314	✓
		Sub Total	7781.9	9361.5	10428.3	11568	1579.6	1066.8	1139.7	
	Corporate	Investment Grade	7,089	8,016	8,325	9,088	927	309	763	✓
		High Yield								✓
	Municipals		3,673	3,772	3,719	3,714	100	(53)	(5)	●
Subtotal		15,821	17,938	19,363	24,370	2,118	1,425	5,007		
Mortgages		14,179	13,558	13,221	12,949	(621)	(337)	(272)	●	

Sources of information: see Table 10

The last table indicated that several asset classes presented growth flags.

The next table combines the results of the three last tables and also adds the additional bubble factors to finally complete the bubble score for the selected asset classes.

Table 14: Overall Bubble risk Factors

Asset Class	Subclass	Subclass 2	Growing Total Returns bubble flag ? (weight =3)	Above Historical Returns Bubble flag ? (weight =3)	Volume evolution bubble flag ? (weight =3)	Significant Change in Industry ? (weight =4)	Increased Leverage in the market? (weight =2)	FED chairman warning ? (weight =2)	Regulation Level ? (weight =2)	Overall Bubble SCORE	
Stocks	Tech		●	●	●	●	●	●	—	0	
	Financials		●	✓	●	●	●	●	↑	3	
	All Stocks		●	●	✓	●	●	●	↑	3	
Bonds	Treasuries	Up to 1 Y	●	●	●	●	●	●	↑	-2	
		> 1 and < 10 Years	●	●	✓	●	●	✓	↑	3	
		>= 10 Years	●	✓	✓	●	●	✓	↑	6	
	Sub Total										
	Corporate	Investment Grade	●	✓	✓	●	●	●	●	—	6
High Yield		●	✓	✓	●	●	●	●	—	6	
Municipals		●	●	●	●	●	●	●	—	0	
Subtotal											
Mortgages		●	●	●	●	●	●	●	—	0	

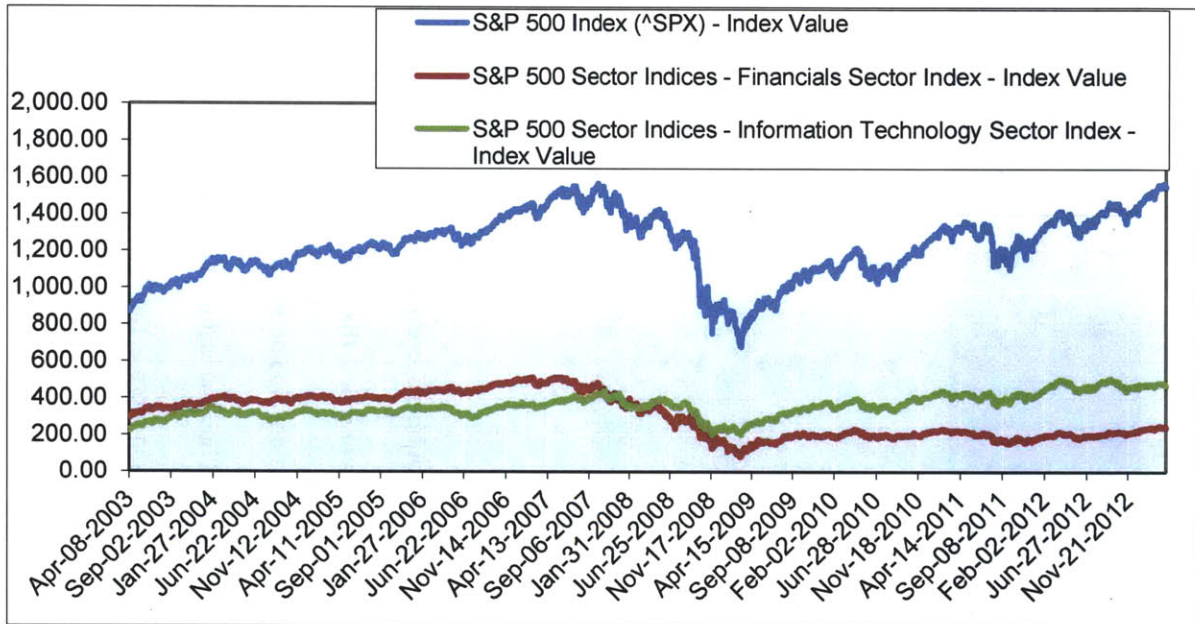
Source: Thesis writer analysis

This last table presented the combined results of the bubble Score strategy. The flags were combined with the weights discussed previously and each asset class was assigned a total number of points or score. The scores varied from a low of -2 to a maximum of 6. The lower numbers indicate asset classes in situations that are not likely to develop bubbles and the higher scores indicate situations in which the bubble development is more likely. The two asset classes that had the highest bubble score were: Longer Maturity Treasury bonds and also Corporate Bonds. The next section will discuss these instruments in more detail.

4.3 Results of the JLS Model

As mentioned in Section 3.5, the JLS model was only applied as a supporting model, given the criticisms that it faces regarding data mining issues. Particularly the model was applied to the equity asset classes discussed in the previous sub-section to determine if there is a prediction of a crash in the near future. Even though the model could be properly adjusted to analyze other types of asset classes (such as bonds), those adjustments were beyond the scope of this research. The next figure present the price series used as inputs to the model.

Figure 5: Index levels used on the JLS model



Source: Standard and Poor's

The next table presents the outputs of the model, as well as the square error of the fit.

Table 15: JLS Model results

Security	Price data Inputted to model			Predicted Crash time	Average Error	R ²	Remarks
	From	To	Number of trading days				
S&P 500 Index (^SPX) - Index Value	3/28/2007	3/13/2013	1500	3/6/2016	12.2%	0.57	Low fit (R ² and Error square)
S&P 500 Sector Indices - Financials Sector Index - Index Value	3/28/2007	3/13/2013	1500	5/18/2016	25.4%	0.58	Low fit (R ² and Error square)
S&P 500 Sector Indices - Information Technology Sector Index - Index Value	3/28/2007	3/13/2013	1500	3/14/2016	13.0%	0.63	Low fit (R ² and Error square)
DJIA	2/21/1923	2/19/1929	1500	6/5/1931	6.8%	0.96	Used to control the efficiency of the model

Source: Thesis writer analysis

According to table (Table 15), the S&P indexes that were added to the model presented crash dates in the year of 2016. However, the fit that the modeled prices had with real data was low. The average error in the fit ranged from 12.2% to 25.4% and the R² ranged from 0.57 to 0.68. To give a reference, when the famous 1929 crash data was inputted in the JLS model, the crash time was predicted to be 6/5/1931 with a comparative higher fit. The average error was just 6.8% and the R² was 0.96. Hence, it is possible to conclude that the fits that the model obtained for the current S&P indexes were not able to yield a reliable bubble forecast. As a consequence, the interpretation of the JLS model is that either there is no expected bubble or, at least, the model is unable to forecast it.

