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Asset bubbles: an empirical test of their effects on a replicating portfolio

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“Some food for thought: the illusion that we understand the past fosters overconfidence in our ability to predict the future” D. Kahneman

Contents

1. Introduction

We live in world characterized by uncertainty. Even though most of the economic theories are based on the same principle of agents' rationality, we often underestimate this fundamental aspect.

There are several ways in which uncertainty could appear in each interaction amongst economic agents and all of these are based on the fact that in real world human rationality does not exist.

In each relationship we face, we do not act following an established path based on reason but we act chasing our needs and emotions.

Very recent theories in finance have demonstrated that economic agents, in this case investors, prefer to move following others' decisions, in order to cover losses or to gain profit on the wave of someone else success. This new school of thought is called behavioural finance and it has showed that, the world and its participants are generally not rational "wealth maximizers". Rather, they are guided by innate biases and heuristics that lead to irrational investments decision.

Academic and professional worlds are divided into two marked categories: *chartist* and *technical*. The former believe that historical trends tend to repeat themselves. So, technicians spend their days examining historical prices through graphs or charts in order to forecast future trends. In short, chartists aim to use their forecasting to influence the market. However, those who are sceptical about the chartist theory have developed the common belief that rather than guessing a price pattern, they influence the market through sheep investors who strictly follow others' suggestions and insights when making financial decision.

On the other hand, the latter, which is the most used and well accepted theory, is based on the intrinsic value of a security. To understand the right definition of intrinsic value one must turn to the meaning of *fair value*: the right value at which a stock, a bond or any other security must be exchanged. The intrinsic value of a share is based on its capacity to generate future positive cash flows. Or rather, to put it simply, to allow its owner to gain a profit from security's detention. Stock's earning potential, it is so based on different drivers such as company's management, referred market and many others. In short, to estimate the right price, an analyst should have extensive knowledge of the firm and must make some assumptions based on that information. With the term assumption, it is commonly accepted, that it refers to some form of prediction of a company's future perspectives. In other words, to fairly set the price, information is needed.

In recent years, information has become our most valuable commodity. Information has the power to influence and to direct prices in a certain way. I will address the importance of information later in this work.

There is another important piece of classical research that is focused on intrinsic value; which is the *random walk*.

"*Random-walk theorists usually start form the premise that the major security exchanges are good examples of efficient markets. An efficient market is defined as a market where there are large numbers of rational profit-maximizers actively competing, with each trying to predict future market values of individual securities, and where important current information is freely available to all participants. […]. In other words, in an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value."* (E. F. Fama, 1979. "Random Walks in Stock-Market Prices. Selected papers. No. 16. Graduate School of Business, University of Chicago).

Fama (1979) represents the essence of intrinsic value, in which the supply will always meet its own demand based on the allocative efficiency of financial markets and, more generally speaking, on the market itself. Fama (1979) refers to the inability of the market, which exists in a perpetual condition of uncertainty, to fairly represent the intrinsic value of each tradable security. However, as in all economic theories, there is the possibility to theoretically overcome human irrationality. This paves the way for a strong hypothesis: we are in an efficient market.

Market Efficiency refers to the market's ability in immediately reflect new information, which are in this case, by definition, free and not costly as in real word. Moreover, we could call this hypothetical market, a market with strong information efficiency, in which even not available news are completely free.

As previously stated, the real world is populated by irrational agents in search of profits, which must be obtained with the smallest risk possible - this sounds strange considering that stock price and risk are negatively correlated. Research in Behavioural Finance tries to explain why investors make suboptimal decisions. One of the most commonly used heuristics, that could even provoke a market instability, is the *Representativeness Heuristics*. Heuristics are the "mental shortcuts" we use in order to make decisions quickly and efficiently. However, although these are useful, they can lead to errors and biases. For example, using stereotypes to judge others and their professionalism. Again, for instance, a well known broker with his insight on a price raising, referred to a specific security, is perfectly able to influence the market because his reliability is very high. In this case, sheep investors will buy the same stock, generating a chain effect, in which the overvaluation of the considered security is a possible consequence. Then, the power of information should not be underestimate because information can create a trend and, this trend can be escalated by those investors who are looking for safety profits, because they believe they are participating in a bull market. If the number of participants continue to grow as fast as possible, the price will reflect new investors' behaviour and will rise rapidly when, at a certain point will be evident the inconsistency of previous assumptions, because the actual[1] is too distant from share's intrinsic value and the price will fall dramatically in fewer time. This peculiar event is what this work aims to study: speculative bubbles.

1.1 What is a bubble?

The fast increase in an asset's price and volatility, referred to a limited period of time that can be expressed in months or few years, overcoming the natural trend of a security, which can significantly vary just in decades, is called a speculative bubble.

This explosive path brings prices far from intrinsic and actual values, basing the supply on unfair and unrealistic expectations; which, in a certain time in the future, the market understands the unbearableness of previous beliefs and the bubble bursts, causing a shock in price levels.

Bubble's characteristics are:

- Increase in traded volumes
- Prices vary sensibly from a day to another
- The market is hysteric
- There are triggering factors, mostly related to information
- It is hard to forecast the begin and the end of such bubbles
- Can only be observed with a retrospective point of view
- Each bubble is different from others and behaves autonomously

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[1] The term actual it is used referring to the actual price of future discounted cash flows that the company is supposed to generate, based on reliable assumptions.

A normal and justified question could be: why should we call these events *speculative* bubbles? The answer is relatively easy. In fact, when investors are captured in the storm of the bubble, they do not trade underlined securities for rational purposes, evaluating the possibility of future dividends, but they are only looking for capital gain in a brief period of time. They want to exploit the wave, being sure to quit right on time the assumed long position[2]. This is the reason why when we talk about bubbles we used to call them speculative.

However, in reality, there are several different types of bubbles and how we call them strictly depends on what they are referring to.

Speculative bubbles can be divided into two main categories.

- *Market bubbles*: a market bubble occurs when the underlying asset is a commodity or a set of securities. Their potential impact is wide and dangerous for economic stability in general. A bright example of market bubble is the recent 2008 financial crisis. In general, this is caused by increases in commodity prices, which provoke a chain effect with all related production activities that the commodity involves, for instance, oil prices. Otherwise, as in 2008, the rising of subprime mortgages and the following financial scandal, provoked a wider effect, threating financial stability all around the world.
- *Asset or stock bubble*: the term asset bubble, which is the main focus of this work, is used when the object of the analysis is a single stock. The causes are almost related to information and speculative purposes, and the effect when

[2] Long position is the term used in financial world to state a purchase of a security; otherwise a short position is opened when an investor decides to sell a security.

the bubble bursts is absolutely not wide even if the consequent shock can be generally dangerous. The frequency of this kind of bubble is higher than the market ones, in fact, bubbles are generally window for capital gains that investors want to exploit until this window is open and to not be burned by the bursting.

Bubbles are, basically, the consequence of an anomaly in financial markets that are caused by common psychological mishaps. The natural interest for new information or a new good, moves investors' interests to a new path, since they are looking for safety profits, these previously cited windows are very desirable and very attractive even for inexperienced investors. Here, two already stated factors starts playing in the same direction: irrational behaviours and information asymmetries.

Regarding irrational behaviours, if there is the chance to earn a profit from others' insights or from a new trend with high appeal, everybody wants to participate. This is a normal way to act since we are all too optimistic about the future and so are investors about market expectations.

Otherwise, information asymmetries or information in general plays a crucial role in negatively influencing decision-making processes. We live in a world in which news flows rapidly thanks to powerful and innovative mass media such as TV and internet. In fact, in the era of globalization and communication every new information can be easily incorporated in fundamentals and so the spread between bid and ask[3] prices has been reduced, and this would be a positive factor if it were not for the fact that

[3] Bid and Ask prices are to different quotations for the same asset. The Bid price represents the reservation price for a buyer, otherwise the Ask price is the minimum price at which a seller wants to receive for a security.

information can be false and deceptive. Information asymmetries derives from this aspect; hence, two people may have different perspectives and different knowledge on the same issue, in this case on an asset, and this divergence can lead both individuals to assume that the other is wrong. If numerous investors have the same biased point of view, they can generate an abnormal event, influencing a trend and so, creating a bubble.

1.2 Bubbles in history and famous business scandals

Since man invented financial markets, bubbles have always occurred in history. In the first organizations led by families during 15th century, all the aspects were strictly controlled by a code of conduct and they were surrounded by an atmosphere in which honour was more important than profit. But, earnings became to be more important just few decades later and managers were inclined to commit crimes to increment their influence and their patrimony. In order to obtain always wider funds and to seek the opportunity to increase their business in 17th century in Netherlands some entrepreneurs have established the first financial market and, again in Amsterdam, the first bubble occurred.

1.2.1 Tulip bubble

The "Tulip Bubble" also known as "Tulip Mania" was the first financial bubble in history. It occurred when the first tulip bulbs were imported in Europe from Turkey. During the 17th Century, the Netherlands was the first economic power of history and its power was spread from the Atlantic Ocean to the Pacific. Consequently, the Dutch were extremely wealthy. As culture, they have always had a strong passion for flowers, and tulips represented a fantastic novelty. The flower was perceived as a combination of exotic beauty and elegance, and the all richest men wanted to have them in their houses. Tulip bulbs became a commodity traded on the the financial market and the price rose reaching the level of thousands of dollars (in current terms) per bulb for speculative purposes. At a certain point in 1637 the bubble imploded and the price felt down leaving the country in an economic crisis for some years.

1.2.2 The Mississippi Bubble

The Mississippi Company was established in 1717 by a Scottish speculator named John Law. The aim of the firm was to trade with the French colonies in North America. In that period, France was experiencing a huge inflation and Law exploited the situation to speculate issuing bank notes, which could be easily converted into fixed quantity of gold. Those papers money were introduced by the Banque General and the Scottish economist sought the chance to heavily invest in the Compagnie d'Occident encouraging a merger with his Mississippi Company. In 1719 another merger occurred, between the Compagnie d'Occident and The East India and China Company, creating a monopoly for the whole colonial trade that provoked an exaggerate effervescence in the market and the price of shares rose up to fourteen times. In the same year, Law decided to convert the entire public debt into company's shares and the Banque Genral, in order to sustain the new speculative wave, issued a large quantity of new bank notes. Law decided to exploit the trend and offered to investors new shares promising high dividend and, to do so, he manipulated the market value of the shares. In 1720, the whole French economy disastrously collapsed and, since the public debt was inevitably tied to the company's stocks, all investors found that what they had was totally worthless.

1.2.3 The South Sea Bubble

Analogously to the Mississippi Bubble which exploded in France, during the same years, the British Empire experienced a very similar episode. The South Sea Company of England was established in 1711 with the aim to trade with southern America after the War of Spain Succession ended. The South Sea Bubble had similar characteristics to the French one, in fact, the English government wanted to convert its own debt into company's stocks, basically transforming annuities into equity shares. At the beginning of 1720, a MP declared that the South Sea Company of England would have absorbed the entire public debt for an amount close to $ 150 million. The news was escalated by newspapers,[4] and to both investors and entrepreneurs were given the possibility to gain a profit from the speculative bubbles. In fact, some adventurers started running their own company; but after few months, the Parliament deliberated with the Bubble Act in 1720 a stop in establishing such new companies. This official act was obtained with pressure, but it reached the scope of creating a monopoly in foreign trade with colonies. Since the occasion was too appealing to let it go, some government officers and members of King George the First's court, invested in the company's shares but these stocks were issued without a material deposit, so inevitably they did not exist, but they were covered by a state loan. The loan acted as guarantee for South Sea Company's shares was basically proceed from the public debt itself, creating a vicious circle since in September 1720 the company and the entire system collapsed.

1.2.4 Railroad Scandal in Britain

Following the explosion of the second industry revolution, a race to railroads began and as the new wave of economic expansion could not be stopped, even world expansion could not. In order to reach new places in a faster way, the introduction of trains completely changed the way in which people travelled. In this context, the proliferation of railway companies was easy to forecast and profit opportunity simultaneously rose. The first huge scandal connected with this business is due to

[4] This is the first case in history in which mass media has influenced the market causing a market bubble.

George Hudson, an English businessman that was able to place himself at the top of four railroad companies at the same time. Since he was also a capable economist and accountant, he started manipulating financial statements in order to pay higher dividends to investors and then, the stock prices rose rapidly. The illegal way in which Hudson paid dividends caused huge cash shortage, and when accidents occurred along the roads, companies were not even able to fix them. The bubble collapsed when England faced a period of economic recession and Hudson was accused of financial crimes.

1.2.5 Jay Cooke

Jay Cooke is considered the first investment banker in history. He raised money financing the American Civil War and after that, he was seeking for new opportunities and he found railway companies. He decided to implement the pre-existing system heavily investing in those firms. So Cooke acquired the Northern Pacific Railroad and simultaneously a giant piece of land issuing uncovered bonds. Costs for building railroads were higher than expectations due to uncountable complications during works and Cooke was forced to look for more capital across the ocean, where economic conditions were not favourable for commercializing such bonds. Inevitably, this resulted in a total collapse that brought Wall Street to close for the first time in history.

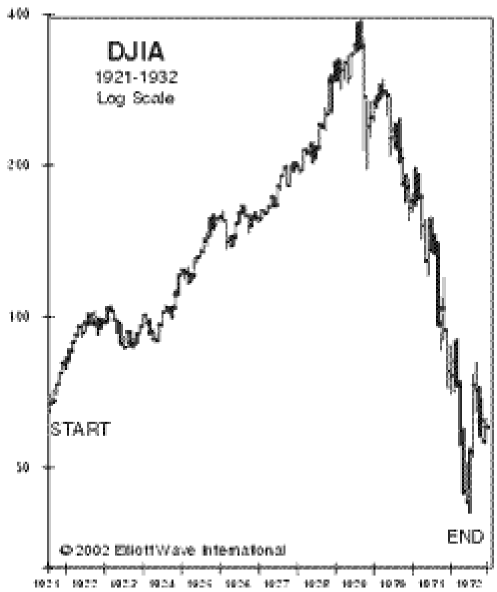
1.2.6 The new Century and the Great Depression

The 19th century began with the new idea of big companies, a dream born thanks to railways and developed through years until reaching a very new dimension. Along this period the distance between the American government and enterprises was very small because of state aid given to private companies, and people were not distant from the concept that each firm was the true realization of the American dream. Just to give few examples, in these years Rockfeller run the Standard Oil, Duke established the

American Tobacco, and many more companies, which are still in the market today, were born. The main drawback of this liberal political economy was an excessive ferment in capital market and many illegal actions were committed by managers and investors in order continuously increase their profit and, since the government adopted the so called *laissez faire,* breaking the law was extremely easy. In fact, in order to protect investors, in 1911 the Blue Sky Law passed and, all listed companies, for the first time, were required to release an exhaustive disclosure about past performances. During the 20's America experienced an incredible period of prosperity and many investors sought to exploit this trend by borrowing money. The so-called "roaring twenties" brought peace and a sensation of wellness across the country after World War I. The speculative wave was impossible to stop and for the first time in history an overproduction crisis occurred, breaking the Say's law. In fact, companies produced higher quantity of products than the required demand and the whole system collapsed. The first signal was captured at the beginning of October 1929, when a strong bear[5] market began and by the 28th of the same month Wall Street finally crashed. Then, the speculative bubble rose price for more than nine years until it popped, leaving the country in the greatest depression ever experienced. The years following the crash were called the Great Depression, and only a radical change of mind brought by Franklin Delano Roosevelt and his New Deal, a political economy with the adoption of drastic interventions by the central state, could positively solve the dramatic American recession.

[5] A bull market is a basket of assets with rising prices or positive expectations about prices; otherwise a bear market represents a set of assets with falling prices or negative expectations.

Figure 1



Source: Colombo, J., 2012. The Stock Market Crash of 1929.

1.2.7 The S.E.C.

Following the 1929 crisis, the US government decided to also regulate the financial market thanks to several laws, which culminated with the foundation of the Securities and Exchange Commission (S.E.C.). The first relevant intervention was the Glass-Steagall Act in 1933, better known as the Banking Act, which represents a milestone on financial institutions regulation to this day. With this law, the state built a wall to distinguish commercial banks from investment banks and the arguments behind this decision are:

- Reduction in risk of losses;
- Elimination of interest conflicts;
- Avoidance of fraudulent banking activity;
- Constrain competition;
- Guarantee fair competition;

These restrictions pushed people in seeing banks from another perspective, assuring a renovated trust in financial institutions; the US government also moved to establish the Federal Deposit Insurance Corporation (FDIC) in order to protect small savers' insurances. The following step in providing a safer e more stable financial environment was the creation of the Security and Exchange Commission (S.E.C.). This state agency, founded thanks to the Securities Exchange Act in 1934, was empowered with the needed authority to monitor all traded shares in New York Stock Exchange firstly, and to regulate all traders, brokers and more generally speaking all the involved agents in financial markets. The first designated chairman of the S.E.C. was Joseph P. Kennedy, father of the president John F. Kennedy, which was one of the most popular and influential figure in 1929 crisis.

