Detecting and Measuring Financial Market Bubbles

By

Fariba Rad

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Agribusiness and Agricultural Economics

University of Manitoba

Winnipeg, Manitoba

August 2018

ABSTRACT

Reviewing the history of financial bubbles indicates that there is no unique definition of the financial bubbles. Given the importance of understanding financial bubbles, the focus of this research is to define and detect bubbles in financial markets. The identification of bubbles is conducted by using stock prices from the internet bubble in the late 1990's. This study defines a bubble based on if the current stock price increases by more than 100% and then decreases by at least 50%. Bubbles were found in 30 of the 40 internet companies studied. The first approach using mostly 10 and 40 day moving averages indicated that most bubbles occurred in less than 150 days from beginning to end. The second approach was to measure the size of the bubble and results showed that most of the bubbles were smaller in size. For the third approach, measuring asymmetry of bubbles, results showed that stocks fall faster than they rise. These insights may be valuable to assist investors and policymakers with their decision making.

Keywords: financial bubbles, bubble size, asymmetry, bubble definition, internet bubble

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude and appreciation to my advisor, Dr. Milton Boyd for his encouragement and support throughout my studies. The advice and inspiration you provided for successful completion of my research was invaluable. As well, I would like to thank my other committee members, Dr. Barry Coyle and Dr. Ruppa Thulasiram for their very helpful suggestions and assistance. My sincere appreciation and thanks go to the faculty, staff, and graduate students from the Department of Agribusiness and Agricultural Economics at the University of Manitoba for their support and encouragement. Finally, my husband deserves all my appreciation for his love, understanding, and the support he provided, and sacrifices he made during my M.Sc. studies.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background of the Research

The term bubble became popular after the Mississippi Bubble that occurred in 1719 in the European stock market, and the term bubble has also been in the news following the 1990's internet bubble and the 2000's real estate bubble (Davies, 2014). In the recent decades, concerns about asset price bubbles have increased. For instance, the "high" bitcoin value may have indicated a possible bubble (Godsiff, 2015).

Economists have done many studies to learn from the history of bubbles, to understand asset price bubbles, and to gain a better understanding regarding the causes of bubbles. It has been difficult to identify when bubbles will occur, and when prices will escalate and when a crash may occur. In other words, it is difficult to know if there is a bubble, unless the bubble bursts (Mizuno et al., 2017). However, there are some financial, economic, and behavioural indicators that may raise the suspicion regarding the existence of a bubble (Shetty, 2016).

Generally, the underlying assumption of a bubble is that even at a higher price there is always a buyer who will buy and subsequently decide to sell to others to make a profit at a higher price. The history of the bubble is full of such events, which are like a cycle (Davies, 2014).

Problem

Reviewing the history of bubbles indicates that there is no unique definition to address

financial bubbles. One of the challenging parts among financial economists is a debate on using the term ‘bubble’, and many theories have been proposed to describe this phenomenon.

> “Asness says that an asset or a security is often declared to be in a bubble when it is more accurate to describe it as ‘expensive’ or possessing a ‘lower than the normal expected return’. Fama goes further, arguing that the word bubble is inherently meaningless because it implies nothing more than saying that the risk appetite has been changed. Shiller disagrees, arguing that bubbles are caused by behavioural aberrations that can sometimes be identified in advance” (Davies, 2014).

These types of definitions for bubbles indicate that there is disagreement on how to define the term bubble, even among Nobel Prize winners Shiller and Fama, and shows that there is no universally accepted definition for a bubble (Davies, 2014).

In addition, a bubble definition is problematic from the point of view of economists because “to define bubbles properly, some metrics are required, and there is still little agreement regarding what the metrics exactly should be” (Dumskis & Sakalauskas, 2012). A large number of studies have proposed methods to detect asset price bubbles (Dumskis & Sakalauskas, 2012). For example, Evanoff et al. (2012) emphasize that a large portion of the work that attempts to describe a model of the bubble defines a bubble as a deviation between asset price and fundamental values (Evanoff et al., 2012).

Importance

Bubbles can play a significant role in the economy, and the consequences of bubbles can be widespread. A major economic sector bubble could be the cause of an economic recession. The ability to detect bubbles is important for policymakers and investors, and it is interesting for

investors to attempt to use their knowledge to achieve excess investment returns (Kubicova & Komarek, 2011).

Objective, Data, and Methodology

The objective of this study is to detect financial bubbles and to build a practical definition of a bubble. Data is collected for the internet bubble, which happened in the late 1990's, and stock price data is used to measure the bubbles which occurred during this time. For the first method, the intersection points of moving average are used to identify the beginning of the bubble, as well as the end of the bubble.