4.4 Remarks about U.S . Treasury bonds

The United States of America Treasury bonds and bills are some of the most important instruments in the global financial markets. These instruments are not only important due to their significant market capitalization (\$ 11.5 T), but also due to their importance in determining the risk-free rate. The risk-free

rate is an important input of many of the financial models that are used to price other assets. Examples of models that use the risk-free rate are the Black and Scholes model to price options and the Capital Asset Pricing Model used to price stocks and other assets. Given the relevance of the Treasury Bonds, this section of the thesis will focus particularly on them.

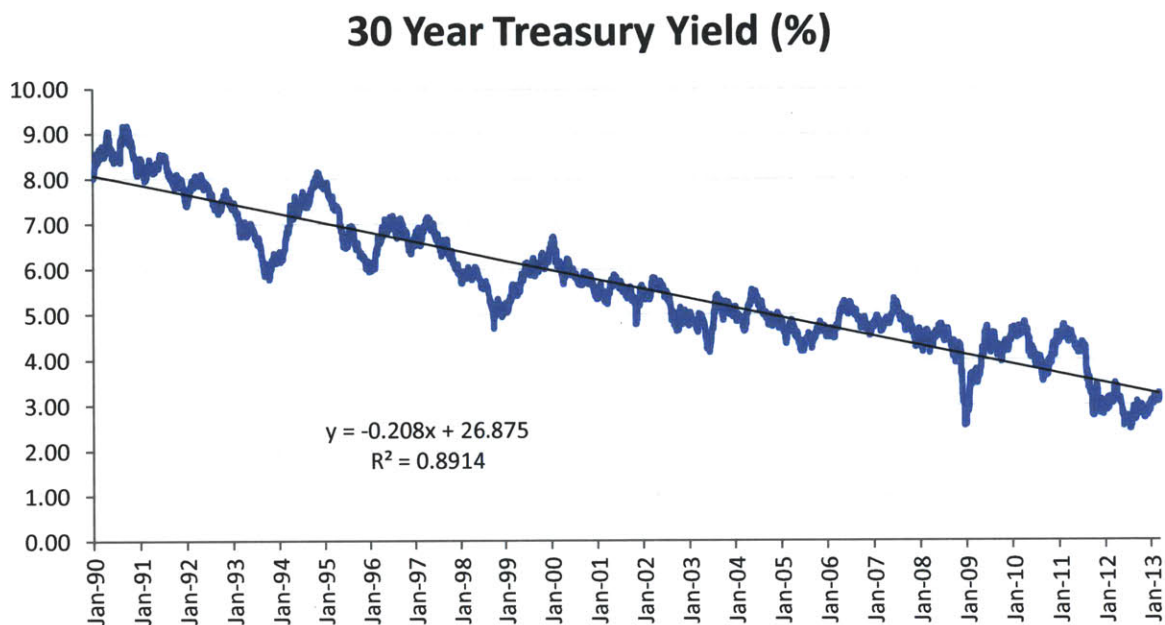
The Treasury Bonds are widely believed - or said to be - risk-free instruments. But are they really risk free? To answer this question it is necessary to fully assess the riskiness of such instruments. Basically, there are two risks that threaten the value of a Treasury bond. The first one is the risk that, once one investor has bought the bond, the issuer, or the government, may fail to repay the coupons or the principal on the due date. That is the default risk. The second risk is related to the secondary market. The investor might decide to sell the bond before its maturity in the secondary market. In this situation, the price of the instrument might be lower than the price the investor would expect to receive, considering the “curve” of the bond. That is the market risk of the bond.

4.4.1 Market Risk

The usual assumption that Treasury Bonds are risk free only concerns the government obligations and does not state anything about the secondary market. In that sense, these bonds are freely traded in the market and their secondary prices can and do change. This volatility leads to the market risk.

The following curve shows the evolution of the 30-Year Treasury Yield.

Figure 6: Evolution of newly issued 30 Year Treasuries Yields



Sources of information: Bloomberg.

The downward trend in the yield is noteworthy. This trend is demonstrated by the regression line that indicates that as each year passes, in the time frame from 1990 to 2013, the 30 Year Treasury yield reduced by 0.208% or 21 bps.

That is a significant and important variation in prices. The total return an investor will receive from holding a Treasury bond will be (assuming that the holding period is short compared to the duration of the bond):