1.2.8 The Black Monday

In the two-year period 1986-1987, the American financial market experienced an extremely strong bull market due to the general idea that stock prices could exponentially grow thanks to mergers and acquisitions. In few words "the bigger the company the higher the price". Hence, during these years, the market was characterised by low interest rates, hostile take overs, and leveraged buy outs in which companies were able to rise huge funds just issuing junk bonds[6]. This specific environment helped the "incubation" of a speculative bubble. The S.E.C. tried to prevent the proliferation of new IPOs in order to maintain market stability without succeeding in it, so the bubble grew rapidly and at the middle of 1987 NYSE showed the first signals of crisis. Inflation rose rapidly due to high economic return and the

[6] A junk bond is a security with the highest yield possible and the lowest rating because of its riskiness.

FED[7], in order to contain this effect, raised short-term interest rates. The natural consequence was a fast increase in the demand of insurance financial products in order to hedge portfolios from future risks, but on Monday 19th October 1987, many investors decided to short their entire positions simultaneously triggering a chain effect. At the end of the day, the Dow Jones Industrial lost around $500 billion in market capitalization, causing the biggest and fastest fall ever seen in financial markets since 1929. Immediately after the crash, the FED lowered interest rates in order to prevent a banking crisis and the whole system recovered in a very short period of time, despite of the seriousness of the crisis.

Figure 2

Source: Colombo, J., 2012. Black Monday - The Stock Market Crash of 1987.

[7] The Federal Reserve System, or simply the FED, is the American Central Bank.

1.2.9 Dot-com Bubble

The 90s was the decade characterised by the rising of technological sector in particular for the markets tied to personal computers. The NASDAQ-100, the index for high-tech companies, registered incredible performances since 1990 and a higher increase through the years close to the new millennium. Around the 2000s a new phenomenon came out. In fact, Internet was rapidly reaching every household and its importance was recognized even in financial markets. Conditions in the market were perfect for the proliferation of the bubble with low level of inflation and uncountable IPOs, so speculators were helped in seeking capital gain from buying and selling stocks. This underlined phenomenon was called "*new economy*", in which the renewed trust in financial institutions pushed away the threats of crisis. From 1996 to 2000 the NASDAQ gained more than 5.000 points, thanks to these favourable conditions, but in the context so many new companies showed poor and lacked business plan; in fact, investors started realizing that the dot-com phenomenon was nothing except a speculative bubble. The NASDAQ index, by 2002 lost 4.200 points reaching 800. In order to save their companies, managers committed frauds on financial statements to rise artificial earnings but this strategy revealed its poor validity very soon and numerous start-ups close down.

Figure 3

Source: Colombo, J., 2012. The Dot-com Bubble.

1.3 Great recession: 2007-2008 financial crisis

The most relevant and recent event, for what concerns speculative bubbles, has been the subprime mortgage crisis which globally affected financial markets causing the biggest and deepest recession since 1929.

In 2005 the American financial market was experiencing a new and powerful positive trend in which low interest rates, low level of inflation and an approximately great quantity of excess cash supported government decisions regarding lowering credit merit for house mortgages. The general and widespread trust in institutions and banks, convinced many families in borrowing money in order to buy a house. Banks were positively inclined in granting such loans, which were collateralized by houses themselves. Banks were relatively sure that all the lent money would have been given back in the future, so these financial institutions decided to issue bonds related to those mortgages. The underlined securities were mortgage-baked securities[8] and collateralized debt obligations[9]. Since the demand for mortgages rose rapidly, banks sought the chance to earn more money from higher and floating interest rates. Raised rates on loans consequently triggered a rise in returns for securities underlying mortgages and many investors felt safe in investing in it since rating agencies ranked them with the highest rate possible, but since these securities are compositions (basket) of various mortgages with different credit merits and different interest rates, they would not be ranked as AAA. The speculative bubble raised prices of houses and securities and, even if some of the borrowers went to default, all mortgages were guaranteed by real estates; hence the general idea was that the market was substantially stable and safe.

In September 2007 many borrowers were not any longer able to repay their own debt and both commercial and investment banks had to repay their short exposure but they had not enough disposal cash to do so, and institution, such as Lehman Brothers declared bankrupt. House prices fell sharply reaching in some extraordinary cases the level of $ 1,00. The total amount of losses, declared by the International Monetary Fund, for banks and related institutions was about $ 4.100 billion.

[8] A mortgage-baked security is an assets sold by banks to guarantee loans. It is set on a basket of different mortgages granted by a bank.

[9] A collateralized debt obligation, or more simply a CDO, is an asset-baked security, used to collateralized default risks on different bonds.

Figure 4

Source: Shiller, R. 2011. Irrational Exhuberance "Housing Data".

Since we live in a globalized world in which financial markets are intimately linked, when the house bubble popped, all countries suffered a severe and profound crisis, especially in Europe. Countries such as Italy, Spain and French experienced a long period of recession but Greece was the one who suffered the most. The estimated period of recession was ongoing for 63 months, leaving the state close to declare default.

1.4 Is it possible to manage bubbles from an institutional point of view?

Americans have always believed in *The Efficient Market Hypothesis*, which is nothing distant from Smith's invisible hand; in other words, a market that is able to efficiently allocate its own resources. This basic concept implies poor interventions from the state in order to regulate and restrict action in financial markets. Inevitably, in this context, two natural questions are raised: why do bubbles still occur? And, is it possible to limit this occurrence by government institutions?

The answer to the first question must be searched in the reasons above-mentioned. Financial instability and irrational behaviours are primary causes of bubbles and, even though history has taught us how to prevent such phenomena, our desire to look for easy profits is inexhaustible. In this context, identifying actors who make a profit is simple but we do not have just to look at investors; in fact, government institutions, such as the FED, are reluctant in limit investors' exuberance because it is on its interest to increment and pomp the financial market.

Consequently, the answer to the second question should be in some sense ambiguous. The answer could be "yes" because institutions have all the necessary instruments and the required knowledge to prevent, limit and forecast bubble occurrences. Nevertheless, we must consider that in present financial markets the proliferation of new securities, such as derivatives, could cause substantial difficulties for cited agencies in preventing these phenomena. In fact, the related information asymmetry could mislead the FED in adopting new measures. Another central factor in the analysis that must be considered is the wideness of financial markets that are, nowadays, limitless and without any form of schedule, with a still increasing complexity in their structure. So, the natural consequence of this logical argument should push the reader to provide "no" as answer for the second question posed above. Although the *Keynesian Revolution*[10] had guided the US outside the crisis with the previously cited

[10] The term *Keynesian Revolution* is usually referred to the new theories developed by the English economist at the beginning of last century. These new economic ideas moved the focus of the analysis

Roosevelt's New Deal, this teaching has not been yet absorbed by governments and the population, as the proposed solution by the English economist could work only in period of profound crisis. History has shown us new political trends that were able to dramatically influence the market such as "*Reganomics*"[11], in which a lax in regulation for the love of the *laissez faire,* had brought a more than positive trend in markets and a trust never experienced before.

1.5 Managing portfolios: a view on the strategy

The aim of this work is to demonstrate empirically the impact of a shock after a bubble bursting of a blue chip stock in the return of a replicating portfolio of a passive investor.

The appeal on this topic must be searched in the instability of financial markets due to investor's behaviours and to show that bubble occurrences are not phenomena just related to catastrophic events, but they are recurring events. The sample of cases that will be shown later on is set in an observation period that starts after the 2008 crisis and end nowadays in order to have a more recent, reliable and comprehensive point of view on the subject. The focus is not on market bubbles in general but on stock or asset bubbles which is an argument not yet well described by the literature.

The work is structured as follow:

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from the supply side to the demand side suppressing de facto the Say's law and previous economic thoughts.

[11] The term *Reganomics* is referred to the economic policy undertaken by president Ronald Regan during 80s. This policy, very close to the British Tatcheirsm, was characterised by a substantial reduction in taxes, a reduction in the welfare state and a more freedom in financial market, as warmly suggested by the Chicago School led by Milton Friedman and the monetarism trend.

- in this chapter the reader has a brief but all-embracing view about bubbles, their history and an introduction about their nature and why they are a still occurring events;
- in the second chapter the reader will be provided with detailed information about classic and modern bubbles literature and about classic theory of financial mathematics;
- in the third chapter the reader will face the empirical case with all the collected data, the performed analysis and the tested results;
- in the fourth and last chapter there will be a final consideration and a deeper discussion about obtained results from an empirical point of view.

After in this paragraph the reader will be provided with a brief explanation of some key elements, which are useful in order to have a deeper comprehension of the subsequent analysis.

1.5.1 Defining the strategies

Portfolio strategies, for both stocks and bonds, are usually divided into two main categories: active and passive. This strong distinction can be essentially based on three different elements:

- The typology of pursued objective;
- The rate of freedom that the portfolio manager has in assuming decision whether sell or buy securities;
- The importance of the chosen analysis for the securities evaluation.

In this work, the investor subject of the empirical test is one who follows a passive strategy, in which the main scope is to reach a well defined result in terms of return, basing the whole strategy on some rules that must be respected. For example, a passive investor, as we will see in the case of this work, wants to replicate the return of an index such as Standard & Poor's 500, or the Italian FTSE MIB; otherwise the investor only wants to reach a defined return in absolute terms, i.e. 5%. Since managing these kind of portfolios is not difficult for their nature, the cost related to evaluate stocks and other securities is relatively low. On the other hand, there is an active strategy in managing portfolios, in which the investor wants to maximize its return in certain period of time, fulfilling some constraints in terms of risks. The investor who follows such a strategy wants to obtain higher result compare to another who adopts a passive way of managing portfolios.

Exhibit 1

Objective	Passive strategies	Active strategies
Relative return	Benchmarking	Maximization respect to a benchmark
Absolut return	Immunization	Maximization referred to a period

The first strategy that must be considered in the sphere of passive ones is called *benchmarking*, because the main scope is to replicate the exact perform of the chosen benchmark, which is in other words an ideal portfolio of securities that can wholly represents a market sector. As stated above, example of such benchmarks are the *S&P 500*, *Nikkei* or the *FTSE MIB*. The correspondent strategy of this previously cited for what concerns the active sphere, is about maximizing the difference between the managed portfolio and the selected benchmark. A second type of passive strategy is the *hedging* or *immunization*, in which the investor wants to reach a well defined objective return. This specific strategy can only be applied to portfolios composed by bonds. This asset management is widely used among institutional investors in order to guarantee a certain return to face future expenses. Respectively to the immunization strategy for what concerns the active sphere we can find a way of managing portfolios in which the main scope is to maximize the return in a well specified period of time.

1.5.2 Benchmarks

A benchmark represents a portfolio composed by securities that are part of the same sector of the financial market and can be used to understand the related performances. As stated above, such benchmarks can be replicated in order to pursue a passive strategy; in this case the investor must identify a benchmark (or index) that is representative for the general market trend and the main objective is to replicate its return. The easiest way in doing so is to buy the same assets that compose the whole index, but in real world is very difficult to perfectly replicate a benchmark.

In order to build a benchmark, it is essential to define a basket of securities for a specific sector that can vary in substance, form, regional area and so on. Anyway in defining a benchmark we must consider three key essential element:

- Which securities we should include in the basket;
- The weight that we should give to each asset;
- If we should consider intermediate cash-flows in evaluating the index.

There are three key requisites for a good index:

- A benchmark must be *representative* of all securities included in the considered basket for the chosen market sector; in other words, the wider the sample of stocks the more representative is the index;
- A benchmark must be *replicable*, in fact it must include only tradable securities;
- A benchmark must be *objective* and *transparent*, so in order to compute the index we should use non-arbitrary rules and they have to be comprehensible by all the involved actors.

An index can be firstly divided into two main categories:

- General: they include all the tradable stocks for a certain market sector;
- Partial: they only include a portion of a certain market sector (i.e. the S&P 500 is a partial index for *blue chip*[12] stocks)

A following key criteria that is fundamental to distinguish market indexes is the weighting factor. A first way to build a benchmark is to use prices (*price weighted*) as weights that is very simple and fast but the computation cannot be realistic, since in the basket we can find a stock for each listed company and the ones with higher prices will influence the benchmark negatively[13]. A second way to compute a benchmark is to give to all traded stocks the same weight, creating a so-called *equally weighted* index which is in any case not reliable because it does not consider the market capitalization of the companies that is a relevant information. In order to consider this relevant aspect, the most reliable way to build up a benchmark is to weight each stock for its market capitalization. This method is known as *value weighted*. There is a fourth choice to create an index and is the so-called *float weighted*, in which securities are weighted for their floating and not for their entire market cap. This relatively new method in computing benchmark is very useful in Europe in which there is a different way to

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[12] A blue chip stock is a share of a company well known for its reliability, ability in making profits and well performing even during bad times because of its reputation.

[13] Must be underlined that the price of a stock depends obviously on firms ability in generating future cash-flows, but it also depends on the number of tradable shares or, more generally speaking, on the number of shares itself.

interpret capitalism from Anglo-Saxon countries, in fact in the old continent the majority of big listed companies have a small floating compare to America's big firms.

After the analysis, to have a deeper comprehension about the different modality in which a benchmark can be built, it is useful to better understand how it is possible to realize a benchmarking strategy. A portfolio manager can adopt such a strategy because he believes that is impossible to over-perform the market because we live in a condition of high efficiency in markets. Apparently replicating a portfolio could be an easy operation but in real world doing so it is not that easy, even for value weighted indexes which are by definition the easiest to be replied. In fact, there are many factors which impede the realization of a good replication portfolio. The first of these factors is represented by transaction costs[14] that a manger or an investor have to face. The second fundamental element that can penalize replicating portfolio performances respecting to the benchmark, is represented by managing costs. Another factor that can positively or negatively affect the underlined portfolio, regards the portion invested in liquidity or in securities that are cash equivalent. A following problem that can not be under estimated concerns the impossibility of the manager in exactly replicating the weights for each stock present in the basket due to assets indivisibility. Other factors must be searched in legal constraints.

There are two different ways in which an investor can replicate an index:

[14] Transaction costs are the remarkable expenses paid by the parties involved in any economic exchange of any sort. The theory of transaction costs was developed by the Nobel prize Ronald Coase.

- Full replication: we have a full replication when the investor buys the same stocks that are present in the basket of the index; this represents the simplest way of replicating a portfolio with the previously cited limitations.
- Sampling: this is a strategy in which the investor picks up just a sample of stocks from the basket of the benchmark; here the biggest drawback is represented by the impossibility in perfectly replicating the index and so the selection plays a crucial role and the theory has always proposed still more difficult method such as multifactorial model based on stock's returns as follows:

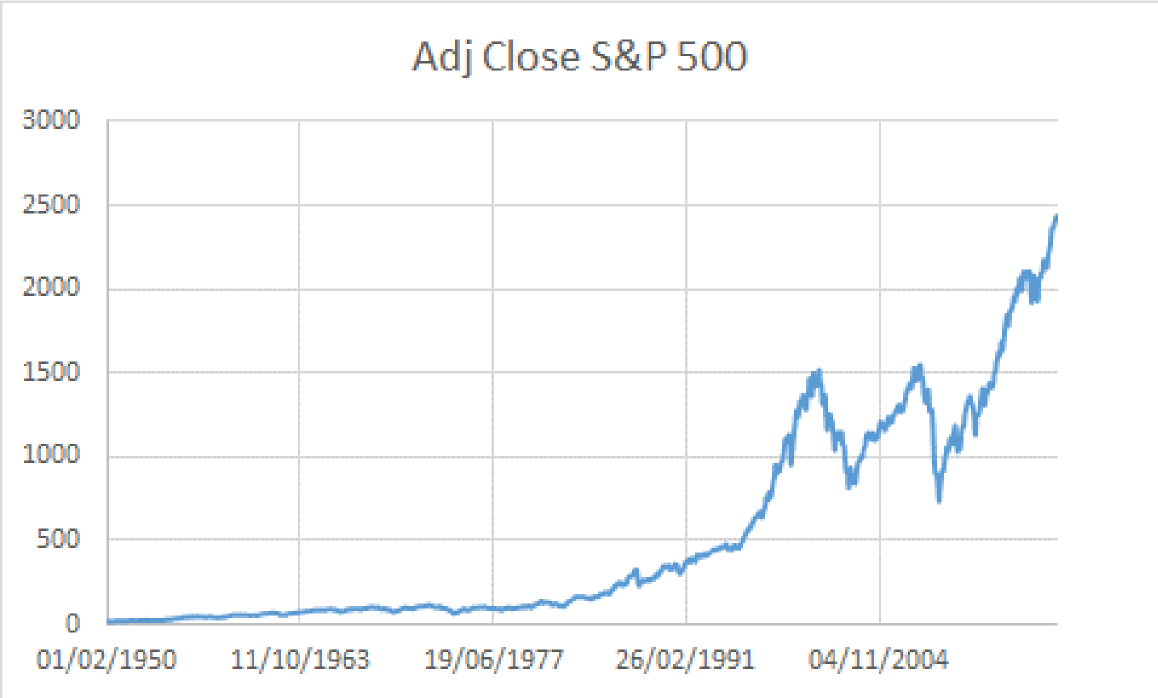
$$r_i = a_i + b_{i1}F_1 + b_{i2}F_2 + \cdots + b_{in}F_n + \varepsilon_i \qquad (1)$$

in which a_i and b_{i1}, b_{i2}, … b_{in} are constants and F_1, F_2, … F_n are factors to explain stocks returns and finally ε_i simply shows a return component that can not be perfectly explained, as the error in a regression model.