For the second method, the approach is based on the size of a bubble. The bubbles are categorized into three levels: small, medium, and large size bubbles. For the third method, the magnitude of the bubble asymmetry is computed. This is done by identifying the beginning and the ending of bubbles, as well as by using the highest point (top of the bubble), and testing for the statistical difference between the mean left asymmetry and the mean right asymmetry.

Background and Contribution

Measuring and detecting of financial bubbles is of interest to policymakers and investors, and may help in their decision making. A review of previous studies on how to measure and detect bubbles shows that there is no unique approach for identifying the existence of financial bubbles. Many studies have defined a bubble based on the linkage between asset price and fundamental value (Siegel, 2003). Also, faster identification of bubbles may have an impact on how investors make financial decisions (Gold, 2017).

This study attempts to detect and measure stock price bubbles and may provide a practical definition of a bubble. This insight may be valuable for investors and stakeholders who are

interested in detecting past asset overvaluation and bubbles. This information may help policymakers and investors with their decision making.

Structure of the Study

The structure of this thesis is organized as follows. The first chapter provides the background of famous examples of bubbles and crashes and a brief review of efficient market theory and behavioural finance theory. Next, it reviews different definitions of bubbles. It explains how a new paradigm can be a cause of a bubble, including how the internet bubble started, as well as previous literature regarding the main reasons for the internet bubble. In chapter two, the data and methodology used in this study are presented. This is followed by chapter three, results, and chapter four, a summary of the thesis.

1.2 Literature Review

1.2.1 Brief Overview of Some Famous Bubbles

In the history of bubbles, there are some famous asset price booms and busts. Below is a brief overview of some notable examples of bubbles observed throughout history.

- **Tulip Mania**

Tulip mania happened in Holland in the 1630's when tulip prices increased sharply, and this drove speculation. This bidding caused some tulips to change hands as many as ten times during a single day. But suddenly this market crashed, and prices rapidly dropped in some cases to one-hundredth of the value just days before (Day, 2008). According to Garber (1989), this sharp increase and fast decrease in prices provides a clear example of the instability and irrationality that may happen in an asset market (Garber, 1989). However, Garber (1989)

concludes that “the bulb speculation was not obvious madness, at least for most of the 1634-37 mania, only the last month of the speculation for common bulbs remains as a potential bubble.” Garber (1989) also indicates this historic event proves that there was a bubble, but that a rational bubble can emerge in asset markets (Garber, 1989).

- **The South Sea Bubble**

The South Sea Bubble happened when the South Sea Company (which planned to trade with South America) was involved in handling of government debt (Voth & Temin, 2004). By investing in the government debt conversion of 1719, this company made large profits on annual interest payments from the government (Voth & Temin, 2004). The South Sea Company increased liquidity and the bank of England converted all the remaining national debt to its shares. When one of the financial arms of the South Sea Company became insolvent, the price of the South Sea shares declined rapidly (Kindleberger & Aliber, 2003). The reason for South Sea bubble may be due to “synchronization risk and that noise trader interpretations were crucial for the overvaluation of stock price, and also this trading opportunity was based on greater fools” (Voth & Temin, 2004). However, Giusti et al. (2013) found that “swapping government debt for company equity was the single most important contributing factor to the South Sea bubble. In addition to this, the ability to defer payment of shares helped to increase the likelihood of a bubble forming and increased its size” (Giusti et al., 2013).

- **Commodity Bubble**

In addition to the above instance, a boom and bust commodity cycle occurred in 2006-2008. Based on a report of the World Bank (2010), this event was one of the largest of the post second world war, especially in 2008 when the crude oil price spiked up to 94 percent from a year earlier (Baffes & Haniotis, 2010).

Irwin et al. (2009) pointed that one of the leading causes of the commodity bubble and crude oil bubble in 2008 was speculation (Irwin et al., 2009). However, Östensson (2011) believed that speculation was not responsible for commodity price increase in 2008 (Östensson, 2011).

In addition, Gilbert (2010) argued that increasing institutional trading might have influenced speculation in the markets (Gilbert, 2010). The events of 1973-1974 and 2007-2009 behaved similarly with a sharp increase in commodity prices and a significant decline. Factors such as macroeconomic events and cross-commodity linkages may have contributed to commodity booms (Carter et al., 2011).

Enders and Holt (2011) also found that a shift in the oil price caused a change in other commodity prices (grains and other food items) in the period of 2007-2008 (Holt & Enders, 2011). In addition, Carter et al. (2011) believed that a boom and bust may have large macroeconomic effects in developing countries as these countries are often dependent on commodity trade (Carter et al., 2011).