$$\text{Total Return} = ydt - Ddy + \frac{1}{2} C\sigma^2 dt$$

where

y = bond yield

P = price

D = Duration

C = Convexity

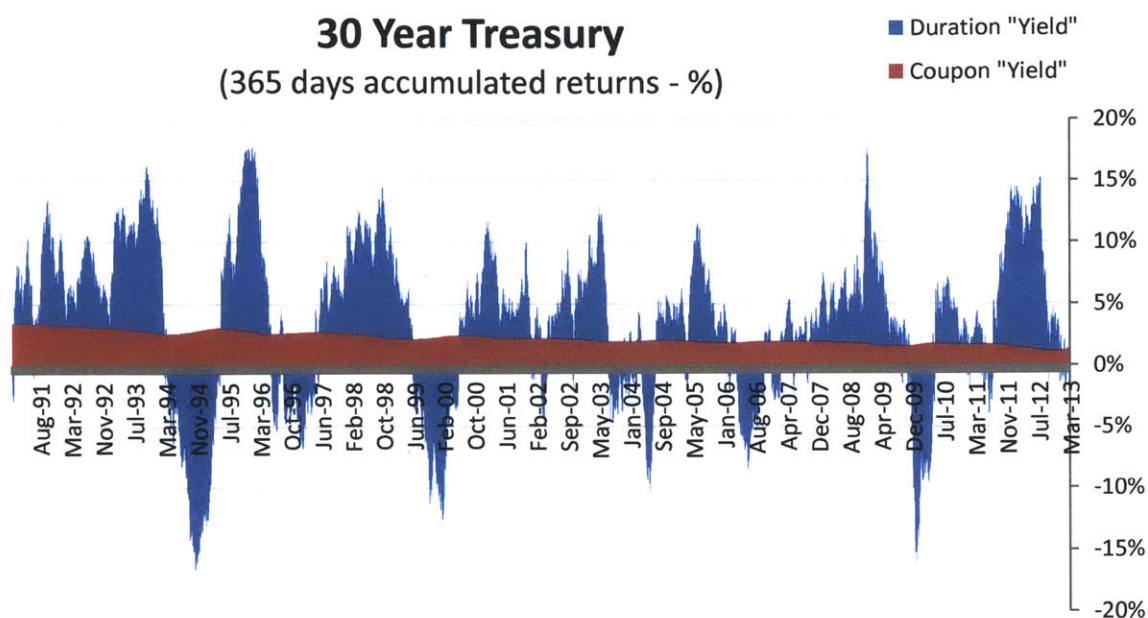
σ = yield volatility

Where D is the duration of the bond (assumed to be 19.5 years for the 30 years Bond) and for simplicity we can assume the coupon is equal to the yield.

This means that the more the interest rates fall, the better the bond performs relative to its coupon, since the resale market price becomes higher. The downward trend in the yields implies that the real returns the investors got from holding the 30 Year bonds were far higher than the coupons on the years from 1990 to 2013.

Using this framework, we could determine the total returns for holding 30 Year treasuries for the noted period and split the return in the two components – the Coupon Yield and the Duration effect. The graph below illustrates these results and the importance of the Duration effect.

Figure 7: Decomposition of 30 Year treasuries returns in Coupon and "Duration" effect



Source: Writer estimation

If an investor had the strategy to buy recently issued 30Y treasuries and resell them after one year, buying a new one afterwards, of each 100 USD that this investor would have made 53 would have come from actual coupons and another 47 would have come from capital gains in the resale of the bond.

This situation can only happen when the yields are reducing, and that is definitely something that cannot happen indefinitely. Zero is the minimum yield possible for the bond. Below this value, investors would simply hold their cash and not invest.

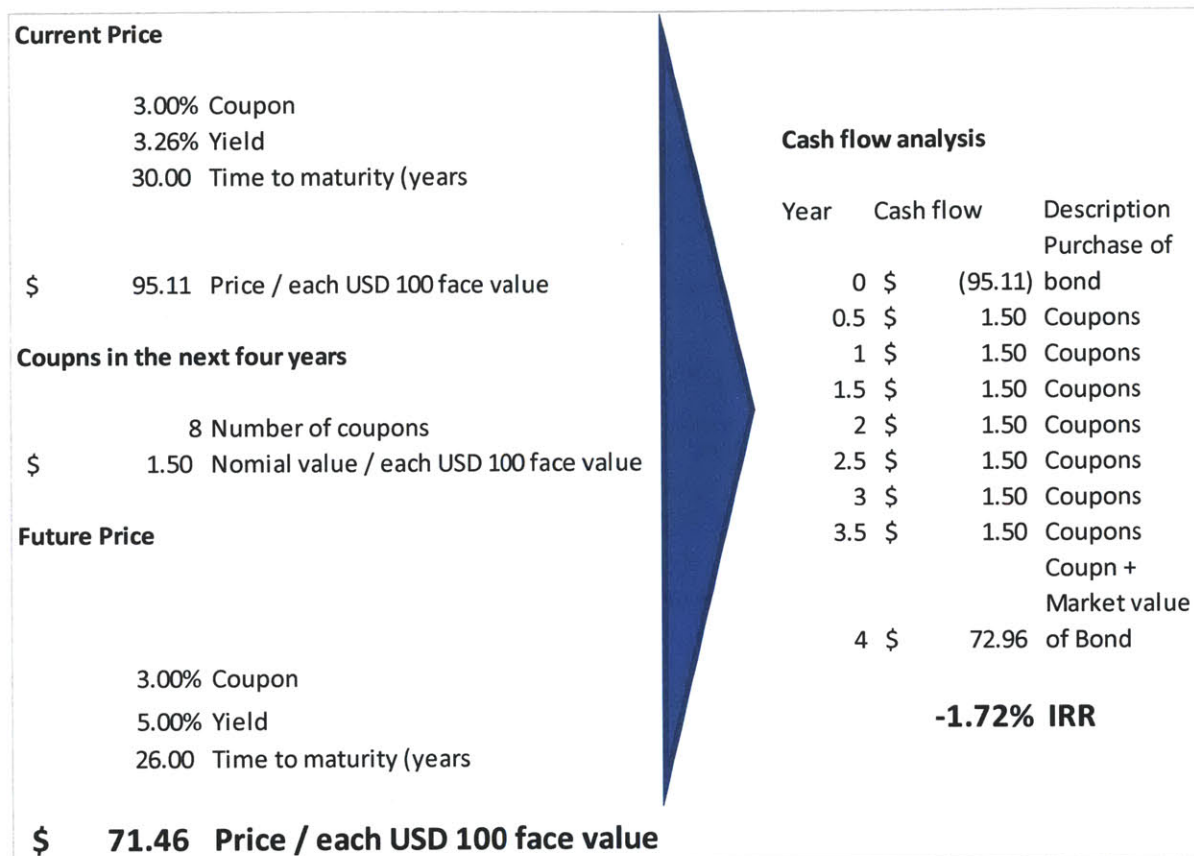
Perhaps one of the best indicators of the future path of this market is contained in the speech given by the FED Chairman Ben Bernanke on March 1st 2013 (30). According to him, the market should expect to see the 30 Years Treasuries trading at "4 or 5% yield in 2017". But what are the implications of these

changes for a current holder of a recently issued 30 years Treasury? Some simplifying assumptions can help in the calculation of this change:

Assumptions:

- 30 Y treasuries and 26 Y treasuries trade at the same YTM, or in other words, the yield curve is flat after the 26 years maturity
- Current Yield is 3.26%
- Yield of 30 Year and 26 Year Treasury Bonds in 2017 will be 5% (according to Chairman Bernanke's estimation)

Figure 8: Calculation of 30 Year Treasuries returns implied by Chairman Bernanke's forecasts



Source: Thesis writer calculation

This is a relatively alarming result. If these assumptions are correct, and Chairman Bernanke's expectations of the evolution of yields of the Treasury Bonds prove to be correct, then owning a 30 Y treasury bond will be a negatively yielding investment for the next 4 years, with its internal rate of return estimated to be -1.7% yearly.