1.5.3 Standard & Poor's 500

The Standard & Poor's 500 is the market index used for the following empirical analysis of this work. Often abbreviated with S&P 500 is a market index based on *blue chip* stocks listed in the NYSE on in the NASDAQ. It is a value weighted index based on market capitalization and includes the biggest 500 listed companies in US. Today is used as central benchmark for several computation and as general index for US financial market. It was firstly introduced in the market in 1923 with a small number of stocks in the basket, which has been augmented to 500 in 1957, when it also assumed the present name of S&P 500. Its ticker is ^GSPC.

Figure 5



Source: finance.yahoo.com

2. Literature review

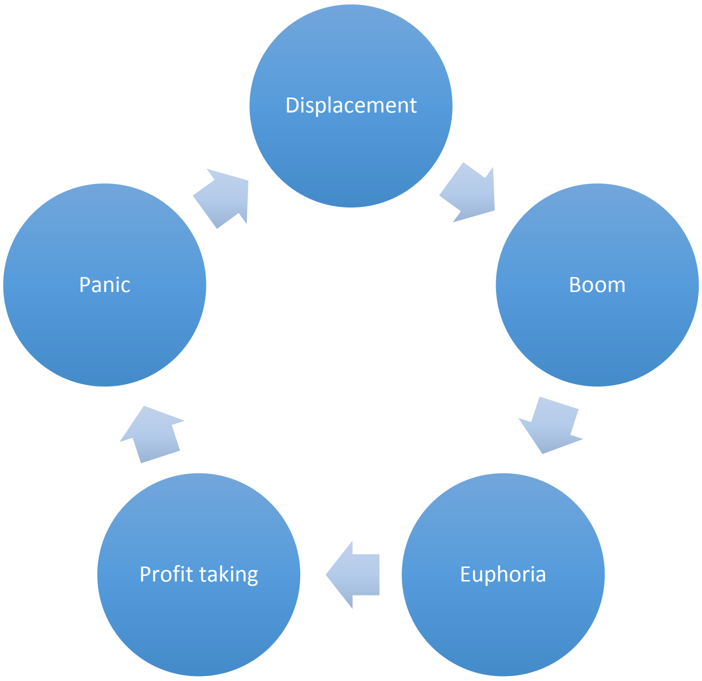
Addressing speculative bubbles is not easy because this topic mainly refers to market failures. Although this topic remains a trend and largely unresolved topic, bubbles, in particular asset bubbles, are not often the main focus of research in economic literature. We already know that these events are led by exogenous and endogenous factors in the market, a market in which agents act in a way that is far from classical portfolio theories. We have already established that information asymmetry and irrational behaviour are the driving factors behind speculative bubbles. Considering their nature, forecasting a bubble is always difficult due to heuristics; and just a small number of analysts, with a critical point of view, are able in doing so. Moreover, bubble crashes are very dangerous for the whole economy even in the case of asset bubbles. Nevertheless, very few researchers have attempted to define a bubble theory in order to better understand the potential impact of a falling prices after a bubble crash. The leading theory was developed by Watson - Blanchard (1982), it identifies bubbles in a restricted environment imposing some fictitious constraints. However, the title of their work "*Rational Bubbles*", is strongly indicative of its limited application to the real world.

This chapter will provide the reader with a deeper and more comprehensive knowledge of classic and contemporary research on bubbles. Moreover, we will highlight classic portfolio theories as a central topic for the following empirical research on asset bubbles and we will examines the consequences of shocks in a replicating portfolio on the S&P 500, held by a passive investor.

Before starting, it is essential to introduce a new paradigm called asset bubble cycle, identified by Kindleberger – Minsky (2009). The two researchers set a five-step cycle for such events composed by:

1. *Displacement*: the displacement phase occurs when investors, that are looking for safe and remarkable profits in capital gain, find a new and unexplored opportunity to speculate. Generally, such opportunities are referred to novelties in financial markets such as IPOs, historically low rates or new technologies with high potential returns.
2. *Boom*: prices rise slowly at first, but when the displacement occurs, many investors join the market, increasing momentum preparing for the real *boom*. When the window for speculation is recognized by market agents, they decide to participate and the boom effect is spread by mass media. In order to not miss the speculative opportunity, other investors join the market influencing prices on volume basis.
3. *Euphoria*: since stock prices skyrocket, in this phase there is no caution in agents. Investors massively bet on price rising and classic theories can not explain this effect since the market is inured by the boom.
4. *Profit taking*: in this phase smart investors who are able to identify that they are in a bubble, sell their positions and take the capital gain. The main problem is to exactly recognize the right moment to exit the market, in other words, to recognize when a bubble is going to collapse causing a shock in the market.
5. *Panic*: in this last phase the trend changes from rising to falling. Asset prices in fact fall faster than they ascended. Investors try to short their position at any price in order to limit losses and, in this case, in order to highlight market failures. Consequently, supply exceeds the demand breaking the Say’s Law.

Figure 6



2.1 Rational Bubbles

In financial markets, agents have different perceptions on what constitutes a fair price for an asset. As previously stated, the fair price, or fundamental value, is the one that perfectly represents the value of a firm based on its future ability in generating positive cash flows. Therefore, a fair price would be one that embeds all related and relevant information. These propositions remain true if we are in a market with strong efficiency. However, a question may arise: what would happen if there were a deviation from the fundamental value, even if in the market previous considerations on efficiency hold?

Deviation from the fundamental value always arises as a result of irrational behaviour that cannot be explained by classical economic literature. In this situation “crowd psychology” assumes relevant importance and the price is affected by people beliefs, which are, by definition, exogenous events in financial markets.

There is one possibility in which behaviours based on rational expectations, lead to a deviation from fundamental, this situation is called a “rational bubble”. The purpose of this branch of economic and financial research tries to create a pattern in order to better understand speculative bubbles and their impact, creating a fictitious model to study them.

2.1.1 Rational expectations and bubbles

In a market with strong efficiency all information is available to agents and their behaviours are perfectly rational. Therefore, prices are set at their fundamentals. In such a market, since expectations are homogeneous among investors, it is impossible to short sell or to reallocate assets held in a portfolio to earn profits in capital gain; so we are in a condition of “no arbitrage”.[15]

Let

$$R_t = \frac{P_{t+1} - P_t + d_t}{P_t} \tag{2}$$

[15] An arbitrage is a peculiar condition in the market for which an agent can earn positive profit from price differences on the same asset. Arbitrage windows rise from market inefficiency. A no arbitrage condition happens in efficient market.

And

$$E(R_t \mid \Omega_t) = r \tag{3}$$

$$E(P_{t+1} \mid \Omega_t) - P_t + d_t = rp_t \tag{4}$$

where P_t is the stock price and d_t its dividend at time t. Moreover, R_t refers to the stock's general return, while Ω_t is the set of information at time t, which is, in this case available to all agents involved in the market. In this situation the market is in equilibrium; in fact, the expected return for the asset j is perfectly equal to the interest rate, which is assumed as constant to simplify the model. The model also states other assumptions, such as investors are risk neutral and short-selling is always available. If we claim that information is not equally available among agents, we admit a larger number of bubbles and more complex situations in which irrational component cannot be excluded.

We know that in a market such as the one described above, the set of information Ω_t includes all future information Ω_{t+1}, so that:

$$E(E(P_{t+1} \mid \Omega_{t+i}) \mid \Omega_t) = \mathrm{E}(P_t \mid \Omega_t) \tag{5}$$

Assuming this equivalence, we could say that the fundamental value P^*_t is simply given by:

$$P_t^* = \sum_{i=0}^{\infty} \Theta^{i+1} E(d_{t+i} \mid \Omega_t) \tag{6}$$

where Θ^{i+1} is the discount factor, obviously smaller than 0, but we should now consider a deviation c_t from fundamental, which increases asset price:

$$P_t^* = \sum_{i=0}^{\infty} \Theta^{i+1} E(d_{t+i} \mid \Omega_t) + c_t = P_t^* + c_t \tag{7}$$

given that: $E(c_{t+1} \mid \Omega_t) = \Theta^{-1}c_t$ in which $\Theta^{-1} > 1$ and so the deviation c_t grows with time. The coefficient c_t represents the bubble. In fact, it is addressed to grow during time and to increment stock's price.

We have set the equilibrium for which a bubble can exist in a rational market; a bubble guided by rational expectations and behaviours. However, a natural question should rise: how can a deviation from fundamental be rational if all the agents have the same set of information? And, how can the deviation coefficient c_t can impact in determine the presence of a bubble?

There are three different answers to the previous questions, so we have three different paths to mathematically explain the potential impact of a deviation from fundamentals even if we are in a market with strong efficiency.

The first way in which we can explain the rational deviation is represented by the so called "deterministic rational bubbles". In this case the sequent relation holds: $c_t = c_0\Theta^{-t}$; clearly showing that price increments are justified by higher capital gain and consequently the deviation is destined to grow exponentially until the bubble bursts. There is an evident drawback in this first case: since the market is in the condition of strong efficiency and all participants are assumed to be rational, the deviation coefficient will grow incessantly because there is no such a way in which agents will not earn profit in capital gain. In conclusion deterministic bubbles are impossible and are just a theoretical speculation.

For the second example the following situation holds:

$c_t = (\pi\Theta)^{-1}c_{t-1} + \mu_t$ with probability of π;

$c_t = \mu_t$ with the probability of 1-π;

where the expected value of μ_t is: $E(\mu_t|\Omega_{t-1}) = 0$.

This situation seems more realistic since the model assumes the possibility of a crash with probability 1-π. Therefore, the deviation coefficient is affected by the probability of a bubble bursting. The uncertainty leads to a higher deviation from the deterministic model and the higher the π the lower the deviation. This relation is valid and seems logical, even because the duration of the positive effect of a bubble depends on the probability of a crash. If there are few signals for a possible bubble bursting the assumed risk by investors in holding the asset is lower if it is close to popping. In fact, for higher probability of a crash the effect will be acceleration, correlated with higher risks and higher returns and price growth.

The third and last situation is the more realistic one, because we now assume that investors have a different set of information $\Omega_{ti} \neq \Omega_t$. This condition usually leads to two different fundamentals and so, the perception of the bubble is completely different amongst agents. The price is as follows:

$$P_t^* = \sum_{i=0}^{\infty} \Theta^{i+1} E(d_{t+i} \mid \Omega_{ti}) + c_t = P_t^* + c_t \tag{8}$$

The new condition satisfies the mathematical model of rational bubbles and the deviation coefficient c_t will be different for every Ω_{ti} in the market, setting the bubble as impossible to forecast and so closer to reality.

2.1.2 Further complications

In previous section it has been shown that, even in a condition in which there are no opportunities to exploit arbitrage windows, bubbles could still occur. However, there are some limitations in this phenomenon, and they are determined by structural conditions or by external institutions (i.e. FED). Let us consider a model of successive iteration in which the following condition holds:

$$\lim_{i \to \infty} E(c_t|\Omega_t) = +\infty \text{ if } c_t > 0 \tag{9}$$

$$\lim_{i \to \infty} E(c_t|\Omega_t) = -\infty \text{ if } c_t < 0 \tag{10}$$

As shown by these two equations, the longer the horizon the higher the price of the stock. This means that for longer period, the shock after a bubble bursting, will be higher if the effect of the bubble is prolonged in time. It is important to considered that, in this case, the probability of a bubble bursting tends to one if the horizon increases. Obviously it is impossible to fit this model on bonds unless the underlined security is a perpetuity. This relationship also implies that negative bubbles are not permissible. In fact, for negative deviation coefficients, the probability that c_t is greater than stock price exist. The stock will have substantially no price, but since negative values for securities are not possible, the model clearly shows that negative bubbles do not exist. This mathematical speculation pushes the model rationality too far from plausible events, but it is a topic that should be considered to better understand bubble occurrence.

Bubbles behaves extraordinarily, and, despite the effort to create a model which is able to contain and mathematically explain their nature, is very hard not to consider irrationality. In fact, bubbles are very close to Ponzi games[16], if they grow too rapidly, they are not reliable with rational purposes. Consider a model in which there is an infinite number of living participants. If the price of a stock is underestimated, then an investor should buy that security, and he will enjoy positive return forever. If previous

[16] A Ponzi scheme is a fraudulent chain game in which investors earn high return in the short term from non-performing assets. Profits come from money invested by new players involved. The natural conclusion is a collapse with high potential losses.

considerations on rational bubbles hold this also implies that negative bubbles cannot exist. If the price is overestimated, an investor should short sell the asset in order to earn infinite positive returns and positive bubbles cannot exist. But in a market with strong efficiency, populated by rational agents, no one wants to hold in his portfolio an asset which is overpriced, because it will be impossible, with such conditions, to earn expected capital gains. Therefore, there will be no match between supply and demand and this is not an equilibrium, showing the impossibility of negative bubble existence. In other words, bubbles cannot emerge if we consider an infinite number of rational agents which participate in an efficient market. But, as stated before, bubbles are very similar to Ponzi games, and since Ponzi games need new participants to allow the game to continue, if we assume that we can add new categories of agents in the market, the previous conditions do not hold any longer, and then, bubbles are permissible and possible.

Is it possible to determine where a bubble is most likely to arise? If we consider, for example, commodities such as gold, they all have two different possible uses: one use is industrial and the other one refers to their nature, in fact they can be used to determine prices of other goods or to be used as reserves. For this insight, we can say that for blue chip stocks it is harder to face bubbles since they have only one nature.

2.1.3 A classical consideration on bubbles

Watson, in his paper, proposes a final consideration on how a stock bubble rises. Suppose that an asset normally traded in a market is in equilibrium, and its fundamental value is equal to its price. This equilibrium also implies that the marginal product of capital is equal to the interest rate, in other words, since transaction costs (or commissions) are the same as returns, the company has no incentive in increasing its stock of capital. But, when a bubble occurs, the company should implement its capital stock in the same proportion as the deviation form fundamental. Doing so, the investor has obtained a return in capital gain but the fundamental value of the stock has been reduced by the increased proportion of capital stock increase. The spread between fundamentals and prices is doomed to exponentially grow until the bubble bursts, demonstrating that there is no connection between a bubble's behaviour and a firm's actions.

2.1.4 General Equilibrium

The effect of a stock bubble, even if we are not talking about general market bubbles, has the power to influence other asset trends. If a stock held in a portfolio suffers of a bubble the first effect is a change in the proportion invested in that assets, if the portfolio is built with the value weighted method, since its market capitalization grows. There is a secondary positive effect linked with other marketable securities. In fact, until the bubble bursts, the market generally experiences a positive trend. Moreover, a rise in prices is also symptom of a higher demand in money and more generally in goods since the general effect can be shown as an improvement in wealth and economic conditions.

On the other end, the negative effect of a bubble bursting can be translated to a general downturn. Goods and stocks in the same sector of the stock that went in bubble are the ones which generally suffer the most. Obviously, both negative and positive effects, depend on the nature and the size of the firm and on the nature of the asset. In fact, if the asset is a commodity, the downturn will be greater than a bubble bursting on a small company stock.

2.2 New theories about speculative bubbles

Recent events in the house market in US have renewed the interest in speculative bubbles and in the related theory. Researchers have put an increased effort in implementing previous literature, in order to better understand such abnormal phenomena as bubbles are. Holding the principle for which trying to contain bubbles in some mathematical models is practically impossible, due to their irrational nature, the new economic research has tried to implement previous schemes introducing new elements and new rational constraints. A further distinction has emerged: *credit-driven bubbles* and *irrational-exuberance bubbles*. The former, uses to rise when excess cash and positive economic condition let lenders prone in lending money to investors; on the other hand, the latter, are, as stated above, led by irrational behaviours and expectations. Moreover, credit-driven bubbles could have higher dangerous effects then irrational ones.

The focus here goes clearly to the credit-drive bubbles just introduced. In this new model, assets are overvalued because the money used to buy them is borrowed, and investors, at some time in the future, must repay their debt and the related accrued interests. The pattern proposes a situation in which distortions from fundamentals are not so frequent but, when they occur, the impact can be devastating and the condition of oversupply, that is the natural market failure for bubbles, is potentially greater than the one for "normal" irrational bubbles. Here, bubble bursting is guided both by oversupply and potential loss for lenders. Assets turnover rate also plays a crucial role, because it is symptom of higher volatility and overvaluation; while irrational components, as deviation from fair prices, because of their nature, can be mitigated and so do not affect bubbles too much in this model. Another factor that must not be undervalued is the nature of borrowing contracts, that, in this specific case, can vary the potential effect of the outcome of a bubble.

2.2.1 Setting up the model

We start defining the assumptions which define the basis for the model. First, we will consider a two-period model as: $t = \{1,2\}$. Moreover, assets are infinitely and perfectly divisible, which are traded with a fixed supply, so there is no opportunity to augment the market introducing new shares, and finally short selling is not allowed. Dividend pay outs are not certain but they payment date is assumed at the end of period 2 and so there will be only two possible and admissible outcomes:

$$d = \begin{cases} D > 0 \ \ with\, probability\, of\, \pi \\ 0\, with\, probability\, of\, 1 - \pi \end{cases} \tag{11}$$

The possible outcome for dividends is obviously unknown at date t_1, but before trading date t_2 the dividend outcome is revealed with a related likelihood $q \in [0,1]$ and let us denote Φ_t as the available set of information for investors at time t about dividends. Moreover, suppose that the following relation is always valid $\Phi_1 = \emptyset$ so that in t_2 we will have:

$$\Phi_2 \begin{cases} d \ \ with\, the\, probability\, of\, q \\ \emptyset\, with\, the\, probability\, of\, 1 - q \end{cases} \tag{12}$$

In order to not complicate the model, let us assume that investors are risk neutral, so that risk appetite will not influence future outcomes, and investors do not discount. With this last strong assumption we imply that the fundamental value for a stock is simply given by the expected dividend considering the available set of information; in other words $P = E[d|\Phi_t]$.