Hamilton (2009) indicates that speculators play a significant role in commodity bubbles as they take away commodities from the market and wait to sell in the future at higher prices, causing a decline in supply and increase the prices (Hamilton, 2009). Fiscal expansion and lax monetary policy contributed to higher commodity prices from 2003 to 2007, and the depreciation of the U.S. dollar for non-U.S. dollar consumers caused a sharp rise in demand and more limited supply (Baffes & Haniotis, 2010). Also, high liquidity caused speculation in the commodity market (Baffes & Haniotis, 2010).

1.2.2 Efficient Market Theory (No Bubbles Exist)

The efficient market theory holds that markets are efficient and the value of expected price today is equal to the discounted value of the next period‘s anticipated value (Meltzer, 2002). This theory holds that information is available, and the market is at the fair value or the correct equilibrium price and there are no bubbles. There is no overpriced or underpriced assets (Fama, 1970). Fama (1970) points out that information comes into the market randomly and is incorporated instantly into today’s price (Fama, 1970). Moreover, Fama (1970) believes that people are rational and make logical decisions (Fama, 1970). It is too hard to make money in the market if it is efficient and if investors want to have a higher return, they have to purchase riskier stocks due to a lack of accurate forecasts in the market (Scheinkman, 2014). Proponents of this theory believe that, if the stock price was undervalued, eventually someone would have suddenly bought stocks and pushed up the stock price to its equilibrium value, and so there is no bargain in this market (Fama, 1970). The efficient market theory would advise the investor to “buy and hold” a stock market index, rather than trying to be an active investor, since most investors cannot beat the market (Fama, 1970).

1.2.3 Behavioural Finance Theory (Bubbles Exist)

Behavioural finance theory, in contrast to Fama, is based on cognitive psychology on how people react and holds that people can be irrational, illogical, and overreact emotionally (Shiller, 2000). This theory attempts to apply some psychology principals and the human condition (e.g. greed, fear, overreaction, and others) to explain financial market behavior (Shiller, 2000).

According to the publication of two papers in 1981 by LeRoy and Shiller, the volatility in stock prices are not justified by the new information in the market about future dividends or the present value of future earnings (Hatipoglu & Uyar, 2011). There is still a debate among financial economists on the existence of bubbles in the market. For example, Garber (1989) believes that change in market conditions and rational behaviour of market participants is responsible for fluctuations in market prices (Garber, 1989). In contrast, Shiller (2000) argued that irrational exuberance (excessive optimism) caused the high stock prices in 1990 (Shiller, 2000), and emotions may play a significant role in financial decision making (Shiller & Akerlof, 2009).

1.2.4 Some Main Causes of a Bubble

- **Noise and Noise Traders as Cause of a Bubble**

Noise is defined as information that has not arrived in the market, yet according to Black (1986), the concept of noise trading forces prices to deviate from their true value. If there is more noise, markets will be more liquid and allow traders to observe prices precisely (Black, 1986). The attitudes of noise traders are correlated, and their opinions cannot always be justified by any economic fundamentals. To put it simply, noise traders follow trends and overreact to both bad news and good news (Kortian, 1995). As volatility changes over time, the rate at which information arrives influences the volatility and stock price. Simply put, almost anything that affects a characteristic of noise traders could change the volatility of a stock price (Black, 1986). In other words, if there is no noise, there would be little trading in individual assets in the market. According to Delong et al. (1990), the presence of noise traders was ignored and these arguments were made by Friedman and Fama. Irrational investors finally meet in the market

through a rational arbitrager and the price can be close to its fundamental value (Delong et al., 1990).

- **Positive Feedback as Cause of a Bubble**

Research indicates that when the cycle of positive feedback occurs for too long, it may create a bubble. In this cycle, investors buy securities when prices increase and sell when prices decrease (Sornette & Kaizoji, 2008). Tokic (2010) indicates that due to receiving good news in the market, noise traders assume prices will rise from initial prices, and they buy more today. This cycle continues, and tomorrow investors buy more in response to the reaction of today's increasing price (Tokic, 2010).

- **Macroeconomics as Cause of a Bubble**

Economists have done many studies to demonstrate the possible linkage between macroeconomic factors and bubbles. For example, macroeconomic determinants may have had a significant influence on the 1973-1974 and 2003-2008 commodity bubbles (Frankel, 1986; Akram, 2009; Hamilton, 2009; Gilbert, 2010). Macroeconomic factors may include: economic growth, money supply, interest rate, exchange rate, and inflation (Li et al., 2017).

  - **Money Supply**

One important factor which may influence stock prices is the amount of money in the economy (Frankel, 1986). When the money supply increases, at least some of the money is invested in stocks or commodities (Širůček, 2013). For instance, in the early 1970's, the U.S. Federal Reserve increased the money supply, which caused the price of

energy to increase rapidly (Rausser, 1985). Sierbert (1999) illustrates the financial bubble in Japan in 1990, caused by increasing the money supply (Siebert, 1999).