The recent speeches from Federal Reserve Bank of San Francisco Vice Chairman Janet Yellen (31) provide support for this theory. According to her proposed "optimal control path", short-term interest rates should remain very low until 2016 and then should experience a steep increase.

4.4.2 Default Risk

The other component of the risk incurred by holding a bond is the default risk. In this sense, the United States Treasury Bonds are considered risk free.

This is truly a very strong assessment and this thesis will do little to counter this assumption, but will only mention that the current CDS spread for the US Treasury obligations is 20bps (source: Bloomberg), which is a very small number, implying that great assurance in the ability of US to handle all of its budget related issues.

4.4.3 The uncertain nature of bubble prediction

There are many indications based on the bubble score model that suggest that the long maturity treasury bonds are prone to a bubble type of behavior. On the other hand one factor that plays a key importance is Chairman Bernanke's forecast about the future yields. This forecast is important to determine the total returns expected in the next 4 years for this bonds. However, the assumption that Chairman Bernanke presents is that the current spot yield curve is not precisely pricing the expected changes in interest rates in the next four years and therefore the yield curve will change significantly. This, by definition is a type of speculation. There is no trade that could be performed with this information that would generate risk-free returns in any state. For one reason, Bernanke's prediction could be wrong. Even if he has a large pool of resources and a lot of experience, the prediction could still be wrong. Some bad event could happen in Europe, or in any other place, and that could make the markets move unexpectedly to safer assets pushing yield to different directions. On the other hands

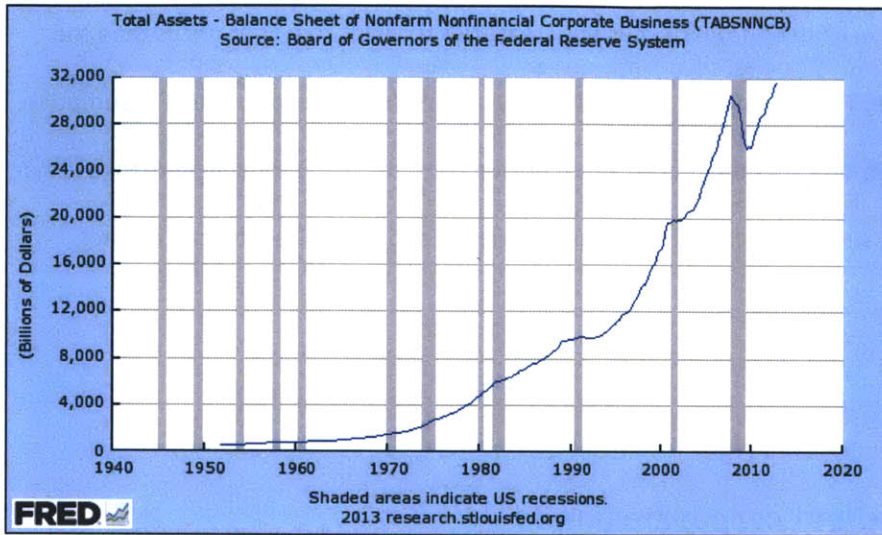
budget discussions in the US congress could evolve in ways that could make it difficult for the US treasury department to serve its debt properly, pushing treasuries to yields to higher prices than the ones predicted by Bernanke. That being said, any bubble forecast will involve some type of assumption or speculation about a parameter that the market is not pricing correctly, and probably Bernanke is in a privileged position to make such a prediction, given his experience and the FED analytical research resources.

4.5 Remarks about corporate bonds

Corporate bonds constitute the second asset class that got the highest number of points under the suggested bubble score model. These Bonds got the score based on two important parameters: real returns above historical average and growth in the market capitalization of the assets. Those two topics will be further assessed for the corporate bonds.

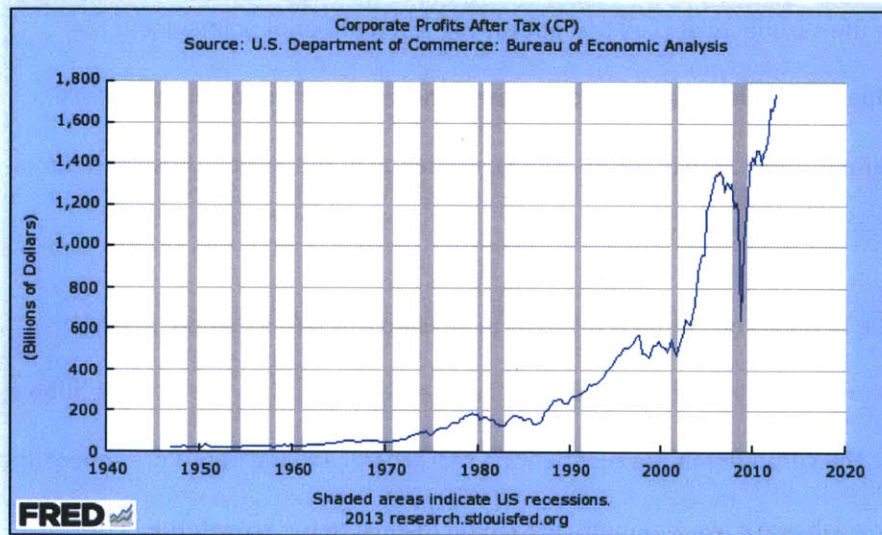
The growth of the total value of bonds outstanding might both indicate a hazard situation, in which overtrading is leading to an unsustainable situation, such as the one experienced on the internet bubble, or it could also indicate that the corporations are experiencing real growth and the bonds are supporting this growth. To better distinguish these two situations, it is useful to analyze the growth the in the corporation's balance sheets. The graph below presents the information regarding the growth of corporate balance sheets, both in terms of assets and also in terms of revenues.

Figure 9: Evolution of Assets of US Corporations



Source: FRED – Federal Reserve Economic Data – FED of Saint Louis.

Figure 10: Evolution of Profits of US Corporations



Source: FRED – Federal Reserve Economic Data – FED of Saint Louis.

It is possible to see in the previous figures that both corporate assets and also profits have grown significantly in the recent years. The next table will present the comparison of the growth rates of corporations' assets, profits and the value of outstanding corporate bonds.