The model also implies the presence of different agent categories, which are:

- *Creditors*: Creditors are the agents endowed with a large amount of resources, in this case we refer to excess cash, at a certain date. They want to increase their stock of capital lending money, but this implies that they can only earn on interest rates.
- *Entrepreneurs*: Entrepreneurs are the ones without resources and assets, but they have the knowledge to earn large returns through production. They are able to produce outputs in a larger quantity of used inputs fulfilling this condition *O*>1, where *O* is the output and 1 is the unit of input. Entrepreneurs are not able to buy assets.
- *Non-entrepreneurs*: This category is populated by agents devoid of assets, resources and even technology. The only difference consists in the fact that they

can buy risky assets. Let $n_t < \infty$ be the non-entrepreneur agents at time t and let $m_t < \infty$ be the entrepreneur agents still at time *t*. Let's also assume that the proportion between non-entrepreneurs and entrepreneurs is fixed at $n_t = \psi m_t$.

- *Original owners*: Original owners are the one which hold assets. They do not participate in credit market even though they are endowed with large resources.
- *Non-participants*: Members of this category do not have assets, money, or the required technology to be an entrepreneur. They also do not take part in financial markets. In other words, non-participants are the rest of population which is not involved in the model, but must be considered for sake of completeness.

The first consideration is related to the possibility of the existence of a deviation from fundamentals, and this is due to the fact that creditors can profitably lend money to non-entrepreneurs. A second consideration must refer to borrowing capacity of agents. If we assume no limit in borrowing, price appreciations would not appear, otherwise if we set a total borrowing we will let deviations from fundamentals arise. We further assume that investors trade at the same time, so the will face the same risk. Another restriction is referred to the production *O*:

$$1 + \frac{\psi(1-\varepsilon)}{1-\psi(1-\varepsilon)} < O < \frac{1}{\varepsilon} \tag{13}$$

This condition let us say that R have positive values if $0 < \psi, \varepsilon < 1$. The range of values that *O* can assume is due to the fact that if the production is too low, lending dos not exist; on the other hand, if the outcomes are too large creditors are not willing to lend money to non-entrepreneurs, since they can rise interest rates for higher productivity.

The last restriction consists in delimiting the number of non-entrepreneurs to not let it grow infinitely, so that:

$$n_1 + n_2 < \frac{(1-q)D}{R} + q\varepsilon D \tag{14}$$

The restriction implies an upper frontier for the number of non-entrepreneurs, and consequently it implies that the asset prices can not grow infinitely generating a situation in which profit from capital gain is impossible.

Other considerations must be made on credit market. First of all, if creditors are not able to distinguish entrepreneurs from non-entrepreneurs the model will fall since there will be no difference between the two categories. The credit market works as follows: lenders set a number of finite contracts that can be "acquired" by borrowers; creditors ask a return set as $1 + r_{it}$,where *i* is the *i*-th creditor, at time 2. The maturity of interest payments is set at the end of date 2 for a practical reason: borrowers must be able to repay the debt and, since we have assumed both entrepreneurs and non-entrepreneurs with no resources, they need to earn profit on their investments before repaying lenders. We further assume that borrowers will always pay interests, because default is set as costly.

2.2.2 Equilibrium

The condition of general equilibrium sets that the price is equal to $\{p_t(\Phi_t)\}^2$, with *t*=1, on the other hand, interest rate is $\{r_{it}(\Phi_t)\}^2$. In equilibrium the demand of assets always finds the supply and prices for both buyers and sellers are exactly the same; creditors in equilibrium earn zero profits and there is no chance to offer different contract from which is possible rise money.

Recalling Watson's research, in an equilibrium a bubble is possible if there is a deviation of the price from fundamental, but in this case the deviation is expressed in terms of information set Φ_t so that $p_t(\Phi_t) \neq E[d|\Phi_t]$. A useful definition for the model is the on regarding *speculation*. Speculation refers to the positive value that investors give to the right to sell their owned assets; in other words, speculation exists when investors, for given prices and interest rates in *t*=1, prefer to hold the asset in order to sell it on a future date, i.e. for this model will be *t*=2, because in the future the information set will be different for sure $\Phi_1 \neq \Phi_2$. Speculation implies a series of multiple transaction amongst agents, which assume long and short positions increasing prices; when this happens we are talking about a *speculative bubble*. We can further distinguish other types of bubble: *quiet bubble* and *noisy bubble*. The former implies a situation in which in the equilibrium a bubble exists, but is traded by no investors in *t*=1 and short sold if the information set in *t*=2 is empty; on the other hand, the latter implies a situation in which a bubble exists and is traded in *t*=1 and short sold if $\Phi_2 = \emptyset$. In other words, a quiet bubble reveals a condition of a single trading; on the contrary, a noisy bubble happens with multiple transactions.

In equilibrium if $\Phi_2 = d$ the price of the asset will simply be equal to the dividend, fulfilling the Gordon Saphiro model.[17] Let us suppose that there is a deviation from fundamental, in this case the supply will be positive, whereas the demand will be equal to zero because creditors would prefer to increase their stock of capital rather than buying assets. On the other hand, if we set a price below *d*, we imply a positive demand but a supply equal to zero.

[17] The Gordon Saphiro Model, widely known as the Dividend Discount Model, is an evaluation method for stocks based on company's future ability in distributing dividends. In other words, the model discounts future dividends at the K_e. So that $P = \sum_{t=1}^{\infty} D_0 \frac{(1+g)^t}{(1+K_e)^t}$; where *g* is the long term growth rate.

In a situation of general equilibrium, in order for the model to work, the ratio $\frac{D}{p_t} > O$, and consequently lenders' interest rate will not be higher than $O\ 1 + r_t < O$. With these assumptions the demand for risky assets, considering that non-entrepreneurs must borrow a unit of resource from lenders, will be n_2/p_2. The supply curve requires more consideration since it has different steps and further complications depending on the nature of the bubble. First of all, we should notice that in t=1 the n_1 non-entrepreneurs have n_1/p_1 stocks while the remaining assets are held by 1- $n_1/p1$ original owners, which are willing to sell their stocks for any p_2 that is greater or equal to εD. The reservation price here is different for the non-entrepreneurs, since they have also to consider interests that must be paid on the unit of resources borrowed in t=1, in fact they expect to earn as follows if they held the asset:

$$\varepsilon\left(\frac{D}{p_1} - (1 + r_{i1})\right) \tag{15}$$

Otherwise, if they decide to sell the asset, they would earn:

$$\frac{p_2}{p_1} - (1 + r_{i1}) \tag{16}$$

So the n_2 non-entrepreneurs will ask a price that consider the previous two considerations:

$$p_2 \geq \varepsilon D + (1 + \varepsilon)(1 + r_{i1})p_1 \tag{17}$$

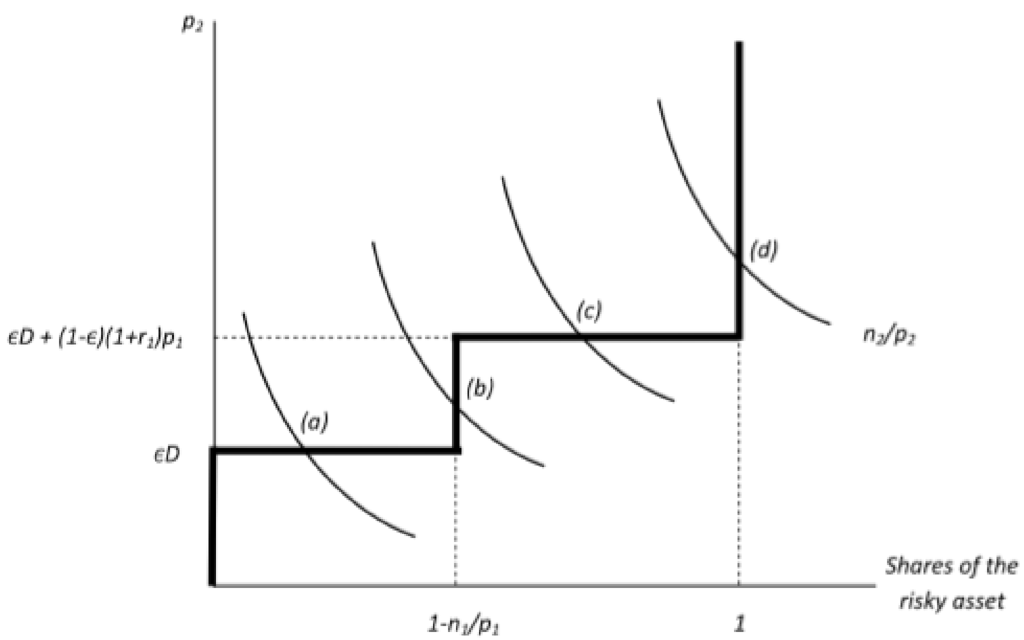
Depending on the nature of the bubble and if it really exists, we can find four different supply curves and four different demand curves:

a. With no bubble, we will have a situation in which p_2=εD. We should note that lenders in this situation of general equilibrium will earn zero profits.

b. In this case all original owners sell at t=2 but all non-entrepreneurs prefer to hold the assets.
c. In the third hypothesis all original owners sell and a part of non-entrepreneurs do the same.
d. In the last case both original owners and all non-entrepreneurs sell at t=2.

As shown in *Figure 7* the demand curves intersect the step supply curve only once each one demonstrating that in each case the prise is unique. Another consideration that should be made regards the impossibility to assume a single interest rate in the case of "c". In fact, there would be at least two different rates which are able to distinguish the non-entrepreneurs that sell the assets in t=2, from the ones which do not sell them.

Figure 7

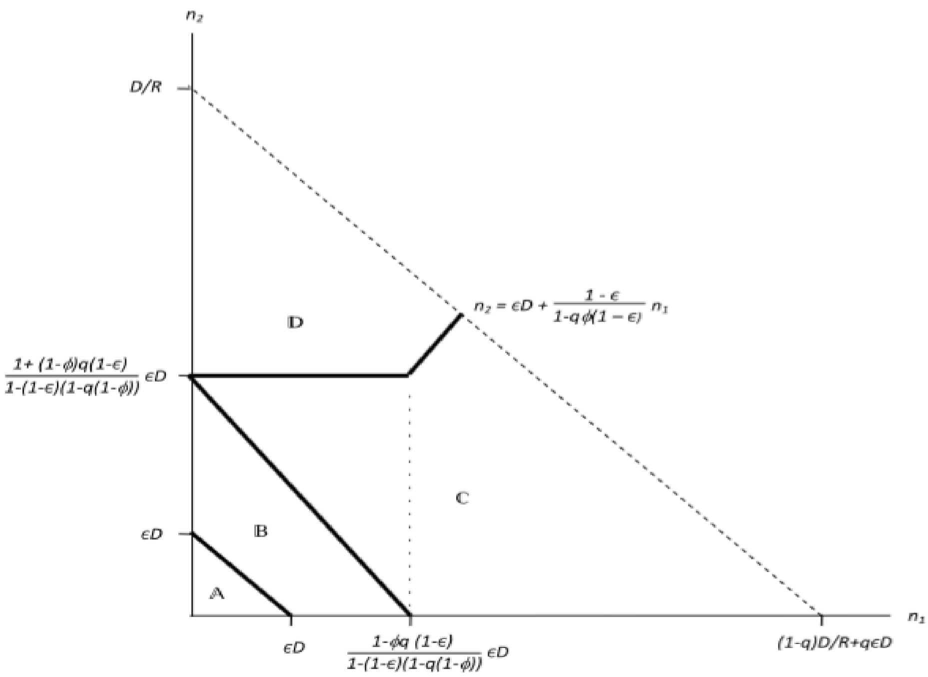


Source: Barlevy, G., 2014. A leveraged-based model of speculative bubbles. Journal of Economic Theory 153 (2014).

The result of the model is quite clear: we can set different but univocal results depending on the numbers of non-entrepreneurs in t=[1,2]. If we have a substantial increase in the number of agents that are member of the previously cited category, we can state that a bubble rise. In other words, for each (n_1, n_2) we can find one and only one equilibrium for prices and interest rates. Furthermore, we can divide the total number of non-entrepreneurs N in four different regions of the graph in *Figure 8*. To each of the four regions we can identify four equilibria:

a) No bubble condition;
b) Quiet bubble;
c) Noisy bubble;
d) Speculative bubble.

Figure 8



Source: Barlevy, G., 2014. A leveraged-based model of speculative bubbles. Journal of Economic Theory 153 (2014).

The main insight here is that variables such as n_1, n_2, ψ, ε influence and determine the existence and the nature of bubbles.

2.2.3 Bubble sizing

As previously mentioned, a bubble exists only when n_1, n_2 is large enough to be greater than εD. The reasoning behind this is quite simple: a bubble arises when a large number of investors decide to borrow units of resources to buy assets. The new flow of cash that is pumped into the market will increase the price of the assets and if the number of non-entrepreneurs is large enough this obviously create a deviation from fundamentals. The size of the bubble β_t is strictly equal to the difference from the price and the expected price – the fundamental value . It is important to remember that β_t is the equivalent to c_t of the previous model, the difference here is determined by the presence of a credit market and by the number of participants in the market. Moreover, we should further notice that, since we have involved two main factors, which are prices and interest rates, the number of participants directly influences the price, while the parameter referred to stock ψ affects the interest rate r_{it}. The last important consideration regarding this model related to bubble sizing is about the two parameters. In fact, prices and interest rates are absolutely not correlated, generating an ambiguous outcome in determining the volume of the bubble. This is mainly due to the fact that we did not exclude irrationality. The result is still the same: determining a model to contain the potential effect of such event is impossible.

2.2.4 Price growth

As previously stated, assets appreciation depends on the number of non-entrepreneurs; here we also consider information as a determinant for an increase in prices. The set of information Φ_t is about the possible outcome for dividends, and if we assume that $d=D$, the news will be immediately incorporated in the price generating a growth. But what happen if we do not know this information? The answer is not immediate but can stimulate some reflections. First of we should consider the demanded assets by n_1 and consequently assuming that original owners could sell or hold their assets. If we assume that just a portion of original owners are willing to sell their shares, then the price is:

$$p_1 = q\varepsilon D + (1-q)p_2 \tag{18}$$

Since $\beta_t \equiv p_t - E[d|\Phi_t]$ is the size of the bubble the price with the deviation from fundamental can be expressed with:

$$p_1 = \varepsilon D + \beta_1 \tag{19}$$

Solving for p_2 and adding the price equation in t=1 in the previous relation we obtain:

$$p_2 = \varepsilon D + \frac{\beta_1}{1-q} \tag{20}$$

The result shows a growth in prices if the probability q<1; in fact, the deviation will be $\beta_2 \equiv p_2 - \varepsilon D$, that is obviously greater than the one in t=1.

2.3 CAPM

This paragraph of literature review is about the capital asset pricing model. The CAPM, based on Markowitz's theory, proposed by Sharpe in 1964 and implemented by Lintner in 1965, is the major research in portfolio theory, and is commonly accepted as the best approximation of the market to forecast and evaluate stock trends. The CAPM establishes a relationship between stock return and its related risk. The risk measured is the so called systemic risk. In other words, it is the risk that cannot be eliminated though diversification, as suggested by Markowitz. In fact, the Nobel Prize winner suggests that the specific risk of each stock can be eliminated creating a well diversified portfolio. The importance of the CAPM in this work is related to the empirical research, in fact the performed regressions are based on this model, and it is essential to give to the reader all the needed knowledge to better understand the following analysis on asset bubbles.