- **Interest Rate**

Decreasing the interest rate may increase the price of assets and vice versa (Frankel, 2006). For example, the correlation between interest rate and commodity price booms in 1970 and 1980 was negative (Pindyck & Rotemberg, 1998). Zhang et al. (2011) also emphasize that low-interest rates for many years and excessive liquidity were the main factors causing the real estate bubble occurrence (Zhang et al., 2011). Commodity production is capital intensive, and any change in the interest rate has a direct effect on the cost of production and supply, and both storable and non-storable commodities are shown to be sensitive to interest rate changes (Carter et al. 2011).

- **Exchange Rate**

Ferreira and Eduardo (2014) believe that exchange rates may diverge from equilibrium level, or form a bubble. Also, trade restrictions and the exchange rate may have a substantial influence on the commodity sector and may have played a significant role in the commodity boom of 1973-1974 (Schuh, 1974), and decreasing the exchange rate may cause commodity prices to increase (Akram, 2009).

- **Inflation**

With increasing inflation, investors may buy more assets to protect their capital against inflation, and this may cause higher prices and bubbles (Girdzijauskas et al.,

2009). Pindyck and Rotemberg (1998) found that commodity prices tend to move together and this co-movement can explain high inflation (Pindyck & Rotemberg, 1998). Also, the supply shock on the food and energy sector from the events of 1973-1974 and 1979-1980 may be due to the high amount of U.S. inflation (Blinder & Rudd, 2008).

- **Ease of Credit as Cause of a Bubble**

Ease of credit tends to encourage economic growth and may cause bubbles such as the 2006-2007 the real estate bubble (Li et al. 2017). Ease of credit may include low-interest rates, increasing money supply, rising inflation, decreasing exchange rates, and easier terms for borrowing, including on margin loans for stock purchases (Li et al., 2017).

  - **Buying Stock on Margin**

Margin loans may have allowed stock prices to increase significantly in past. For example, in the late 1920's, the great crash happened when buying on margin became popular, and up to 90% of the borrowed money may have been used for stock purchases (Bartholomew, 2015). The demand for stock increased and stock prices increased very quickly. Eventually, some investors decided to sell their stocks and prices dropped sharply (Bartholomew, 2015).

- **Lack of Short Selling Position as Cause of a Bubble**
    - **The Difficulty of Taking a Short Position in the Stocks**

A short position is an investment strategy where investors attempt to borrow shares and then sell them at a higher price, and then buy them back at a lower price, making a profit (Haruvy & Noussair, 2006). The idea behind the short selling strategy is that investors expect to see a decrease in the price of the stock over time (Haruvy & Noussair, 2006).

The main difficulty of short selling is the risk of a sharp increase in price, and that investors could lose heavily. While the short selling investor has the potential to gain the entire value of a stock, the investor also can lose an unlimited amount of money if the stocks were to rise in value. Therefore, short selling is a risky strategy for investors and so they may not do it, especially in times of bubbles (Haruvy & Noussair, 2006).

Short selling could potentially help prevent increasing prices and bubbles, but because it is high risk to go short, investors are not always willing to take the risk of unlimited losses. Another difficulty that investors face with short selling is a "short squeeze". This occurs when other investors buy up the shares and drive up the price and short investors are faced with high margin calls and losses which then force them to liquidate stock to cover their short position. If this happens, the price of the stock could be pushed even higher. As well, sometimes owners of shares are less willing to loan their shares to short sellers, and so short selling is difficult or not possible. In addition, there can be a borrowing cost for the shares, which can be higher. If there is higher share borrowing demand, and this could discourage short selling (Haruvy & Noussair, 2006).

- **Use of Put Options to Go Short**

By buying put options, investors can make money if the stock price decreases (Schwab, 2016). Compared to a short selling strategy, put options are less risky as investors know their maximum losses in advance (losses limited to the value of the option premium) (Schwab, 2016). According to Battalio and Schuliz (2005), the main issue with put options is the option premium. If the volatility of stock price is high, the premium could be expensive, and investors may not have an interest in buying put options. In addition, if investors want to carry their position over time, the value of the premium could be too expensive due to the high volatility of stock prices (Battalio & Schuliz, 2005).

1.2.5 The Different Definitions of Bubble

- **Financial Bubble Definition**

A bubble happens when the market has a large increasing price followed by a sudden decreasing price (Carter et al., 2011). In many past studies, the term bubble is used to explain a period when price change is based on investors changing perception of supply and demand factors (Carter et al., 2011).