Table 16: Evolution of selected financial information for corporations

Financial Information	2009	2010	2011	2012	Growth 2009-2012 (CAGR)
Bonds Outstanding (\$ B)	\$ 7,089	\$ 8,016	\$ 8,325	\$ 9,088	8.63%
Assets (\$ B)	\$ 26,188	\$ 28,037	\$ 29,973	\$ 31,619	6.48%
Profits (\$ B)	\$ 4,685	\$ 5,772	\$ 5,900	n/a	12.23%

Source: Securities Industry and Financial Markets Association, Statistical Data on Bonds Outstanding, Federal Reserve Bank of Saint Louis

Analyzing the growth of corporate bonds of 8.63% CAGR in the last three years it seems to be a large number. However the growth in profits of 12.23% and the growth in assets of 6.48% suggest that the corporations are increasing their balance-sheets and their profitability, and, hence, the increase in the corporate bonds outstanding could be largely justified by this growth.

The second parameter that made the corporate bonds to score high in the bubble score strategy is the fact that their recent total returns are higher than their average returns. In this sense, the corporate bonds are sensible to the same factors discussed for the government bonds, with the difference that corporate bonds tend to have a smaller duration, making them less volatile.

4.6 Remarks about other commonly mentioned potential bubbles

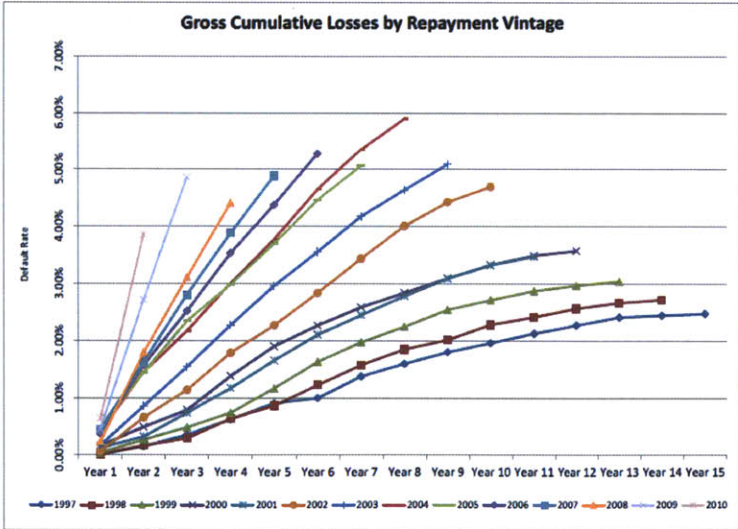
..Ever since the financial crisis, Americans have begun to see bubbles everywhere they turn... (32)

Christopher Matthews, Reporter for TIME Business

Often the mainstream and specialized media refer to the concept of “bubbles” in different ways. Mihir Desai (33) argues that CEO’s compensation is currently a topic that is fueling a bubble. The concept of the “compensation bubble” is that there is a lack of accountability in the CEO compensation plans and this leads to a reinforcing loop of increasing risks to corporations. Even if that is an important topic that should deserve proper attention, this is not a truly financial bubble. Investors do not buy and sell CEO “contracts”, but instead investors buy and sell company securities. Hence, the “compensation bubble” could directly affect the company securities (stocks and bonds), and those were previously analyzed and scored using the financial bubble score model.

Another line of credit that is often regarded to be prone to bubble behavior (34) is student loans. Some of the proponents of this possibility argue that the increasing leverage of the student loans combined with the bad economy justify the expectation of the bubble.

Figure 11: Private Student Loans Gross Cumulative Defaulted Dollars curves by repayment entry vintage by years of seasoning for five non-profit lenders (that account for 85% of the PSL universe)



Source: Consumer Financial Protection Bureau (35)

However, student loans accounts for only 1.0 T \$ or less than 2% of the overall market capitalization of the pool of assets analyzed. Furthermore, 85% of the student loans (32) are backed by the federal government. In that sense, these are not tradable instruments and cannot build fuel the speculation mania, since they are priced considering the government guarantee.

5 Institutional alternatives to reduce the severity of bubbles

One of the objectives of this thesis is to suggest functional alternatives for informed and prudent investors to avoid some of the worst consequences of bubbles. The previous sections discussed two alternatives to search for bubbles ex-ante and this section will suggest some functional ways that prudent investors could protect themselves from the worst consequences of bubbles.

These suggestions could be combined with the bubble identification strategies suggested in the previous section of this thesis or with any other bubble identification approach, as long as the approach clearly indicates the assets that are likely to develop a bubble.

One point that might be misinterpreted as a bubble control technique is market timing. According to Henriksson and Merton (36), market timing is the strategy to identify the moment in which one particular market will outperform another market. Market timing can be part of an important alpha generating strategy. Market timing can be applied in all times, even in times in which bubble type of events are not building up. On the other hand, the strategies that will be discussed for bubble control are only applicable in situations in which there is a bubble building or, at least, a significant likelihood of a bubble formation.

Two strategies are suggested that can be applied to make prudent investors prepared to bubbles. They differ in the way they accomplish this goal. One alternative does depend on structural changes that

require new legislation and or regulation and the other alternative does not require such changes. The next subsection will discuss these alternatives, starting with the one that does not require new legislation or regulation.

5.1 Investor-driven alternative – “Anti-bubble Fund Style”

This investor-driven alternative does not require the enacting of new legislation or regulation, but instead relies on the individual investor’s decision to avoid bubbles. This could be accomplished with an “Anti-bubble” fund style. The investment management landscape today presents several alternatives for investments. Investors can find both mutual funds and exchange traded funds (ETFs) that track different indexes and investment styles. To exemplify the diversity of ETFs available, Black Rock, one of the leading providers in ETFs, alone offers 281 different ETFs for its investors. One particular type of fund style is the socially responsible investing fund style (37). This style aims to invest in companies with “positive environmental, social and governance (“ESG”) characteristics relative to their industry and sector peers.” Similarly it is possible to create an anti-bubble or counter-cyclical fund style that would aim to invest in strategies that avoid the assets prone to bubble behavior.

This new style would basically use any reasonable source of bubble behavior prediction such as either of the two discussed in this thesis (Bubble Score or JLS model) or any other, and apply this information to conduct the investment asset allocation. This new style could achieve this goal in different ways. It could significantly underweight any asset class that is prone to bubble behavior or else it could hold the asset classes known to be risky, but also buy some downside protection. In this way, investors in this fund could still benefit from some of the upside during the fueling period of the bubble, and still have a protection when and if the bubble event occurs. Simply just not holding the risk asset seems to be the safer option, but on the other hand, it is also the option that might forgo the upsides completely and face stronger opposition from the opponents of the concept of bubble, such as the ones mentioned in

section 2.1. Bubble predictions are far from perfect and for any given asset class considered likely to develop a bubble, the bubble could take years to develop or maybe not develop at all. Therefore it is probably better to implement the anti-bubble style with the strategy to underweight the bubble-prone asset class or with the strategy to buy downside protection for that asset class. These two alternatives will provide protection and still preserve some of the upside returns from the given asset classes.