2.3.1 Stock returns and risk measures

Every day, or to be more precise, every second, the prices of assets vary. This can be either positive or negative. These variations can be guided by infinite exogenous and endogenous factors, but is essential to know the magnitude of such changes. We will call such variation as stock's return and we will express it as percentage. The formula used in the computation is very simple:

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \tag{21}$$

We can set different time horizon depending on our observation period. But, what is the use for such returns? The answer is not that easy. We know that forecasting future possible outcomes is very hard and is largely based on assumption. In fact, we use the past to predict future trends, assuming that the observed asset will behave as it did in the past. For example, to forecast the average trend for the next month we should use past monthly observation and then compute an average. That average will represent the most reliable future outcome.

$$\overline{R} = 1/N \sum_{i=1}^{N} r_i \tag{22}$$

We now have information about a stock's return. However, price variations represent the first source of risk. The dispersion of returns around the average can be measured using the variance:

$$\sigma_i^2 = \sum_{i=1}^{N} \frac{(R_i - \overline{R})^2}{N} \tag{23}$$

However, what is commonly used, also known as *volatility*, is the standard deviation, more simply the square root of the variance:

$$\sigma_i = \sqrt{\sum_{i=1}^{N} \frac{(R_i - \bar{R})^2}{N}} \tag{24}$$

Investors do not buy just one asset but they prefer to buy multiple stocks at the same time building their own portfolios. In order to compute the return of such portfolios they need to know the proportion invested in each asset. We will start by considering a simple case with *N*=2 assets. There are two risk measures that must be considered: the the covariance and the correlation, which are respectively for assets *i*, *j*:

$$\sigma_{i,j}^2 = \sum_{t=1}^{N} \frac{\left(R_{it} - \overline{R_i}\right)^2 (R_{jt} - \overline{R_j})^2}{N} \tag{25}$$

$$\rho_{i,j} = \frac{\sigma_{i,j}^2}{\sigma_i^2 \sigma_j^2} \tag{26}$$

Moreover, the portfolio mean is simply given by:

$$R_p = \sum_{i=1}^{N} X_i r_i \tag{27}$$

Where X_i is simply the proportion invested in the *i*-th asset. On the other hand, the variance of the portfolio is computed as:

$$\sigma_p^2 = E(R_p - \overline{R_p})^2 = X_i^2 \sigma_i^2 + X_j^2 \sigma_j^2 + 2X_i X_j \sigma_{ij}^2 \tag{28}$$

It is also important to add a fundamental constraint in portfolio composition. This is expressed by the following equation:

$$\sum_{i=1}^{N} X_i = 1 \tag{29}$$

We are well aware that it is impossible to limit the model using only two assets since in real world portfolios are composed by a large number of securities; so we now consider cases with *N* assets. To do so we need matrix notations in order to compute the essential statistics such as portfolio's variance and return. We start considering the two vectors *X* – proportions – and *R* – returns.

$$X = \begin{bmatrix} X_1 \\ X_2 \\ X_n \end{bmatrix} R = \begin{bmatrix} r_1 \\ r_2 \\ r_n \end{bmatrix}$$

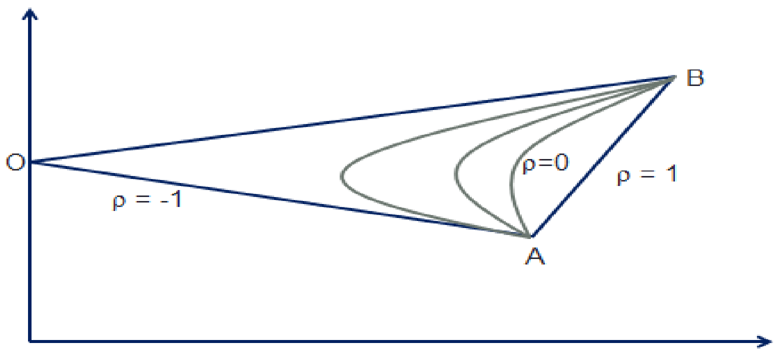
Since we have used vectors to better represent portfolio composition, we should continue doing so introducing the Variance – Covariance Matrix for the *N* assets.

$$S = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1N} \\ \vdots & \ddots & \vdots \\ \sigma_{N1} & \cdots & \sigma_{NN} \end{bmatrix}$$

The Portfolio variance will be:

$$\sigma_P^2 = \sum_{i=1}^{N} (X_i^2 \sigma_i^2) + \sum_{i=1}^{N} \sum_{j=1}^{N} (X_i X_j \sigma_{ij}) \tag{30}$$

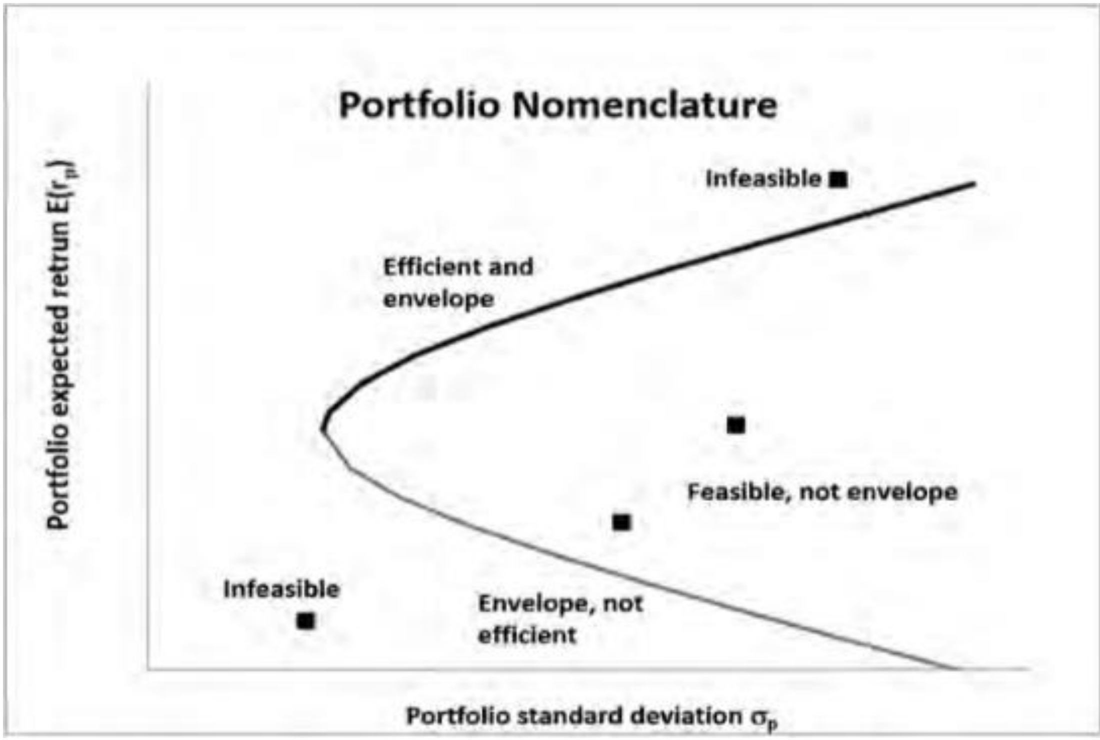
Figure 9



Source: Elton, E. J., Brown, S. J., Gruber, M. J., Goetzman, W. N., 2014. Modern Portfolio Theory and Investment Analysis. Wiley.

Returning to the two asset cases, we can plot a graph which combines a portfolio's return and its volatility. The resulting line is also called envelope curve. In fact, all the so-called efficient portfolios lie on this curve. The shape of the curve can vary depending on the correlation coefficient among the assets as shown in *Figure 9*.

Figure 10



Source: Benninga, S., 2014. Financial Modeling. The MIT Press.

Implementing the concept, we can say that a *feasible portfolio* is any portfolio which respects the already stated constraints in which the sum of proportions must be equal to 1. All the feasible portfolios are contained in the *feasible set* of a portfolio and, they lie on the *envelope curve,* if for a given return they minimize the volatility. Moreover, a portfolio is said *efficient* if for a given volatility it maximizes the return. The set of all efficient portfolios is also called *efficient frontier*.

2.3.2 Portfolio analysis and single-index model

Selecting portfolios to invest in is not a simple process and some metrics are required to do so. These measures are the portfolio return and its volatility, expressed in standard deviation. Analysts in the real world try to estimate future possible outcomes for their portfolios and they also want to mitigate risks depending on their risk appetite. Another important issue in determining portfolios selection is about correlation amongst securities. In order to determine such measure an analyst can decide between two different processes: *index models* and *averaging techniques*. In this work, because of the focus of the empirical analysis, the reader will be only provided with knowledge about index models. The most used in practice of such models is the *single-index model*, that is a good approximation of reality and it is very useful in estimating correlation matrix and in equilibrium tests.

It is commonly known that if we take a sample of stocks they show that when market is a bull one, most of them tend to show a growth in prices; on the other hand, when we face a bear market stocks register a fall in prices. This effect is due to a general correlation amongst securities. Positive and negative market effects must be related to the already stated systematic risk. Hence, to compute stock's return we should use the following equation:

$$R_i = a_i + \beta_i R_m \tag{31}$$

Where:

- a_i is a random variable which represents a component that is independent form market trend;
- R_m is the market return;
- β_i that is a constant that expresses the deviation from stock return respect to market return; this variable is also known as a sensitivity measure.

The a_i parameter is a component that is completely insensible to market variation and is composed by two elements:

$$a_i = \alpha_i + \varepsilon_i \tag{32}$$

Where:

- α_i is the expected value of a_i;
- ε_i is a random element that represents uncertainty, commonly known as *error*.

Rearranging previous equation, we obtain:

$$R_i = a_i + \beta_i R_m + \varepsilon_i \tag{33}$$

Since both R_m and ε_i are random variables, they have their own mean and standard deviation that imply a covariance. We assume that $cov(\varepsilon_i, R_m) = 0$, which guarantees that the return of the *i*-th asset is independent. We also add that the covariance between the *i*-th asset and the *j*-th asset is $cov\left(\varepsilon_i, \varepsilon_j\right) = 0$, which implies that only the market return vary in both assets.

To better understand how a single-index model works there are 5 propositions that the reader must be aware of:

1. a_i is a constant and we can find proportion in X_i using the following vector:

   $$E(R) - a_i = \begin{bmatrix} E(r_1) - a_i \\ E(r_2) - a_i \\ E(r_N) - a_i \end{bmatrix}$$

   Using a new vector denoted as *z* that is:

   $$z = S^{-1}\{E(R) - a_i\} \tag{36}$$

   We can derive:

   $$X_i = \frac{z_i}{\sum_{j=1}^{N} z_j} \tag{37}$$

2. Any two envelope portfolios are enough to set the entire envelope curve and given two envelope portfolios: $X = \{X_1, X_2, \dots, X_N\}$, $Y = \{Y_1, Y_2, \dots, Y_N\}$; all other portfolios are convex combination of them.
3. Recalling the relation which express stock's return we should add that $\beta_i = \frac{\sigma_{ij}}{\sigma_j^2}$
4. If a portfolio *Y* exists and for any portfolio X previous conditions hold, then portfolio Y is an envelope portfolio.

   If propositions 3 and 4 hold, they show a Security Market Line in a regression model with a R^2=100%. Moreover, it is important to introduce the *market portfolio* that is a value weighted portfolio composed by al tradable securities in the market.
5. a_i can be identified as a risk free return in the market, thus modifying the return formula as:

$$R_i = rf + \beta_i(E(R_m) - rf) + \varepsilon_i \qquad (35)$$

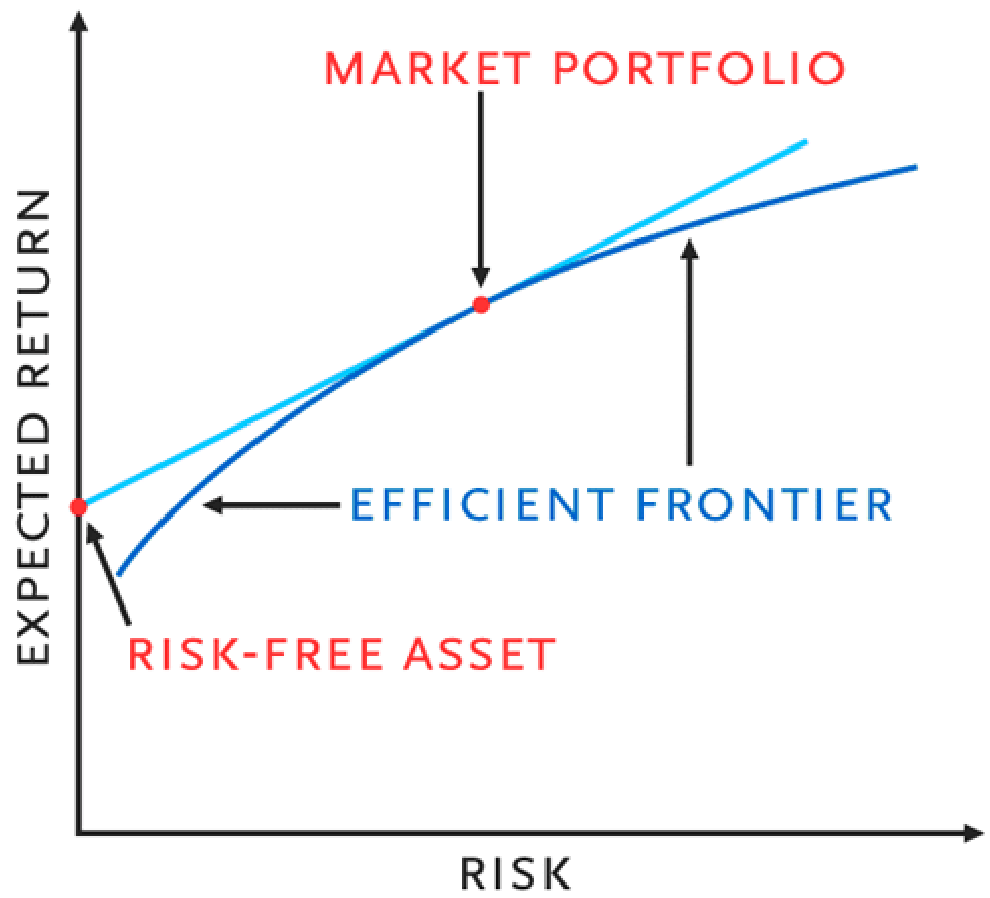
2.3.3 CAPM

As stated above, the real world is characterized by multiple interactions, irrational behaviours and other exogenous factors, that lead to a structural deficiency in determining a mathematical model that perfectly represents the reality. The best approximation with all its variants is the CAPM, which obviously has its own limitations mostly derived by the assumption on which is based. These hypothesis are:

1. Total absence of transaction costs;
2. Assets can be infinitely and perfectly divisible;
3. There is no taxation on personal income;
4. Investors do not affect the market buying and selling stocks;

5. Market participants in their decision making process only consider stock's return and stock's volatility;
6. Short sales are allowed;
7. Lending and borrowing are unlimited and the interest rate is the risk free;
8. Investors are aware about returns and volatility;
9. Investors' expectations are homogeneous;
10. All assets are marketable, including human capital.

Figure 11



Source: Benninga, S., 2014. Financial Modeling. The MIT Press.

In order to derive the CAPM we should start from the beginning. Every investor faces his own efficient frontier, but since we have assumed that borrowing and lending is risk free and there is homogeneity in both expectations and information; thus the efficient frontier will be exactly the same for everybody. Investors will reasonably hold the same portfolio that will lie on the efficient frontier in the tangency point with a line that starts from the risk free on the vertical axis. This line is also known as the capital market line (CML). Thus, the portfolio hold by investors will certainly be the market portfolio (M) plus a risk free security.

To conclude, the reader should keep in mind that the expected return can be summarize as follows:

$$(Expected\ Return) = (Price\ of\ Time) + (Price\ of\ Risk)\ x\ (Amount\ of\ Risk)$$

3. The effect of a bubble bursting on a replicating portfolio

In this chapter the empirical analysis will be performed in order to show the negative effect of a bubble bursting of a blue chip stock on a replicating portfolio of a passive investor on the S&P 500. The main aim is to demonstrate that, even if the bubble is an asset bubble on a stock which generally has low volatility and high reliability, can negatively impact on such big portfolio contributing to a downturn in a proportion higher than the weight of the asset in the index. To do so, some additional information is required. Indeed, this will provide the reader with the necessary knowledge to perform a linear regression on a market index, about the data gathering process and about all performed computations.

3.1 Theory behind practical application

The CAPM is a good approximation of reality, in fact it is widely use to perform analysis to evaluate stocks, to compute rates (i.e. WACC)[18] and to study events that could affect prices such as mergers, fusions, extraordinary announcements or, as in this case bubbles. In other words, the CAPM can be used in event study, that is a method to determine if an event can generate abnormal movements in a stock price. The *Abnormal Returns* are a measure that expresses the difference between stock price and its expected return regressed on the market portfolio. The sum of all abnormal

[18] The Weighted Average Cost of Capital (WACC) is the rate at which company's Free Cash Flows must be discounted, because it is a fair "representation" of company riskiness. In fact the WACC takes into consideration both equity side and debt side so that $WACC = \frac{E}{V}K_e + \frac{D}{V}K_d$; where E is the value of Equity, D is the value of Debt, $V = E+D$, K_e is the cost of capital computed with the CAPM and K_d is the cost of debt.

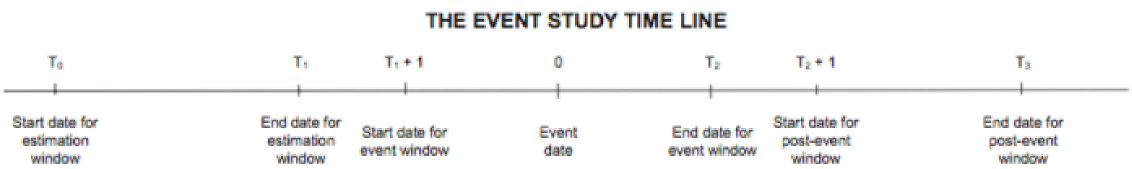
returns is also called *Cumulative Abnormal Returns* and clearly shows the whole impact of a determined event on stock price in a certain period of time. The period of observation is the *event window*.

3.1.1 Time composition

An event study is composed by three main phases:

1. *Estimation window*: it is used to estimate past behaviours, so in this frame all required metrics are computed in order to perform the regression in the sequent phase.
2. *Event window*: it is the main focus of the analysis, here regression analysis is performed. Can vary depending on the observed event.
3. *Post event window*: it is used to look at long term events and prices normalizations but it is not often used.

Figure 12



Source: Benninga, S., 2014. Financial Modeling. The MIT Press.