- **Merriam-Webster Dictionary Definition of a Bubble**

A bubble is defined as "a state of booming economic activity (as in a stock market) that often ends in a sudden collapse" (Merriam-Webster, 2017).

- **Stiglitz Definition of a Bubble**

A bubble occurs "if the reason that the price is high today is because investors

believe that the selling price will be high tomorrow—when "fundamental" factors do not seem to justify such a price—then a bubble exists" (Stiglitz, 1990).

- **Patel Definition of a Bubble**

A bubble is defined as when a stock market crash is "below a certain threshold such as two standard-deviations" during a specific period (Ma et al., 2017; Patel et al., 2015; Baris, 2015).

- **Mishkin Definition of a Bubble**

A bubble is defined as the situation in which the market price drops over 20 percent. Moreover, the speed of the crash is another factor considered in this definition (Mishkin & White, 2002)

- **Markwat Definition of a Bubble**

A market crash may become a contagion (domino effect) in global stock markets, and Markwat et al. (2008) also defined a bubble as when "the market falls below the fifth percentile of return distribution" (Markwat et al., 2008).

- **Siegel Definition of a Bubble**

Siegel (2003) explains the "definition of a bubble as any time the realised asset return over a given future period is more than two standard deviations from its expected return" (Siegel, 2003).

- **Scherbina Definition of a Bubble**

"A bubble is a deviation of the market price from the asset's fundamental value" (Scherbina, 2013).

- **Blanchard and Watson Definition of a Bubble**

A bubble is defined as when there is asymmetric volatility due to the increasing price that produces large negative returns (Blanchard, 1982).

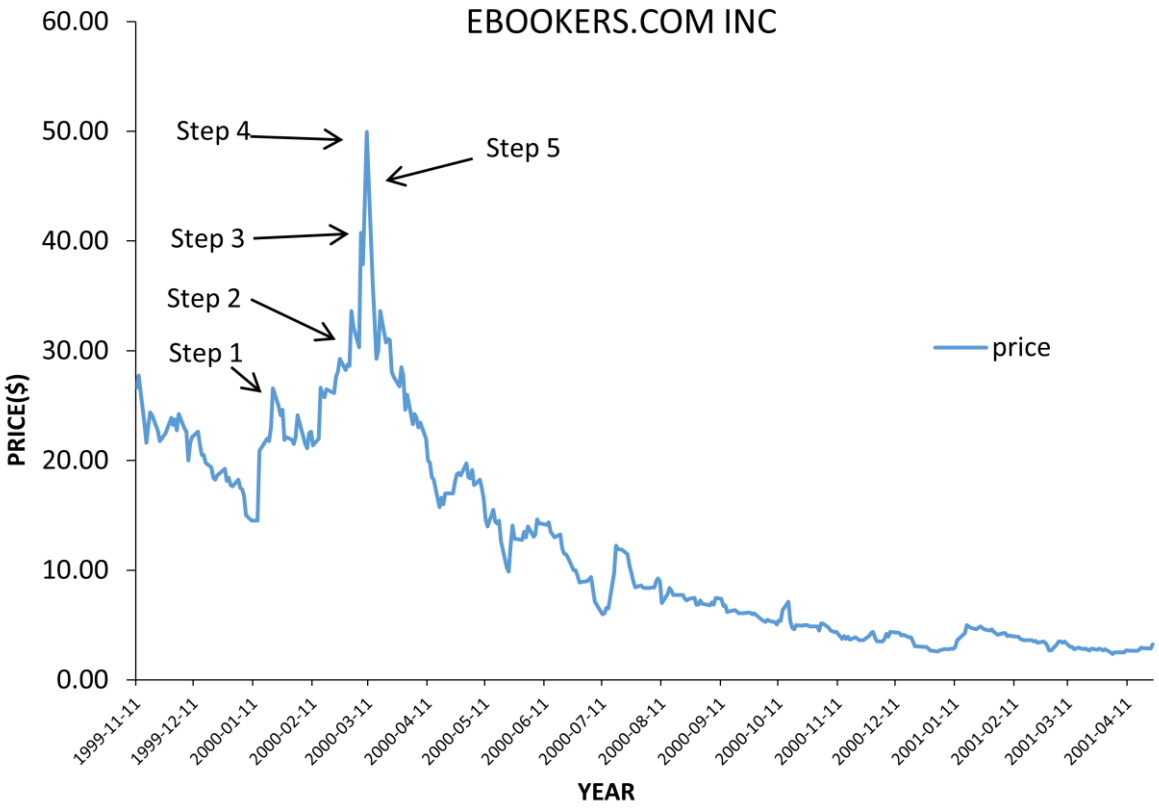
- **Goetzmann Definition of a Bubble**

Goetzmann defined a bubble as increasing 100% (doubling market value) or more in value which is followed by a 50% fall (Chambers & Dimson, 2016; Goetzmann, 2015).