The pillar of the anti-bubble fund style would be an anti-bubble base index. This base index would be the target for the asset managers who would implement this strategy. The composition of this index should start with the broadest array of assets, including Stocks, Bonds and Mortgages, similar to the approach presented in Table 9. These assets should be weighted based on their market capitalization to mimic the broadest type of market possible. After this step is completed, some type of bubble-searching test should be applied periodically, either one of the two suggested in this thesis, or any other that is regarded as able to spot bubbles. The asset classes that are ranked high or that presented a high probability of developing a bubble should have their weights reduced by a multiple in this index or some protective options should be added to the index.

Once the index is properly developed, the individual asset managers could launch funds aiming to follow this index. This style would give a positive incentive for the money managers: they would not try to “dance the dance” on the bubbling markets and, instead, they would try to track and beat the index by mimicking its composition. In that sense, investors would get their expectations aligned with the money managers and the behavioral biases could be reduced significantly. It is extremely frustrating for managers and investors to underperform and therefore managers have little incentive to be contrarian regularly. However, if there is this new index for them to track, they would only be judged by the investors for their relative performance compared to this index. In that sense, their risk tolerance would change, and it would foster safer decisions.

One setback of this strategy is the need of the anti-bubble index. It requires some organization in order to build the index. First of all it would be necessary to accurately select the components of the broader market. Furthermore it would be necessary to determine a specific process to search for bubbles. The methodology should be determined to avoid “case by case” evaluations. And finally both the selection of base securities and the bubble searching should be updated in a timely manner to provide a daily value for the anti-bubble index.

The Index could be provided by a number of different sources. A financial institution could perform this function, either an investment bank such as Barclay’s Capital which is famous for its Bond indexes, or else an investment management advisor such as S&P and the Dow Jones group which are famous for their Stock indexes. Another alternative would be to have this task in the hands of academia. The Federal Reserve with its significant resources could provide both the technical skills necessary to build the index, as well as the confidence that the market would need to fully embrace this idea.

5.1.1 Put protective strategy

One of the alternatives that managers could use to mimic the “Anti-bubble” style index would be to buy some downside protection such as Put options. Such put options, particularly the long maturity ones, are helpful to protect a portfolio once the prices of the underlying assets are going down. The flexibility of put option allows managers to precisely determine which share of their exposure they want to hedge. They might want to hedge precisely to mimic the index, but they could also underweight or overweight the put options to express views on the market and to search for some alpha to their portfolios. Another positive characteristic of the put options is that managers can use them on a broad index such as the S&P 500 to hedge a potential downturn in the stock markets, but managers could still hold a portfolio of actively selected stocks that are not exactly the S&P 500. Once again the put option strategy proves to

be flexible enough to allow managers to express their views of the market in search for alpha, while still controlling their risks with the put. Finally puts can be easily found for different types of securities. They are broadly available for stocks and futures, and also currently exist for ETFs that track some particular index. Managers can use this flexibility by buying puts that track a given ETF that track a given index. That suits manager's needs, and once the "anti-bubble" index is in place, there could even be options on this index that could be used by investors to combine with short-termed risk-free assets to build low risk portfolios that offers great liquidity and also good collateral for other transactions that might require collateral.

5.2 Regulatory Alternative – Agency to map risks

This alternative is based on the concepts of two different industries: the oil industry and the air transportation industry. Similar to what exists in the air transportation industry, this alternative suggests the establishment of a new agency solely intended to assess the situation of the financial markets and to search for crises. This agency would not focus on enacting any legislation or regulation, but only on technically analyzing the markets and issuing alarms and recommendations, when the markets are in hazardous situations. This alternative could be compared to the situation that now exists in the US agencies that regulate and provide safety for the air travel industry. The National Transportation Safety Board (37) is the agency empowered with the mission to analyze air accidents and to suggest solutions for the problems that led to the accidents. The Federal Aviation Administration (38) is the main regulator of the air industry and has the responsibility to generate adequate regulation based on the NTSB analyses of the accidents and also on all other concerns that the FAA might have regarding air safety and air travel efficiency. Similarly the financial markets could benefit from this structure. The Federal Reserve, the Commodity Futures Trading Commission and the Securities and Exchange

Commission (SEC) have the responsibility to regulate the markets. However, the financial markets still lack an unbiased agency analogue to the NTSB to analyze vulnerabilities and eventual crashes of the financial system. This new agency would be the main contact point for the Congress and other branches of the government to discuss crises and preventive measures. This branch could be responsible to prepare the Anti-bubble index, mentioned in the previous subsection.

Furthermore, similarly to what happens in the oil industry, this new agency could also have the responsibilities to give some proper guidelines to the markets. An analogue function is performed by the Energy Information Administration:

The U.S. Energy Information Administration (EIA) collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.

EIA Website (39)

This new agency could provide some realistic forecast bands for the prices of financial instruments. This agency would use sound academic theory to provide guidelines for the markets to price the individual securities – housing prices, stocks and bonds. That would be similar to the function that the EIA now performs by forecasting oil prices for the next 40 years. This new agency could reduce some of the cyclical effects that have lowered the growth pace of the overall economy, therefore improving the efficiency of the economy.

Another function of this agency could be to analyze innovative financial instruments. The agency could constantly search for new instruments and systemically analyze the new instruments to understand the

way they fit into the overall market and the functions they perform. This agency could also be charged with the mission to conduct stress tests not only of banks, but also of other large financial institutions such as pension plans, hedge funds and even mutual funds, with the goal to assess whether or not these institutions are prepared to endure possible downturn scenarios.