3.1.2 Performing the model

In performing the model, we should regress stock's returns on the market portfolio using the CAPM in which the following relation already shown holds:

$$R_i = a_i + \beta_i R_m \tag{36}$$

Coefficients a_i and β_i are computed in the estimation window. The market portfolio, since there is no index in the world that can perfectly represent the whole market with all tradable assets, it is assumed as an index such as Dow Jones, NYSE, Nasdaq or S&P 500. The theory suggests one should use industry indexes for litigation purposes instead of using composite indexes such as S&P 500 or the Fortune 500.

To compute the abnormal returns for a day t in the event window we use CAPM notation, defining this deviation as the difference from price to expected return based on market result:

$$AR_{it} = R_{it} - (a_i + \beta_i R_{mt}) \tag{37}$$

Abnormal returns clearly show the impact of the event on stock's prices, assuming that such events are led by exogenous factors. Moreover, the cumulative abnormal return represents the whole impact of the event for its whole duration. CAR_t, as previously stated is simply the arithmetical sum of all abnormal returns, from the beginning of event window to a certain date t in the observation period that can be the end or a intermediate day.

$$CAR_t = \sum_{i=1}^{t} AR_{t+i} \tag{38}$$

3.2 Data gathering

The empirical analysis is focused on blue chip stocks, since they are highly traded, very well known and bubble occurrence for such assets is not usual; hence, the research ais of higher interest. The sample of bubbles has been picked up from the S&P 500 in order to ensure that the stocks are blue chip. The period of observation varies from case to case since bubbles do not have the same magnitude, duration and general effect on the market. All the collected data refers to a precise period of time. In order to not contaminate results and to give to this analysis the highest possible reliability, the bubbles chosen occurred in the last 8 years following the 2008 financial crisis. General market collapse such as Dotcom bubble and the most recent crisis could negatively affect the results, so to avoid this problem the research starts in 2009. Because of the nature of the stocks it is hard to find events as bubbles, in fact the sample contains eleven cases plus an external case that will be used as proof for empirical evidence.

To recall the scope of this work, the analysis aims to demonstrate that the negative effect after a bubble bursts impact more than proportionally, even in a huge portfolio as a replicating one on the S&P 500 is. All data was collected from finance.yahoo.com, and the selected price is the adjusted closing for traded volumes, since this fairly represents the price on a specific day. To find bubbles, all the 500 shares that compose the S&P 500 were observed; historical data was used to compute volatility and price variations in order to get the highest possible. Moreover, a technical analysis was performed on each share in order to visually highlight bubbles on historical graphs. If a stock shows a bubble, this can be is easily identifiable because in the historical trend we can find a spike far from average normal values; and after this peak there is a sharply fall in price levels, as proposed in *Figure 1*, *Figure 2* and *Figure 3*.

3.2.1 The sample

Here there is a brief description about selected companies:

- Halliburton Co. (HAL) is an energy multinational company in the field of oil services;
- Helmerich & Payne (HP) is an oil drilling company;

- Mallinckrodt Plc. (MNK) is a pharmaceutical company specialized in the production of generic drugs;
- Marathon Oil Corp. (MRO) is an energy company specialized in the production of oil and natural gas;
- Micheal Kors Holding Limited (KORS) is fashion and luxury company highly specialized in the production of women accessories and handbags;
- Mylan N.V. (MYL) is company operating in the health care sector;
- Newfield Exploration Co. (NFX) is an energy company that produces oil, natural gas and liquid gas;
- Nobel Energy Inc. (NBL) is an energy company specialized in oil and gas exploration;
- Nordstrom (JWN) is a company that operates in the sector of luxury stores selling clothes, jewels, accessories, bags, fragrances and cosmetics;
- Western Digital Corp. (WDC) is a computer and data storage company and is also market leader in hard disk production.

There is an external case used as proof for the empirical analysis that is:

- GoPro Inc. (GPRO) is a technology firm that mainly produces cameras.

3.2.2 The market index

As previously stated, the market index on which all data were regressed is the S&P 500. For the analysis it has also been assumed, for the sake of simplicity, that this index is a benchmark for a replicating portfolio in full perfect replication. So, data for the market portfolio has been collected again from finance.yahoo.com, and has been matched with trading days of the companies' stocks that compose the sample of the analysis.

3.3 The analysis

To perform the analysis, the first step was to recognize the estimation window and the event window. For each analysed stock the estimation window coincides with price increase in the bubble period; on the other hand, since the scope of this work is to show potential impact of a bubble bursting, the event window starts when the bubble explodes and ends when stock prices begin to maintain a normal level, or when the trend inversion becomes clearly visible and stable. All required metrics are computed based on estimation window time horizon and are:

- The intercept a_i;
- The slope β_i;
- The coefficient R^2;
- The standard error of the regression;
- The correlation ρ_i.

For each stock and for each observation period of the S&P500 three different average returns have been computed:

- Estimation window return;
- Event window return;
- Overall return.

For each case the reader will be now provided with graphs and summarizes exhibits with significant results.

3.3.1 Halliburton Co. (HAL)

The observation period for Halliburton Co. starts on 1st November 2012 and it ends on 31st December 2014, reaching the maximum price on 23rd July 2014 a $70,78. The first recorded price is $30,65 and at the end of the event window is $37,86. It is clear that the estimation window is significantly longer than the event window, as suggested by the main theory. As shown in *Figure 13*, the highlighted area clearly shows a bubble. In fact, the stock experienced an increase in prices for the estimation window of 83,7% and a drop of 62,6% in the event window. The overall volatility on a daily basis was of

1,8% demonstrating sensible variation in prices close to 200 bps, that are not conventional for blue chip stocks.

Figure 11

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 2

	Regression metrics
Intercept ai	0,000856
Slope β	1,411808
R-squared	0,431964
St error	0,011367
Correlation	0,586684

Exhibit 3

	HAL	S&P 500
mean overall	0,04%	0,07%
mean estimation window	0,19%	0,08%
mean event window	-0,56%	0,03%

Exhibit 4

	Rgressed Values
Average Abnormal Return	-0,68%
Cumulative Abnormal Return	-76,52%

3.3.2 Helmerich & Payne Inc. (HP)

For Helmerich & Payne Inc. the estimation window goes from 15th April 2013 to the 3rd July 2014; on the other hand, the event window ends on 8th December 2014. The starting price was $49,91, while the highest was $105,34. The last gathered price is $56,42, which also is the end of the event window. The price level experienced an increase of 111%, but after the bubble bursts the drop in prices was about 46,4%. As in previous case the estimation window is longer than the event window, and the overall volatility computed on a daily basis was 1,8%, once again very close to 200bps per day. Such high variations in price levels are the first symptom of bubble rising. In *Figure 14* the reader will note the sensible price increase and the subsequent fall.

Figure 12

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 5

	Regression metrics
Intercept ai	0,001467
Slope β	1,199334
R-squared	0,319189
St error	0,012028
Correlation	0,529979

Exhibit 6

	HP	S&P 500
mean overall	0,04%	0,07%
mean estimation window	0,19%	0,08%
mean event window	-0,56%	0,03%

Exhibit 7

	Rgressed Values
Average Abnormal Return	-0,76%
Cumulative Abnormal Return	-83,21%

3.3.3 Mallinckrodt Plc. (MNK)

In this case the observation period goes from 10th October 2013 to 9th November 2015. Prices vary from $43,37 to $132,51 reached on18th March 2015, which coincides with the end of the estimation window and the beginning of the event window, that ends with a price of $59,01. The number of observation is *N*=513. Price variations for the estimation window is about 205,5%, while prices drop of 56,22% in event window from the highest recoded level. The overall volatility is 2,65% on a daily basis. Since the standard deviation is higher, even cumulative abnormal returns are higher than previous cases. The reader should notice that the estimation window is again longer than the event window and that in this case the stock suffered the famous IPO effect[19], because was listed in 2013.

[19] The IPO effect is one of the most common abnormal events, which cause potential deviation from fundamentals. In this case, investors are attracted from the market novelty and they all bet on it forecasting positive returns.

Figure 13

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 8

	Regression metrics
Intercept ai	0,002641
Slope β	1,129700
R-squared	0,156719
St error	0,019149
Correlation	0,442178

Exhibit 9

mean overall	0,06%	0,03%
mean estimation window	0,32%	0,05%
mean event window	-0,49%	0,00%

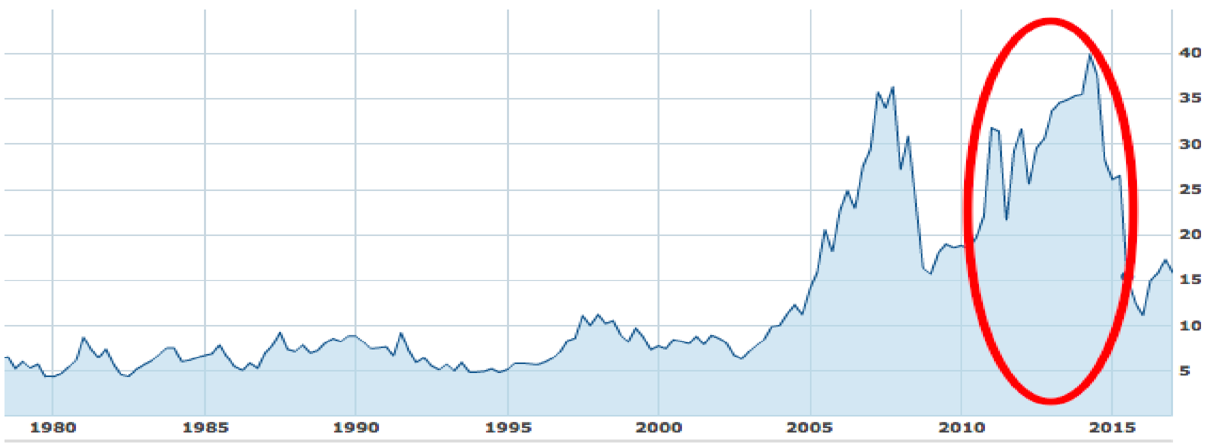
Exhibit 10

	Rgressed Values
Average Abnormal Return	-0,76%
Cumulative Abnormal Return	-125,46%

3.3.4 Marathon Oil Corp. (MRO)

The observation period starts on 18th June 2012 and ends on 12th February 2016 with a number of observations *N*=920. The starting price is $21,77, while the ending is $7,39; the highest reached level is $39,36 on 29th August 2014, that is also the date that divides the estimation window from the event window, which is again shorter than the estimation as suggested by the theory. The positive registered variation in prices is 80,8%; on the other hand, prices drop of 81,2% after the bubble has burst. The average volatility is 2,34%, showing a high deviation from the average price. As can be seen in *Exhibit 13*, the prolonged effect of the bubble combined with this high standard deviation have caused a high cumulative abnormal return. In *Figure 16* the reader will notice the peculiar structure of this bubble, in fact in the observation period, before the real bubble bursting, there are two more spikes.

Figure 14



Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 11

	Regression metrics
Intercept ai	0,000095
Slope β	1,354393
R-squared	0,440005
St error	0,010918
Correlation	0,580605

Exhibit 12

	MRO	S&P 500
mean overall	0,06%	0,03%
mean estimation window	0,32%	0,05%
mean event window	-0,49%	0,00%

Exhibit 13

	Rgressed Values
Average Abnormal Return	-0,43%
Cumulative Abnormal Return	-159,63%

3.3.5 Michael Kors Holding Limited (KORS)

The estimation window starts on 9^{th} July 2012 with a price of $46,62, and ends on 25^{th} February 2014 with a price of $99,84. On the other hand, the event window ends on 20^{th} July 2015 with a price of $39,92. The total number of observation is *N*=762, which, contrary to other cases, are more equally distributed between the estimation window and the event window. Price appreciation is 134,4%, while, after the bubble busting, prices dropped of 60%. The average volatility computed on a daily basis is 2,31%. We should notice that the stock suffered the IPO effect, since it has been listed at the beginning of 2012.

Figure 15

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 14

	Regression metrics
Intercept ai	0,001130
Slope β	1,253024
R-squared	0,155151
St error	0,021394
Correlation	0,301192

Exhibit 15

	KORS	S&P 500
mean overall	-0,01%	0,06%
mean estimation window	0,21%	0,08%
mean event window	-0,26%	0,04%

Exhibit 16

	Rgressed Values
Average Abnormal Return	-0,42%
Cumulative Abnormal Return	-148,00%

3.3.6 Mylan N.V. (MYL)

The observation period begins on 22nd September 2014 and ends on 19th October 2015 for a total number of observation *N*=272. The first recorded price is $46,53, while the last one is $43,74. The highest price is $76,06 and it is recorded on 24th April 2015, which is also the date in which the estimation window finishes. Here there is a balance between the duration of the estimation window compared to the event window. The price level grows of 63,4%, on the other hand the drop is 42% after the bubble bursting. The average volatility, computed on a daily basis, is 2,44%, which implies a cumulative abnormal return quite high considering the short duration of this bubble, as can be seen in *Exhibit 19*. The brief life of the abnormal event can be easily seen in the graph of *Figure 18*.

Figure 16

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 17

	Regression metrics
Intercept ai	0,002781
Slope β	1,328733
R-squared	0,210729
St error	0,022003
Correlation	0,452571

Exhibit 18

	MYL	S&P 500
mean overall	-0,02%	0,01%
mean estimation window	0,33%	0,04%
mean event window	-0,42%	-0,03%

Exhibit 19

	Rgressed Values
Average Abnormal Return	-0,66%
Cumulative Abnormal Return	-81,57%

3.3.7 Newfield Exploration Co. (NFX)

The observation period starts on 23rd August 2010 and ends on 17th October 2011, with a total number of observation *N*=292. The starting price is $49,42, while the ending one is $40,51. The highest price, recorded on 29th March 2011, is $76,45, which coincides with the starting date of the event window. In this case the proportion between estimation window and event window is very well balanced. The positive variation in prices is equal to 35,4%, on the other hand, prices dropped after the bubble bursting of 47%. The average volatility computed on a daily basis is 2,57%. This bubble is very peculiar because it occurred just after the 2008 financial crisis, showing that there is a poor connection between bubbles and economic cycles.

Figure 17

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 20

	Regression metrics
Intercept ai	0,001165
Slope β	1,228060
R-squared	0,326956
St error	0,014891
Correlation	0,797064

Exhibit 21

	NFX	S&P 500
mean overall	-0,07%	0,04%
mean estimation window	0,29%	0,14%
mean event window	-0,43%	-0,06%

Exhibit 22

	Rgressed Values
Average Abnormal Return	-0,47%
Cumulative Abnormal Return	-66,54%

3.3.8 Nobel Energy Inc. (NBL)

The observation period starts on June 18th 2012 and ends on 12th December 2014, with a total number of observation *N*=627. The starting price is $39,14, while the ending one is $42,49. The highest price, recorded on 23rd June 2014, is $76,31, which coincides with the starting date of the event window. The estimation window is much more longer than the event window due to the peculiar structure of the bubble, in fact, it shows multiple spikes before the real bubble bursting, as shown in the graph in *Figure 20*. The positive variation in prices is equal to 94,9%, on the other hand, prices dropped after the bubble bursting of 44,3%. The average volatility computed on a daily basis is 1,59%.

Figure 18

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 23

	Regression metrics
Intercept ai	0,000342
Slope β	1,309236
R-squared	0,451465
St error	0,010488
Correlation	0,626571

Exhibit 24

	NBL	S&P 500
mean overall	0,01%	0,06%
mean estimation window	0,13%	0,07%
mean event window	-0,47%	0,02%

Exhibit 25

	Rgressed Values
Average Abnormal Return	-0,53%
Cumulative Abnormal Return	-64,58%

3.3.9 Nordstrom (JWN)

The observation period starts on 26th August 2013 and ends on 24th June 2016, with a total number of observation *N*=714. The starting price is $48,96, while the ending one is $36,34. The highest price, recorded on 20th March 2015, is $72,78, which coincides with the starting date of the event window. In this case, the duration of the event window is well balanced with the one of the estimation window. The positive variation in prices is equal to 48,6%, on the other hand, prices dropped after the bubble bursting of 50,1%. The average volatility computed on a daily basis is 1,71%.