1.2.6 Five Stages of a Bubble

In a typical cycle of a bubble, there are five stages of characterization of bubbles which are explained by Minsky and Kindleberger (Williams, 2017). The first step is called displacement which occurs when investors get interested in a new paradigm. This paradigm can be an innovation such as internet technology. In the case of the internet bubble, it can be seen that the internet revolution became popular and investors were over-optimistic about stock prospects (Roche, 2013). The second step is called the boom and is the stage in which the stock price begins to increase slowly. In this time frame, stock information is available through the media to attract mass market investors (Williams, 2017). For the next step, euphoria, the price skyrockets and almost reaches the highest level, with greater fool theory playing out in this stage. Positive feedback also plays a significant role (Williams, 2017). In the fourth step, which is labelled as profit taking, smart investors gain large profits while prices are at the highest level. These investors decide to exit their position in the market by selling the stocks. When this happens, it may be a sign that the prices could not go much higher (Roche, 2013). The last step is known as a bust and occurs when investors panic, as prices reverse course and fall faster than they increased (Williams, 2017).

Figure 1.1 Five Stages of a Bubble Activity



This Figure Explains 5 Steps of a Bubble Activity According to the Minsky – Kindleberger Model.
Step 1 Displacement, Step 2 Boom, Step 3 Euphoria, Step 4 Profit Taking, Step 5 Bust (Williams, 2017).

1.2.7 A New Paradigm as a Cause of a Bubble

When investors are attracted to a new paradigm such as an innovation, it may cause speculation. Railway Mania is an example of a speculative frenzy that became a new paradigm when railroads began (Odlyzko, 2011). Many railway companies were established during this time, but many companies failed or were bought by other companies largely due to poor financial planning. In cases where the companies were bought out, the larger companies later realized that building a railway was not easy as initially thought. The ultimate result was a rapid drop in the railroad stocks (Odlyzko, 2011). In other words, Railway Mania was a result of overvaluing the possibility of success. This phenomenon also happened in Canal Bubble in 1790 and Internet Bubble in the late 1990's (Odlyzko, 2011).

1.2.8 How the Internet Bubble Began

Economic history repeatedly demonstrates situations in which investors were drawn in by a new paradigm: Tulipmania, railroad bubble, canal bubble, and recently the internet bubble. Internet activity increased heavily from 1990 to 1997 with investment in internet companies, and the NASDAQ Composite Index quickly increased (Morris & Alam, 2012). With the Netscape Communications Inc. initial public offering (IPO) in March 1995, its stock value jumped on the first day of trading (Delong, 2006). The number of people who were using the internet significantly increased during the internet bubble.

People began to view the internet in a new way, and its utility changed from a luxury to a necessity (Morris & Alam, 2012). According to Morris and Alam, due to the remarkable increase in internet usage, financiers were eager to invent internet technology firms. Emotion had a

significant impact on an investor's behaviour, and many investors had not assessed the situation and future return. In other words, the fundamental metrics used to justify stock price were too optimistic (Boulton, 2014).

Many internet companies became widely known, and shareholder confidence was excessively bullish. Many stakeholders came to feel that these companies could easily handle some losses, but that they would profit in the future (Boulton, 2014). Initial losses for many investors were intended to be a sacrifice at the beginning of this trend, however, this ended in large losses (Parker, 2016).

The valuation of internet companies rose exponentially in a short period. For example, the valuation of the NASDAQ increased from around 1000 in 1995 to over 5000 in 1998 (Voth & Temin, 2004). Much of the internet bubble occurred (approximately) from 1997 to 2001 when the internet underwent extreme growth among investors and customers (Voth & Temin, 2004). At this moment, many web-based companies were founded, and after five-year growth in the market, many start-up internet companies failed to keep their business models profitable (Hale & Galbraith, 2003).

1.2.9 Main Causes of the Internet Bubble

There are variety of reasons why many of these internet companies failed with many failing around early 2000 (Voth & Temin, 2004). Some reasons include speculative or fad-based investing, the excess of venture capital funding, feedback loops, and investors' irrational behaviour such as overconfidence (Goodnight & Green, 2010). Below are some main causes of the internet bubble.

- **Interest rates**

Low-interest rates between 1998-1999 made venture capital funding widely available which sharply increased share prices and prompted investors to wrongly ignore traditional measures of company performance which may have promoted irresponsible risk taking (Boulton, 2014). According to Boulton, during this time, traditional accounting and financial measures lost their value relevance for a number of investors.