The existence of such an agency would help investors to better understand the vulnerabilities of the market. Furthermore such an agency would be in a strong position to issue credible bubble warnings, helping investors to avoid fueling a bubble. One of the tools that this new agency could use to help control speculative runs is education. Lo (6) argues that education can make the financial markets better prepared to withstand crises. One example of such an educative action would be to require some particular buyers in some markets to sign a "Risk Notice" before acquiring an asset that is likely to develop a bubble. By doing that, these investors, often not sophisticated, would get important information that would help them make a better and more informed purchase decision. One example of such situations would be to require regular homebuyers to sign "Risk Notices" when home prices are at some given levels such as historical peaks. These notices would contain information regarding the prices and also inform the buyer of the risks of a significant downturn. In that sense, such notices would make this investors prepared for the possible scenarios and would make some of them to change their minds, therefore reducing the severity of the bubble and making the less sophisticated investors less vulnerable to bubbles. This would perform the same function as a "Liability Waiver" that is often signed in extreme sport such as skydiving and shark-diving. Once the participant is required to sign the "Liability Waiver" he or she knows of the risks incurred and therefore can reassess his decision before going forward. For this reason, the number of people that suffers accidents in such extreme sports is significantly reduced, since risk adverse people will decide to avoid the sport.

6 Conclusion

This thesis has presented some of the key theories related to bubble dynamics. Important models, such as Hyman Mink's and also the Efficient Market Hypothesis, were discussed and a new strategy was developed to search for bubbles based on the combining of these theories. The important behavioral biases discussed by Lo and Carroll completed the theoretical framework. This thesis also reviewed some of the key historical bubbles and analyzed how these historical bubbles fit with existing bubble theories. Based on a combination of these theories and their fit with past events, a new model to search for bubbles was suggested. The Bubble Score model focuses on combining several inputs into an overall score of likelihood to develop a bubble, in a procedure similar to the one conducted for a credit score. These inputs come from the elements that theory suggests should be present during a bubble type of event.

The Johanson-Ledoit-Sornette Model was also presented. This model uses historical prices to forecast bubbles and crashes based on the assumptions of traders' decision-making that oscillate with time. Both the JLS and the Bubble Score model were applied to US financial markets and each of the asset classes was assessed for its likelihood to develop bubbles.

The results of the Bubble Score model indicated that U.S. Treasury bonds and corporate bonds were the asset classes most likely to generate a bubble type of behavior. Further analysis of these two asset classes indicated that the significant growth in the corporate bond industry was largely driven by the growth in corporate profits and assets in general, therefore proving likely to be sustainable. On the other hand, long-maturities treasury bonds scored higher on the model and hence presented a real risk. The thesis presented evidence that risk from Treasury bonds comes from two factors: the credit risk and the price variation in the secondary market. Despite the absence of credit risk, since US treasury bonds are considered to be risk free, the treasury bond holders still face risks that come from their price

formation in the secondary market. Investors that are not willing to hold the bonds to maturity may experience losses by holding these bonds. The thesis also presented information from a speech given by FED Chairman Ben Bernanke that states that yields on thirty-year treasuries may rise quickly, reaching 5% as early as 2016.

Finally, two alternatives were suggested to make the financial markets, and particularly prudent investors, better prepared to endure the bubble type of events. These alternatives are intended to reduce the severity of bubbles and also their frequency. The first alternative is the development of a new "Anti-Bubble" type of investment, which consists of a new style of fund that would track an "Anti-Bubble" Index. This index would be a broad market index that underweights asset classes that are prone to bubble formation. The second alternative is the development of a new agency, with the mission to analyze the financial markets and determine the best ways to forecast bubbles, and to do so on a frequent basis. This agency would not have a regulatory mission, but instead would focus only on the technical side of the analysis, in a framework similar to the one that now exists in the highly secure air travel industry, in which the NTSB analyzes crashes and suggests improvements which the FAA uses to enact new regulations.

7 References

1. **Greenspan, Alan.** Remarks by Chairman Alan Greenspan At the Annual Dinner and Francis Boyer Lecture of The American Enterprise Institute for Public Policy Research, Washington, D.C. *Federal Reserve Website*. [Online] December 5, 1996.
<http://www.federalreserve.gov/boarddocs/speeches/1996/19961205.htm>.
2. **MARTIN FACKLER / New York Times.** Take It From Japan: Bubbles Hurt. *The New York Times Website*. [Online] December 25, 2005. [Cited: March 20, 2013.]
http://www.nytimes.com/2005/12/25/business/yourmoney/25japan.html?pagewanted=all&_r=0.
3. **Reinhart, Carmen M. and Rogoff, Kenneth.** *This Time Is Different: Eight Centuries of Financial Folly*. s.l. : Princeton University Press; Reprint edition, July 18, 2011.
4. **Hooke, Jeffrey C.** *Security Analysis and Business Valuation on Wall Street + Companion Web Site: A Comprehensive Guide to Today's Valuation Methods*. s.l. : Wiley, 2010 .
5. **Mansharamani, Vikram.** *Boombustology: Spotting Financial Bubbles Before They Burst*. s.l. : Wiley, 2011.
6. **Lo, Andrew W.** *Regulatory Reform in the Wake of the Financial Crisis of 2007–2008*. March 10, 2009.
7. **Les Christie, CNN/Money staff writer.** Slowdown? Real estate still going strong. *CNN Website*. [Online] September 14, 2005. [Cited: March 20, 2013.]
http://money.cnn.com/2005/09/13/real_estate/buying_selling/real_estate_fall_trends/.
8. **Dealbook / NY times.** Citi Chief on Buyouts: 'We're Still Dancing'. *Dealbook Website*. [Online] July 10, 2007. [Cited: March 20, 2013.] <http://dealbook.nytimes.com/2007/07/10/citi-chief-on-buyout-loans-were-still-dancing/> .
9. **Samuelson, Paul A.** Proof That Properly Anticipated Prices Fluctuate Randomly. *Industrial Management Review*. Spring 1965, p. 41.
10. **Lo, Andrew W.** The Adaptive Markets Hypothesis: Market Efficiency from an Evolutionary Perspective. *Journal of Portfolio Management*. Forthcoming .
11. **Carroll, John S.** *The Three Lenses: A Guide to Understanding Organizations (case 11-122)*. s.l. : MIT Sloan Management, June 17,2011.
12. *Theory of Reflexivity* . **Soros, George.** Washington, D.C. : s.n. The MIT Department of Economics World Economy Laboratory Conference .