Figure 19

Source: yahoo.finance.com

Following the exhibits with the summarised information about regression metrics, mean results and abnormal returns:

Exhibit 26

	Regression metrics
Intercept ai	0,000493
Slope β	0,838175
R-squared	0,220425
St error	0,011475
Correlation	0,437464

Exhibit 27

	JWN	S&P 500
mean overall	-0,04%	0,03%
mean estimation window	0,10%	0,06%
mean event window	-0,21%	-0,01%

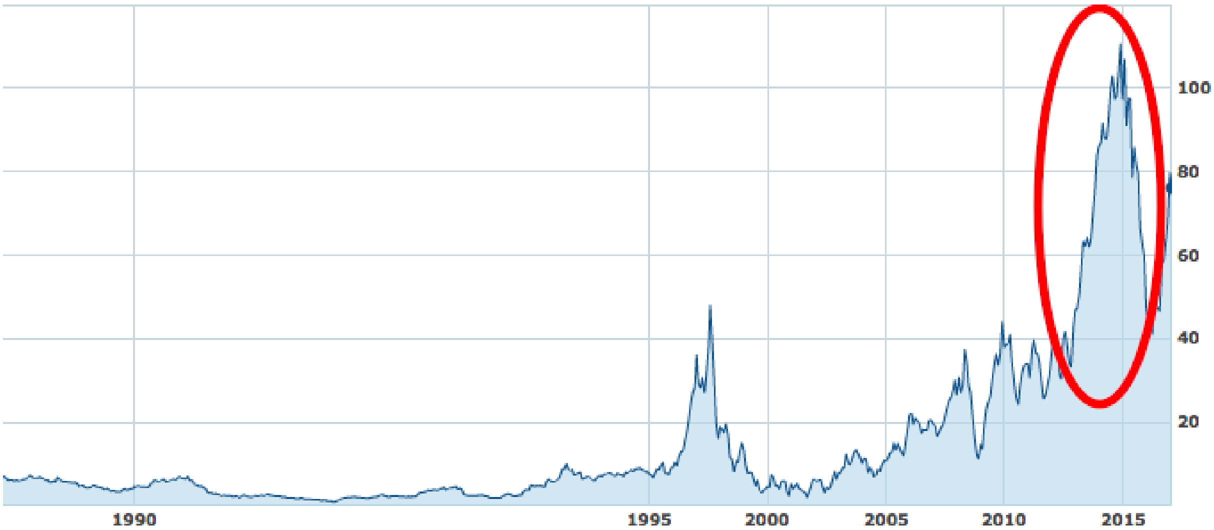
Exhibit 28

	Rgressed Values
Average Abnormal Return	-0,26%
Cumulative Abnormal Return	-81,76%

3.3.10 Western Digital Corp. (WDC)

The observation period starts on 26th November 2016 and ends on 12th February 2016, with a total number of observation *N*=810. The starting price is $32,29, while the ending one is $39,57. The highest price, recorded on 22nd December 2014, is $106,76, which coincides with the starting date of the event window. In this case the estimation window is longer than the event window, confirming theories on bubble for which prices drop faster than they increase in such abnormal conditions. The positive variation in prices is equal to 230,6%, on the other hand, prices dropped after the bubble bursting of 62,9%. The average volatility computed on a daily basis is 1,97%. This stock is the one that has registered the highest value in price growth in the whole sample as can be clearly seen in *Figure 22*. At the same time, it is very interesting in looking at the cumulative abnormal returns in *Exhibit 31*; in fact, despite the highest recorded numbers in price variations, the CAR_t do not assume external values in the observed sample.

Figure 20



Source: yahoo.finance.com

Following the exhibits with the summarized information about regression metrics, mean results and abnormal returns:

Exhibit 29

	Regression metrics
Intercept ai	0,001359
Slope β	1,245251
R-squared	0,272488
St error	0,014422
Correlation	0,543959

Exhibit 30

	WDC	S&P 500
mean overall	0,03%	0,03%
mean estimation window	0,23%	0,07%
mean event window	-0,34%	-0,04%

Exhibit 31

	Rgressed Values
Average Abnormal Return	-0,43%
Cumulative Abnormal Return	-124,99%

3.3.11 GoPro Inc. (GPRO) – the external case

The observation period starts on 26th June 2014 and ends on 5th February 2016, with a total number of observation *N*=407. The starting price is $31,34, while the ending one is $39,57. The highest price, recorded on 7th October 2014, is $106,76, which coincides with the starting date of the event window. Only in this case the estimation window is shorter than the event window. This peculiarity is mainly due to the IPO effect, which has negatively affected stock's prices. The positive variation in prices is equal to 199,5%, on the other hand, prices dropped after the bubble bursting of 89,4%. The average volatility computed on a daily basis is 4,68%. The reader should now notice the values for the cumulative abnormal returns and for the mean listed in *Exhibit 32* and *Exhibit 33*. The explanation for such numbers will be provided in the next chapter alongside the conclusion of this work.

Figure 20

Source: yahoo.finance.com

Following the exhibits with the summarized information about regression metrics, mean results and abnormal returns:

Exhibit 32

	Regression metrics
Intercept ai	0,015518
Slope β	0,435336
R-squared	0,002342
St error	0,056876
Correlation	0,181953

Exhibit 33

	GPRO	S&P 500
mean overall	-0,28%	-0,01%
mean estimation window	1,54%	-0,02%
mean event window	-0,67%	-0,01%

Exhibit 33

	Rgressed Values
Average Abnormal Return	0,74%
Cumulative Abnormal Return	-10,70%

3.4 Results

In this chapter, the empirical analysis was performed and it gave some interesting outcomes. Most of this results were expected, fulfilling the main scope of this work; otherwise, other results were not expected but they gave strength and reliability to previously stated assumptions. However, the reader should keep in mind that speculative bubbles, and more specifically asset bubbles, are extraordinary events, especially for well known large companies, as the ones in the sample; hence, every results can be subjected to misleading interpretations.

In the analysis all the stocks are part of the S&P 500 excepting for GoPro Inc., which will be used as a proof for tested company, in order to show abnormal behaviours of the replicating portfolio if a component suffers of a bubble.

First of all, as can be easily seen in *Exhibit 35*, which is a summarised table with all the obtained result for the whole sample, the reader should notice that the average daily return for the event windows, so basically for each stock after the bubble bursting, is higher in absolute value than the positive return experienced in the estimation windows. Therefore, this fact confirms the main theory about financial bubbles for which prices use to drop in a higher measure than they increased before the bubble pops. This is mainly due to the panic stage, investors try to liquidate their positions in order to limit losses and so they sell assets at lower prices generating a fast and sharp decrease in price levels. These behaviours are led, once again, by irrationality, and so by heuristics; in fact, investors when they feel lost, trying to imitate others behaviours and so everybody wants to give away his bad assets. This outcome was easily predictable, because as previously stated, past researches in bubbles have always shown that shocks are always more serious, speaking about volumes, than price increase.

Exhibit 2

	Mean Overall	Estimation Window Mean	Event Window Mean	Average Abnormal Return	Cumulative Abnormal Return
HAL	0,04%	0,19%	-0,56%	-0,68%	-76,52%
S&P 500	0,07%	0,08%	0,03%		
HP	0,03%	0,24%	-0,56%	-0,76%	-83,21%
S&P 500	0,07%	0,08%	0,04%		
MNK	0,06%	0,32%	-0,49%	-0,76%	-125,46%
S&P 500	0,03%	0,05%	0,00%		
MRO	-0,12%	0,11%	-0,45%	-0,43%	-159,63%
S&P 500	0,04%	0,07%	-0,02%		
KORS	-0,01%	0,21%	-0,26%	-0,42%	-148,00%
S&P 500	0,06%	0,08%	0,04%		
MYL	0,06%	0,32%	-0,49%	-0,66%	-81,57%
S&P 500	0,01%	0,04%	-0,03%		
NFX	-0,07%	0,29%	-0,43%	-0,47%	-66,54%
S&P 500	0,04%	0,14%	-0,06%		
NBL	0,01%	0,13%	-0,47%	-0,53%	-64,58%
S&P 500	0,06%	0,07%	0,02%		
JWN	-0,04%	0,10%	-0,21%	-0,26%	-81,76%
S&P 500	0,03%	0,06%	-0,01%		
WDC	0,03%	0,23%	-0,34%	-0,43%	-124,99%
S&P 500	0,03%	0,07%	-0,04%		
GPRO	-0,28%	1,54%	-0,67%	-2,21%	-743,72%
S&P 500	-0,01%	-0,02%	-0,01%		

Another remarkable result of the analysis concerns the cumulative abnormal returns. This measure indicates the total deviation from expected values, which can be equated to the fundamentals, in the estimation window. The range of results vary form -66,54% to -159,63%. This amplitude in outcomes is only due to different bubble's magnitudes and bubble's durations. The results, compared to the one of GoPro Inc., clearly shows that such deviations are not large enough to not negatively affect the portfolio's returns. In fact, even if GoPro Inc. is a large and well known company and, since is not included in the portfolio, which is also assumed to be the market index, the cumulative abnormal return is very large. This demonstrates that, for external cases, the correlation between portfolio's return and stock's return is very poor, and so there is no connection between them. It is also interesting to notice that, the average abnormal return, for the external case, is at least four time bigger than the stocks in the sample, confirming that if the stock is not included in the portfolio, the return obtained by the investor from its full replicating portfolio is not affected by such events, even if asset bubbles always create disorder in the markets.

The most interesting outcomes, which also confirm the hypothesis of this work, concerns portfolio's returns. There is an empirical evidence which shows that the replicating portfolio on the S&P 500 tends to lose at least 50% on the average daily return in the event window from the average daily return in the estimation window. The range of values goes from -47,25% up to -176,02%, demonstrating that the asset bubble experienced by one of the asset included in the portfolio, creates a negative effect larger than the weight given to such stock. This means that the even if the portfolio is highly diversified, composed by a large number of assets and built with only blue chip stocks, which have by definition low volatility, it suffers a negative downturn in performances if one of the component experiences a bubble. The proof can be sought again in the external case of GoPro Inc. In fact, in the period of observation, the replicating portfolio on the S&P 500 experience a negative average daily return of

0,02% in the estimation window. On the other hand, during the event window, the portfolio has still a negative average daily return, but in a reduced measure of 0,01%, while the stock experiences a -0,67%, which is also the highest negative return of the whole analysis, in the same period. The empirical evidence, has demonstrated that the shock of a bubble has a high dangerous impact for the whole portfolio, but if the stock is not considered in the portfolio's composition, its negative impact does not affect the performances.

The problem related to such events is how to hedge long positions from asset bubbles. The investor object of the analysis is not able, by definition, to liquidate his portfolio in short time. A possible solution can be in buying futures to cover the possible negative returns; but, since the problem states in the impossibility to know when the bubble would burst and its magnitude, this is also a difficult path to follow. Hedging portfolios from bubbles is probably impossible due to the extraordinary nature of these events. Let us suppose for a moment that the passive investor has been able in recognize the bubble and he has also forecasted a reliable date when the bubble will burst. This hypothetical case, stated just for mental speculation purposes, can lead to profit in capital gain if the investor can sell his portfolio. The reader should remember that stocks included in the portfolio are perfectly and infinitely divisible, so it is impossible to sell just a portion of the portfolio.

It is important to remark that the holding period plays a crucial role. If the time horizon assumed by the investor ends during the event window, this will create capital losses. If the time horizon does not coincide to the shock period, this will not create problem because the investor will continue to hold the portfolio earning dividends. A possible solution for the first case here assumed is to prolong the holding period and selling the portfolio when it will be profitable doing so.

However, it is clear, from the results, that even asset bubbles have dangerous effect in this kind of portfolios, which are safer than the ones held by active investors.

It is clear that such events cannot be easily forecasted so is difficult to hedge portfolios. In conclusion, bubbles are extraordinary events led by information asymmetries and irrational behaviours; they can be incredibly dangerous if they are market bubble, as the one of 2008 financial crisis, or less dangerous, as in the case analysed in this work, but they still have negative impact on the economy even if in a reduced measure.

4. Conclusion

Speculative bubbles are one of the most difficult and interesting topic in finance. The main theory related to such events is relatively recent and lacking in some fundamental aspects because of their frequency. In this work, we have shown the importance in non-underestimate bubbles and their potential negative impact for investors, constraining the research to well-defined type of bubbles, stocks and market agents.

Firstly, we have identified the context in which bubble occurs, understanding that the main drivers are information asymmetries and irrational behaviours. As stated in the first chapter, we live in a world led by emotions and feelings in which economists try to set mathematical pattern in order to understand various phenomena. A financial analyst, in fact, uses such patterns in order to forecast future stock's prices in order to assume the right decision. What investors want to know is the fundamental value of a stock, which is the price at which a security should be traded in a financial market with strong information efficiency. We have seen that such markets are fictitious and are used in portfolio theory to derive the formulas that we used in practice. But, we know that in real world prices embed also an irrational component that cannot be explained. This irrationality leads to bubble creation, but such events also requires the right context to grow. For example, in history, bubbles arose for speculation and other fraudulent actions as financial statements manipulations, but also from wrong expectations and overproduction crisis. What is clear is that in every case the environment was good for bubbles incubation. We have seen that excess cash, low interest rates, novelties and positive news can create ferment in financial markets triggering speculative bubbles.

The main aim of this work was to show the potential impact of the effect of a bubble on a replicating portfolio. To do so a sample of blue chip stocks was selected in a period that starts after 2008 financial crisis until nowadays. Each analysed bubble was regressed on the S&P 500, which was assumed as the full replicating portfolio, and deviations from fundamentals were computed as abnormal returns. The results have shown that after the bubble bursting the average daily return of the portfolio loses at least 50% from the previous period, that coincides to the estimation period in which regression metrics are computed. What emerges from the analysis is that the asset bubbles always affects portfolio's return in a proportion greater than its weight.

Later in this chapter the reader will be provided with a list of possible limitations of the research and a final and conclusive consideration about financial bubbles.

4.1 Limitations and future research

The analysis presents some critical issues. First of all, because of the nature of the topic and, more specifically, because of the nature of bubbles themselves, the sample could not be larger. Addressing asset bubbles on blue chip stocks has narrowed the sample, since, as previously stated, blue chip stocks barely suffer of a bubble. Moreover, the limited time horizon of the observation has further limited the number of involved stocks.

The reader should also keep in mind that each speculative bubble is unique, and so it is impossible to set a pattern to identify a common and well-established behaviour. Furthermore, bubbles are irrational events, which act out of the normal schemes set by classical economic and portfolio theory. Deviations from fundamentals are normal in financial markets, what is extraordinary it is the magnitude of such distances. It is also important to add that the validity of this work can be subject of revisions depending on different interpretation of the obtained results.

To implement the performed analysis in future researches, a statistic model to set a confidence range for cumulative abnormal returns, based on bubble's magnitude and duration, can be set in order to give more validity and reliability to the work.

In future researches, asset bubbles on blue chip can be analysed in a wider time horizon, being careful in not considering abnormal market trends such as the dotcom bubble or worldwide financial crisis. Another field can that can be explored, concerns the ability in predicting bubble bursting, based on a sort of maximum capacity for the deviations from fundamentals.

4.2 Final consideration

After a long discussion about bubbles, should be clear to the reader, that was not easy at all addressing with such peculiar events. The sample, as stated above, is composed by heterogeneous bubbles, since they all differ from each other, and, performing such analysis and interpreting the results required some insights in order to give it reliability.

Now further considerations are required to aware the reader about the difficulty in addressing with this topic.

Bubbles are, for their nature, irregular events in which, unexplained endogenous and exogenous factors play the central role. By construction, all the economic theories, from the dawn of this social science, are based on fictitious hypothesis, constraints and limitations in order to let mathematical equations work. In this contest, bubbles cannot be ruled. First of all, we should remind that agents' rationality in the decision making process is a basis assumption, but, as we saw, the real world is dominated by feelings and emotions even in financial markets. In fact, emotions, overconfidence and other biases let bubbles occur in a sort of endless cycle. What differs here, from the main theory on economic cycle, is the impossibility to set a stable trend. Bubbles occur when the environment is good for the proliferation of such events. As we saw in Chapter 2, novelties, excess cash, low interest rates on borrowing and many other factors are the determinants to let a bubble rise. So, how can exist a mathematical model, which could bridle these extraordinary events? The answer to this question has been already given in this work, but it is important to add some additional economic insights just for pure speculation.

Adam Smith, the father of the Economy, in his works states the crossing of the doctrine from the Physiocracy, for which the agriculture the wealth of nation only comes from land development and agriculture, to the social market economy (SOME), also known as the capitalism. What is important in Smith's works concerning bubbles, is the asset allocation. Adam Smith more than an economist was a philosopher, and in the "*Theory of Moral Sentiments*", for the first time he introduced the concept of the "invisible hand", further developed by other classic and neoclassic economists. The main idea behind this concept is that the market, composed by people who look at their own interests, belonging to their self-love, which is far from selfishness, is able to autonomously and efficiently allocate its resources. This implies that state interventions and other regulation in the market, and more specifically to financial market, are not needed. If we would follow Smith's paradigm we should say that bubbles are not admissible in market by construction.

Another concept to analyse, that has been already cited in this work, is the Say's law. Jean Baptiste Say, a French economist, following Smith's thoughts, proposed an economical law for which prolonged economic crisis are not permissible. In other words, he said that in the regime of free trade or the so called *laissaez-faire*, all participants decide to be vendors or acquirers at market prices. If there is an excess in the supply at a certain time prices tend to decrease. Hence, this fall in price levels will pump up the demand again. To summarise, the supply is always able to generate its own demand. This naturally implies that overproduction crisis are not possible, but bubbles have the characteristics of such crisis. In fact, we should remind that after the bubble bursting, investors want to liquidate their positions, but other market participants do not want to buy "junk assets". Therefore, asset holders lower prices in order to meet the demand, which is in this case totally absent. It is clear that such economic pattern does not fit with bubbles and real world. Evidences have shown in the past that prolonged overproduction crisis are possible and admissible.

One century later Alfred Marshall and the school of marginalists, developed the concept of market failures and market imperfections. Further implemented by the School of Harvard and the School of Chicago, the main idea is to make economic theories closer to reality, saying that market imperfections are possible. In fact, in this case, even if Marshall's researches was totally dedicated to Micro-economic studies, we can say that financial market can be assimilated to all other markets. Actually, in financial market the possibility to arrive at a perfect market competition is higher, because of information and technology. Therefore, this should aware the reader on how much is difficult that a bubble may arise and so, its potential harmfulness must not be underestimated.

In conclusion, financial bubbles are the perfect representations of market failures.

This final concept is indicative in showing the fallacy of economic theories. In fact, the economic science is social science, and so, by definition imperfect and this work aimed to show the danger that could emerge from underestimating irrational behaviours.