- **Accounting Information**

Lax accounting rules and misleading financial reporting made many internet companies popular in the public, even though they had small revenue, no profits, and no sustainable business model (Boulton, 2014). Eventually, most of these companies collapsed as they were not profitable.

- **Media**

During the internet bubble, the financial media played a role in attracting investors and in making investors overconfident in the growth of specific companies. Shiller emphasized that the financial media intensively promoted internet stocks and believes this hype was a primary factor that fuelled internet bubbles (Bhattacharya & Galpin, 2007).

1.2.10 Review of Past Studies on the Internet Bubbles

According to Pastor and Veronesi, by the late 1990's, the unusual rise of internet stocks, especially on the NASDAQ Exchange, led many financial economists to describe this event as a bubble. The uncertainty about the future profitability of a firm was the main determinant in the

overvaluation of fundamental value (Pastor & Veronesi, 2005). They used the Gordon Growth Model to show that the uncertainty about the growth rates of technology in the late 1990's led to the high level and volatility of technology stock prices (Pastor & Veronesi, 2005).

Ofek and Richardson (2002) argue that because of the limitation on the short sale, the valuation on the prices was high in the late 1990's. Jarrow et al. (2011) used the stochastic volatility equation model to detect bubbles based on data from the internet bubble 1998-2001. This model was able to identify the presence of bubbles in many of internet stocks (Jarrow et al., 2011).

In addition, economists have done some studies to understand and identify the potential of bubbles in the technology industry. As a result, these studies compared the fundamentals parameters from the past with current data to forecast the possibility of technology bubbles in the near future.

Kopsell and Lienkamp (2015) studied the potential of overvaluation of the technology industry by investigating the technology bubble. Common valuation indicators such as price to earnings ratio, price to book ratio, dividend yield, average annual returns, and standard deviation were used to estimate future performance and companies' fundamentals (Kopsell & Lienkamp, 2015). The results show that ratios such as P/E and P/B were overvalued for technology companies during the internet bubble (Kopsell & Lienkamp, 2015).

CHAPTER 2

DATA AND METHODOLOGY

2.1 Data

This study focuses on the common stock price of 40 companies that were affected by the internet technology bubble that occurred in the late 1990's. Some of these companies went bankrupt as a result of the bubble, while others such as Amazon survived. The data for this analysis was collected from the Center for Research in Security Prices (CRSP) as well as from the Yahoo Finance website. The time span of the data varies from company to company, largely as a result of some companies failing or going bankrupt which limited the data availability. In some other cases, it was also difficult to obtain an access to the data. Due to the data limitations, it is not possible to choose the same time horizon for all of the companies. The longest range of available data is from 1980 to 2016. However, the focus of this research placed a time frame ranging from 1990 to 2005 which seems like the best choice and which captures a large percentage of the internet bubble companies. The data consists of U.S. daily closing stock prices for each company, and Table 2.1 contains the names of companies that are used in this research.

Table 2.1 List of Internet Companies Used for this Analysis, 1990-2005.

Company Name

Amazon *May 5,1997- December 30, 2005*
Argonaut Group Inc. *January 10,1990 - December 30, 2005*
Bamboo Com Inc. *August 26, 1999 - December 30, 2005*
Books A Million Inc. *November 3, 1992 - December 30, 2005*
Broadcast International Inc. *January 2, 1991 - December 30, 2005*
Cdnow *April 26, 1998 - July 10, 2000*
Celera Inc. *January 1, 1990 - July 29, 2002*
Cisco Systems *February 16, 1990 - December 30, 2005*
Digital Insight *August 10, 1996 - December 30, 2005*
Digital Solutions Inc. *January 3, 1994 - December 30, 2005*
Double Click *June 3, 1995 - December 30, 2005*
eBay.Com *September 24, 1998 - December 30, 2005*
Ebookers.Com *November 11, 1999 - February 25, 2005*
eGain *February 8, 1997 - December 30, 2005*
eToys.Com *June 25, 1999 - February 2, 2001*
Flooz.Com *February 1, 1999 - June 10, 2001*
Geocities *August 8, 1998 - July 25, 1999*
Govworks *January 10, 1998 - May 3, 2000*
Infoseek *June10, 1994 - April 1, 1998*
Info Space *December 15, 1998 - December 30, 2005*
Info.Com May *10, 1996 - August 4, 1999*
Inktomi *June 10, 1998 - March 19, 2003*
Internet America Inc. *December 10, 1998 - August 14, 2001*
Liquid Audio *February 10, 1996 - December 30, 2005*
Looksmart *January 3, 1995 - December 30, 2005*
Lycos Inc. *April 2, 1996 - October 27, 2000*
Micro Strategy *June 11, 1998 - December 30, 2005*
Nasdaq *March 3,1995 - December 30, 2005*
Netspace.Com *August 25, 1992 - December 30, 2005*
Nortel Networks Corporation *January 1, 1990 - December 30, 2005*
Network.com *May 20, 1995 - August 13, 1998*
Pets.Com *February 10, 1998 - November 1, 2000*
Psfweb *May 25, 1994 - April 20, 2003*
Startek Inc. *June 19, 1997 - December 30, 2005*
Startup.Com *July 10, 1999 - February 25, 2000*
System.Com *June 8, 1996 - December 15, 1999*
The Globe.Com *November 13, 1998 - April 20, 2001*
The Learning Company *January 2, 1991 - June 13, 1999*
Thinking Tools Inc. *October 25, 1996 - October 10, 1998*
Yahoo *April 12, 1996 - December 30, 2005*