13. **Minsky, Hyman P.** The Financial Instability Hypothesis: An Interpretation of Keynes and an Alternative to "Standard" Theory. *Nebraska Journal of Economics and Business*. Winter 1977, pp. 5-16.
14. **Schchter, Stanley, Gerin, William and Hood, Donald C.** Was the South Sea Bubble a Random Walk ? *Journal of Economic Behavior and Organization*. 6, 1985.
15. **Garber, Peter M.** *Famous First Bubbles: The Fundamentals of Early Manias*. s.l. : The MIT Press; Reprint edition, 2001.
16. **French, Doug.** The Dutch monetary environment during Tulipmania. *The quarterly Journal of Journal of Austrian Economics*. SPRING 2006, Vols. VOL. 9, NO. 1 .
17. **Temin, Peter and Voth, Hans-Joachim.** Riding the South Sea Bubble. *Working Paper Series*. Cambridge, MA, USA : s.n., Dec 21, 2003.
18. **Wood, Christopher.** *The Bubble Economy: Japan's Extraordinary Speculative Boom of the 80's and the Dramatic Boost of the 90's*. Jakarta : Soltice Publishing, 1993.
19. **Dodd, Christopher.** Opening Statement on "Mortgage Market Turmoil: Causes and Consequences". *U.S. Senate Committee on Banking, Housing and Urban Affairs*. March 11, 2007.
20. **Krugman, Paul.** Blindly Into the Bubble. *New York Times Website*. [Online] December 21, 2007. [Cited: April 4, 2013.] <http://www.nytimes.com/2007/12/21/opinion/21krugman.html>.
21. **Foote, Christopher L., Gerardi, Kristopher S. and Willen, Paul S.** *Why Did So Many People Make So Many Ex Post Bad Decisions? The Causes of the Foreclosure Crisis*. Boston : Federal Reserve Bank of Boston Discussion Papers, 2012.
22. **Bordo, Michael D. and Jeanne, Olivier.** *Boom-Busts in Asset Prices, Economic Instability, and Monetary Policy*. Cambridge, MA : National Bureau of Economic Research, 2002.
23. **Yan, Wanfeng, et al., et al.** Detection of crashes and rebounds in major equity markets. *International Journal of Portfolio Analysis and Management*. Number 1/2012, Vol. Volume 1.
24. **Sornette, Didier, et al., et al.** Clarifications to Questions and Criticisms on the Johansen-Ledoit-Sornette Bubble Model. *working papers series*. 2011. Vols. ETH Risk Center – Working Paper No. 11-004, Available at SSRN: <http://ssrn.com/abstract=2191524>.
25. **Sornette, Didier.** *Why Stock Markets Crash: Critical Events in Complex Financial Systems*. s.l. : Princeton University Press, 2003.
26. **Chang, George and Feigenbaum, James.** Detecting log-periodicity in a regime-switching model of stock returns. *Quantitative Finance*. 2008. Vols. 8:7, 723-738, Available online: <http://dx.doi.org/10.1080/14697680701689620>.
27. **Ilmanen, Antti.** *Expected Returns: An Investor's Guide to Harvesting Market Rewards* . s.l. : Wiley, 2011.

28. **Federal Reserve Bank of New York, Research and Statistics Group.** Quarterly Report on Household Debt and Credit, February 2013, . *Federal Reserve Bank of New York Website*. [Online] February 2013. [Cited: March 20, 2013.]
http://www.newyorkfed.org/research/national_economy/householdcredit/DistrictReport_Q42012.pdf.
29. **Christopher Condon / Bloomberg.** Money-Market Funds Get \$50 Billion Backstop From U.S. (Update2). *Bloomberg Website*. [Online] September 19, 2008. [Cited: March 20, 2013.]
<http://www.bloomberg.com/apps/news?pid=newsarchive&sid=atTTFP7z594g>.
30. **Bernanke, Ben S.** Remarks by Chairman Ben S. Bernanke At the Annual Monetary/Macroeconomics Conference: The Past and Future of Monetary Policy, sponsored by Federal Reserve Bank of San Francisco, San Francisco, California. *Federal Reserve Website*. [Online] March 1, 2013.
<http://www.federalreserve.gov/newsevents/speech/bernanke20130301a.htm>.
31. **Steve Liesman, CNBC Senior Economics Reporter.** Fed Might Target Rate Guidance to Data, Not Dates: Yellen. *CNBC Website*. [Online] November 13, 2012. [Cited: March 27, 2013.]
<http://www.cnbc.com/id/49810317>.
32. **Christopher Matthews, Reporter for TIME Business.** Viewpoint: Stop Calling Student Loans a "Bubble"! *Time Website*. [Online] March 07, 2013. [Cited: March 27, 2013.]
<http://business.time.com/2013/03/07/viewpoint-stop-calling-student-loans-a-bubble/>.
33. **Desai, Mihir.** The Incentive Bubble. *HARVARD BUSINESS REVIEW*. March, 2012.
34. **Steve Denning, Contributor Forbes.** The Dow Floats Ever Higher On A Sea Of Economic Bubbles. *Forbes Website*. [Online] Forbes, March 6, 2013. [Cited: March 27, 2013.]
<http://www.forbes.com/sites/stevedenning/2013/03/06/the-dow-floats-ever-higher-on-a-sea-of-bubbles/>.
35. **Consumer Financial Protection Bureau.** *Private Student Loans - Report to the Senate Committee on Banking, Housing, and Urban Affairs, the Senate Committee on Health, Education, Labor, and Pensions, the House of Representatives Committee on Financial Services*. 2012.
36. **Henriksson, Roy D. and Merton., Robert C.** On market timing and investment performance. II. Statistical procedures for evaluating forecasting skills. *Journal of business*. 1981, Vols. 513-533.
37. **Greenspan, Chairman Alan.** Remarks by Chairman Alan Greenspan At the Annual Dinner and Francis Boyer Lecture of The American Enterprise Institute for Public Policy Research, Washington, D.C. [Online] 12 05, 1996. <http://www.federalreserve.gov/boarddocs/speeches/1996/19961205.htm>.
38. **Kindleberger, Charles P. and Aliber, Robert Z.** *Manias, Panics and Crashes: A History of Financial Crises*. s.l. : Palgrave Macmillan; Sixth Edition, Revised Edition edition, September 27, 2011.
39. **Johansen, Anders, Ledoit, Olivier and Sornette, Didier.** Crashes as critical points. *International Journal of Theoretical and Applied Finance*. 2000, Vol. 03, 02.

40. **Johansen, Anders and Sornette, Didier.** Predicting Financial Crashes Using Discrete Scale Invariance. *working papers series*. Available at SSRN: <http://ssrn.com/abstract=212568>.

41. **Protter, Philip.** A Mathematical Theory of Financial Bubbles. *working papers series*. 2012. Available at SSRN: <http://ssrn.com/abstract=2115895>.