References

- Albolafia, M. Y., 2010. Can speculative bubbles be managed? An institutional approach. So!apbox Editorial Essays. Strategic Organization 8 (I). 93-100.
- Anderson, K., Brooks, C., 2014. Speculative bubbles and the cross-sectional variation in stock returns. International Review of Financial Analysis 35 (2014), 20-31
- Barlevy, G., 2014. A leveraged-based model of speculative bubbles. Journal of Economic Theory 153 (2014). 459-505.
- Benninga, S., 2014. Financial Modeling. The MIT Press.
- Berk, J., DeMarzo, P., 2014. Corporate Finance. Pearson.
- Bidian, F., 2015. Portfolio constraints, differences in beliefs and bubbles. Journal of Mathematical Economics 61 (2015). 317-326.
- Blanchard, O. J., Watson, M. W., 1982. Bubble, Rational Expectations and Financial Markets. National Bureau of Economic Research, Working Paper No. 945.
- Brooks, C., Katsaris, A., 2005. Trading Rules from Forecasting the Collapse of Speculative Bubbles for the S&P 500 Composite Index. The Journal of Business, Vol. 78, No. 5 (September 2005). 2003-2036.
- Caginalp, G., Porter, D., Smith, V., 2001. Financial Bubbles: Excess Cash, Momentum, and Incomplete Information. Journal of Psychology and Financial Markets. 80-99.
- De Simone, E., 2012. Storia economica: dalla rivoluzione industrial alla rivoluzione informatica. Franco Angeli.
- Diba, B. T., Grossman, H. I., 1988. The Theory of Rational Bubbles in Stock Prices. Wiley Blackwell, Royal Economic Society, The Economic Journal, Vol. 98, No. 392, (Sep. 1988). 746-754.

- Elton, E. J., Brown, S. J., Gruber, M. J., Goetzman, W. N., 2014. Modern Portfolio Theory and Investment Analysis. Wiley.
- Fabrizi P. L., 2013. Economia del Mercato Mobiliare. Egea.
- Fama, E. E., 1965. Random Walks in Stock-Market Prices. Graduate School of Business University of Chicago. Selected Papers No. 16 (Jan. 1965).
- Franses, P. H., 2016. A simple test for a bubble based on growth and acceleration. Computational Statistics and Data Analysis 100 (2016). 160-169.
- Galì, J., Gambetti, L., 2013. The Effects of Monetary Policy on Stock Market Bubbles: Some Evidence. Barcelona GSE Wotking Paper Series, Working Paper No. 724. (Dec. 2013).
- Gray, K. R., Frieder, L. A., Clark Jr, G. W., 2007. Financial Bubbles and Business Scandals in History. International Journal of Public Administration. 859-888.
- Haruvy, E., Noussair, C. N., 2006. The Effect of Shortselling on Bubbles and Crashes in Experimental Spot Asset Markets. The Journal of Finance, Vol. LXI, No. 3. 1119-1157.
- Holm, U., Breitung, J., 2012. Testing for Speculative Bubbles in Stock Markets: A Comparison of Alternative Methods. Journal of Financial Econometrics, Vol. X, No. 1. 198-231.
- Hull, J. C., 2015. Options, Futures and Other Derivatives. Pearson.
- Jones, B., 2014. Identifying Speculative Bubbles: A Two-Pillar Surveillance Framework. International Monetary Fund Working Papers.
- Kamal, J. B., 2012. Optimal Portfolio Selection in Ex-Ante Stock Price Bubble and furthermore Bubble Burst Scenario from Dhaka Stock Exchange with Relevance to Sharpe’s Single Index Model. Dhaka University (Sep. 2012).
- Maldonado, W. L., Tourinho, O. A. F., Valli, M., 2012. Exchange rate bubbles: Fundamental value estimation and rational expectations test. Journal of International Money and Finance 31 (2012). 1033-1059.

- Markowitz, H., 1952. Portfolio Selection. The Journal of Finance, Vol. 7, No. 1 (Mar. 1952). 77-91.
- Markowitz, H., 1959, Portfolio Selection: Efficient Diversification of Investments. Cowles Foundation for Research in Economics at Yale University.
- Nneji, O., 2015. Liquidity shocks and stock bubbles. Journal of International Financial Markets, Institutions & Money 35 (2015). 132-146.
- Phillips, P. C. B., 2016. Modeling speculative bubbles with diverse investor expectations. Research in Economics 70 (2016). 375- 387.
- Saqib, O. F., 2001. The East Asian Crisis in Kindleberger-Minsky's Framework. Brazilian Journal of Political Economy, Vol. 21, No. 2. (Jun. 2001).
- Scheinkman, J. A., Xiong, W., 2003. Overconfidence and Speculative Bubbles. Journal of Political Economy, Vol. 111, No. 6. 1183-1219.
- Shi, S., Song, T., 2016. Identifying speculative Bubbles Using an Infinite Hidden Markov Model. Journal of Financial Econometrics, Vol. 14, No. 14. 159-184.
- Shi, S., 2010. Bubbles or Volatility: A Markov-Switching Unit Root Test with Regime-Varying Error Variance. The Australian National University, Working Paper in Economics & Econometrics (Jun. 2010).
- Tuckman, B., Serrat, A., 2012. Fixed Income Securities. Wiley Finance.
- Wang, M., Wong, M. C. S., 2015. Rational speculative bubbles in the US stock market and political cycles. Finance Research Letters 13 (2015). 1-9.
- Wang, P., Wen, Y., 2012. Speculative Bubbles and Financial Crises. American Economic Journal: Macroeconomics, Vol. 4, No. 3. 184-221.
- West, K. D., 1986. A specification test for speculative bubbles. NBER Working Papers Series.

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Summary

Our world is characterised by uncertainty and, even though all the economic theories are based on agents' rationality, we often underestimate this important factor. Human irrationality can appear in infinite forms and this is mainly due to the fact that no one act following a rational mental pattern.

From Smith on, agents' rationality is assumed as an axiom to let all the models work, but it is impossible to not consider other exogenous and endogenous factors that could affect such patterns. Even in finance, the rational component is the base on which all the mathematical model are set. Only in recent times, a new wave of thought has introduced human behaviours in the models: the behavioural finance. In fact, investors prefer to follow others' decisions in order to make profits or to limit losses, and this "imitation game" can lead to some dangerous effects.

Finance world is mainly divided in two big branches: chartist and technical. The former believe that historical trends tend to repeat themselves. So, technicians spend their days examining historical prices through graphs or charts in order to forecast future trends. In short, chartists aim to use their forecasting to influence the market. However, those who are sceptical about the chartist theory have developed the common belief that rather than guessing a price pattern, they influence the market through sheep investors who strictly follow others' suggestions and insights when making financial decision.

On the other hand, the latter, which is the most used and well accepted theory, is based on the intrinsic value of a security. To understand the right definition of intrinsic value one must turn to the meaning of *fair value*: the right value at which a stock, a bond or any other security must be exchanged. The intrinsic value of a share is based on its capacity to generate future positive cash flows. Or rather, to put it simply, to allow its owner to gain a profit from security's detention. Stock's earning potential, it

is so based on different drivers such as company's management, referred market and many others. In short, to estimate the right price, an analyst should have extensive knowledge of the firm and must make some assumptions based on that information. With the term assumption, it is commonly accepted, that it refers to some form of prediction of a company's future perspectives. In other words, to fairly set the price, information is needed.

A third piece of classical theory is the so-called random walk, for which is impossible to set a path for stock's prices since they do not follow any established pattern.

In order to better understand the work, we should recall the importance of information, which is today our most valuable commodity and can be traded and shared as any other good. Information in finance is fundamental because we can distinguish different kind of markets based on its availability. The market in which all the prices embed all available information at every time is called a market with strong efficiency. In fact, the bid-ask spread is equal to zero.

In this context, financial analysts are supposed to find the fundamental value of a security, which coincides with its fair price, and so, making decision on where invest money.

However, since irrationality exists, the price at which securities are traded most of the time has a deviation and, if such deviations are consistent, we are facing a speculative bubble.

The fast increase in an asset's price and volatility, referred to a limited period of time that can be expressed in months or few years, overcoming the natural trend of a security, which can significantly vary just in decades, is called a speculative bubble.

This explosive path brings prices far from intrinsic and actual values, basing the supply on unfair and unrealistic expectations; which, in a certain time in the future, the market understands the unbearableness of previous beliefs and the bubble bursts, causing a shock in price levels.

Bubble’s characteristics are:

- Increase in traded volumes
- Prices vary sensibly from a day to another
- The market is hysteric
- There are triggering factors, mostly related to information
- It is hard to forecast the begin and the end of such bubbles
- Can only be observed with a retrospective point of view
- Each bubble is different from others and behaves autonomously

A normal and justified question could be: why should we call these events *speculative* bubbles? The answer is relatively easy. In fact, when investors are captured in the storm of the bubble, they do not trade underlined securities for rational purposes, evaluating the possibility of future dividends, but they are only looking for capital gain in a brief period of time. They want to exploit the wave, being sure to quit right on time the assumed long position. This is the reason why when we talk about bubbles we used to call them speculative.

However, in reality, there are several different types of bubbles and how we call them strictly depends on what they are referring to.

Speculative bubbles can be divided into two main categories.

- *Market bubbles*: a market bubble occurs when the underlying asset is a commodity or a set of securities. Their potential impact is wide and dangerous for economic stability in general. A bright example of market bubble is the recent 2008 financial crisis. In general, this is caused by increases in commodity prices, which provoke a chain effect with all related production activities that the commodity involves, for instance, oil prices. Otherwise, as in 2008, the rising of subprime mortgages and the following financial scandal, provoked a wider effect, threating financial stability all around the world.

- *Asset or stock bubble*: the term asset bubble, which is the main focus of this work, is used when the object of the analysis is a single stock. The causes are almost related to information and speculative purposes, and the effect when the bubble bursts is absolutely not wide even if the consequent shock can be generally dangerous. The frequency of this kind of bubble is higher than the market ones, in fact, bubbles are generally window for capital gains that investors want to exploit until this window is open and to not be burned by the bursting.

Bubbles are, basically, the consequence of an anomaly in financial markets that are caused by common psychological mishaps. The natural interest for new information or a new good, moves investors' interests to a new path, since they are looking for safety profits, these previously cited windows are very desirable and very attractive even for inexperienced investors. Here, two already stated factors starts playing in the same direction: irrational behaviours and information asymmetries.

Regarding irrational behaviours, if there is the chance to earn a profit from others' insights or from a new trend with high appeal, everybody wants to participate. This is a normal way to act since we are all too optimistic about the future and so are investors about market expectations.

Otherwise, information asymmetries or information in general plays a crucial role in negatively influencing decision-making processes. We live in a world in which news flows rapidly thanks to powerful and innovative mass media such as TV and internet. In fact, in the era of globalization and communication every new information can be easily incorporated in fundamentals and so the spread between bid and ask prices has been reduced, and this would be a positive factor if it were not for the fact that information can be false and deceptive. Information asymmetries derives from this aspect; hence, two people may have different perspectives and different knowledge on the same issue, in this case on an asset, and this divergence can lead both individuals to assume that the other is wrong. If numerous investors have the same biased point of view, they can generate an abnormal event, influencing a trend and so, creating a bubble.

Speculative bubbles are extraordinary phenomena but they are not a novelty. In fact, we can study several cases since XVII century with the very first Tulip Bubble. After the industrial revolutions, bubbles were related to huge financial scandals such as the South Sea Bubble or the Mississippi Bubble. Other important bubbles are the Great Depression in 1929, the Black Monday in 1988, the Dotcom bubble and the recent 2008 financial crisis.

The aim of this work is to demonstrate empirically the impact of a shock after a bubble bursting of a blue chip stock in the return of a replicating portfolio on the S&P 500 held by a passive investor.

The appeal on this topic must be searched in the instability of financial markets due to investor's behaviours and to show that bubble occurrences are not phenomena just related to catastrophic events, but they are recurring events. The sample of cases is set in an observation period that starts after the 2008 crisis and end nowadays in order to have a more recent, reliable and comprehensive point of view on the subject. The focus is not on market bubbles in general but on stock or asset bubbles which is an argument not yet well described by the literature.

The sample is composed by ten companies belonging to different sectors but all included in the S&P 500 plus an external case used as proof:

- Halliburton Co (HAL);
- Helmerich & Payne (HP);
- Mallinckrodt Plc. (MNK);

- Marathon Oil Corp. (MRO);
- Micheal Kors Holding Limited (KORS);
- Mylan N.V. (MYL);
- Newfield Exploration Co. (NFX);
- Nobel Energy Inc. (NBL);
- Nordstrom (JWN);
- Western Digital Corp. (WDC).
- GoPro Inc. (GPRO).

To perform the empirical analysis all data were collected from finance.yahoo.com, and two different period of time were pinpointed: the estimation window, in which regression parameters were computed, and the event window, which starts when the bubble bursts and finishes when price levels return to be stable. The regressions are used to identify the deviations from expected values, so stock's returns were regressed on the S&P 500, and after that, they were arithmetically summed to highlight the cumulative abnormal return as a measure of the total deviation.

The analysis gave the following results. First of all, the average daily return for the event windows, so basically for each stock after the bubble bursting, is higher in absolute value than the positive return experienced in the estimation windows. Therefore, this fact confirms the main theory about financial bubbles for which prices use to drop in a higher measure than they increased before the bubble pops. This is mainly due to the panic stage, investors try to liquidate their positions in order to limit losses and so they sell assets at lower prices generating a fast and sharp decrease in price levels. These behaviours are led, once again, by irrationality, and so by heuristics; in fact, investors when they feel lost, trying to imitate others behaviours and so everybody wants to give away his bad assets. This outcome was easily predictable, because as previously stated, past researches in bubbles have always shown that shocks are always more serious, speaking about volumes, than price increase.

Another remarkable result of the analysis concerns the cumulative abnormal returns. This measure indicates the total deviation from expected values, which can be equated to the fundamentals, in the estimation window. The range of results vary form -66,54% to -159,63%. This amplitude in outcomes is only due to different bubble's magnitudes and bubble's durations. The results, compared to the one of GoPro Inc., clearly shows that such deviations are not large enough to not negatively affect the portfolio's returns. In fact, even if GoPro Inc. is a large and well known company and, since is not included in the portfolio, which is also assumed to be the market index, the cumulative abnormal return is very large. This demonstrates that, for external cases, the correlation between portfolio's return and stock's return is very poor, and so there is no connection between them. It is also interesting to notice that, the average abnormal return, for the external case, is at least four time bigger than the stocks in the sample, confirming that if the stock is not included in the portfolio, the return obtained by the investor from its full replicating portfolio is not affected by such events, even if asset bubbles always create disorder in the markets.

The most interesting outcomes, which also confirm the hypothesis of this work, concerns portfolio's returns. There is an empirical evidence which shows that the replicating portfolio on the S&P 500 tends to lose at least 50% on the average daily return in the event window from the average daily return in the estimation window. The range of values goes from -47,25% up to -176,02%, demonstrating that the asset bubble experienced by one of the asset included in the portfolio, creates a negative effect larger than the weight given to such stock. This means that the even if the portfolio is highly diversified, composed by a large number of assets and built with only blue chip stocks, which have by definition low volatility, it suffers a negative downturn in performances if one of the component experiences a bubble. The proof can be sought again in the external case of GoPro Inc. In fact, in the period of observation, the replicating portfolio on the S&P 500 experience a negative average daily return of

0,02% in the estimation window. On the other hand, during the event window, the portfolio has still a negative average daily return, but in a reduced measure of 0,01%, while the stock experiences a -0,67%, which is also the highest negative return of the whole analysis, in the same period. The empirical evidence, has demonstrated that the shock of a bubble has a high dangerous impact for the whole portfolio, but if the stock is not considered in the portfolio's composition, its negative impact does not affect the performances.

The problem related to such events is how to hedge long positions from asset bubbles. The investor object of the analysis is not able, by definition, to liquidate his portfolio in short time. A possible solution can be in buying futures to cover the possible negative returns; but, since the problem states in the impossibility to know when the bubble would burst and its magnitude, this is also a difficult path to follow. Hedging portfolios from bubbles is probably impossible due to the extraordinary nature of these events. Let us suppose for a moment that the passive investor has been able in recognize the bubble and he has also forecasted a reliable date when the bubble will burst. This hypothetical case, stated just for mental speculation purposes, can lead to profit in capital gain if the investor can sell his portfolio. The reader should remember that stocks included in the portfolio are perfectly and infinitely divisible, so it is impossible to sell just a portion of the portfolio.

It is important to remark that the holding period plays a crucial role. If the time horizon assumed by the investor ends during the event window, this will create capital losses. If the time horizon does not coincide to the shock period, this will not create problem because the investor will continue to hold the portfolio earning dividends. A possible solution for the first case here assumed is to prolong the holding period and selling the portfolio when it will be profitable doing so.

However, it is clear, from the results, that even asset bubbles have dangerous effect in this kind of portfolios, which are safer than the ones held by active investors.

It is clear that such events cannot be easily forecasted so is difficult to hedge portfolios. In conclusion, bubbles are extraordinary events led by information asymmetries and irrational behaviours; they can be incredibly dangerous if they are market bubble, as the one of 2008 financial crisis, or less dangerous, as in the case analysed in this work, but they still have negative impact on the economy even if in a reduced measure.