Note: For some companies, data may begin after 1990 and end before 2005.

2.2 Methodology

2.2.1 Past Bubble Models

The majority of the definitions for a bubble are based on the linkage between asset price and fundamentals such as cash flow and discount rate. Siegel (2003) used the linkage between fundamental value and asset price to measure bubbles, and used 20 to 30 years of data. Siegel excluded the internet bubble in analysis because using a future long time period would require waiting until 2030 to see future earnings and fundamental values of internet companies. In this type of definition of a bubble, there is no agreement on using a unique time frame or parameters, and it requires considerable future data to compute the present value of future earnings (Siegel, 2003).

2.2.2 Overview of the Bubble Model Used in this Study

Rather than using fundamental data as above, this study uses only past stock prices to detect and measure bubbles. Moving averages of past stock prices are used to detect and measure bubbles, since this requires only past prices, and so a bubble in an asset market can be more easily measured.

This model is organized in three main steps. For the first approach, the model defines a bubble, which is when the stock price from a specified point increases by more than 100%, and then decreases by at least 50%. To measure bubbles, moving averages are used to identify the beginning and the end of the bubble, and 40 companies are studied.

For the second approach, the size of the bubble is measured and categorized into three levels: small, medium, and large bubble size. The size of the bubble is obtained by measuring the bubble, based on percentage increase and percentage decrease in price.

For the third approach, the magnitude of the bubble asymmetry is computed, which is the amount of left asymmetry divided by the amount of right asymmetry. In order to calculate left and right asymmetry there is a need to calculate price increases and price decreases, and the length of time (number of days) for the price increases and the price decreases.

2.2.3 Defining and Measuring a Bubble

Step 1: A bubble is defined if the current price from the beginning of the bubble (step 2.a) has more than 100% increase and then decrease by at least 50%.

Step 2: Measure the bubble by using the moving average cross rule to identify the beginning of the bubble [e.g. if the short moving average is up (MAUP)] and the end of the bubble [e.g. if the short moving average is down (MADOWN)].

a) Short Moving Average Up (MAUP): when a short-term moving average (e.g. 10 day moving average) crosses *above* a long-term moving average (e.g. 40 day moving average). This point is considered the beginning of the bubble (Figure 2.2).
b) Short Moving Average Down (MADOWN): when a short-term moving average (e.g. 10 day moving average) crosses *below* a long-term moving average (e.g. 40 day moving average). This implies the end of the bubble (Figure 2.2).

i. Use 10 and 40 day moving average, if the total duration of the bubble from the beginning of the bubble to the end of the bubble is less than 150 days (for example, 10 days is short-term moving average and 40 days is long-term moving average).

ii. Use 20 and 80 day moving average, in some exceptional cases, if unable to find proper points (ending points) by 10 and 40 day moving average in the duration of less than 150 days.

iii. Use 30 and 120 day moving average, if the total duration of a bubble is between 150 days to one year,

iv. Use 50 and 200 days moving average, if the total duration of a bubble is more than one year.

Note: In some rare cases the moving averages do not cross over but instead pass near each other with very minimal distance. If the gap is equal to or less than 2% of short-term moving average, then this is considered an acceptable crossover point.

Step 3: Identify the highest point (top of the bubble).

This is the highest point that the stock price reaches during a bubble (Figure 2.2).

Step 4: Percentage *increase* in stock price (from the beginning of the bubble to top of the bubble)

Calculate the percent change from the beginning of the bubble to top of the bubble (highest point).

- This percent change must be 100% or above to continue (if less than 100% the bubble does not exist).

Step 5: Percentage *decrease* in stock price (from the top of the bubble to the ending point of the bubble).

Calculate the percent change from the top of the bubble (highest point) to the ending point of the bubble.

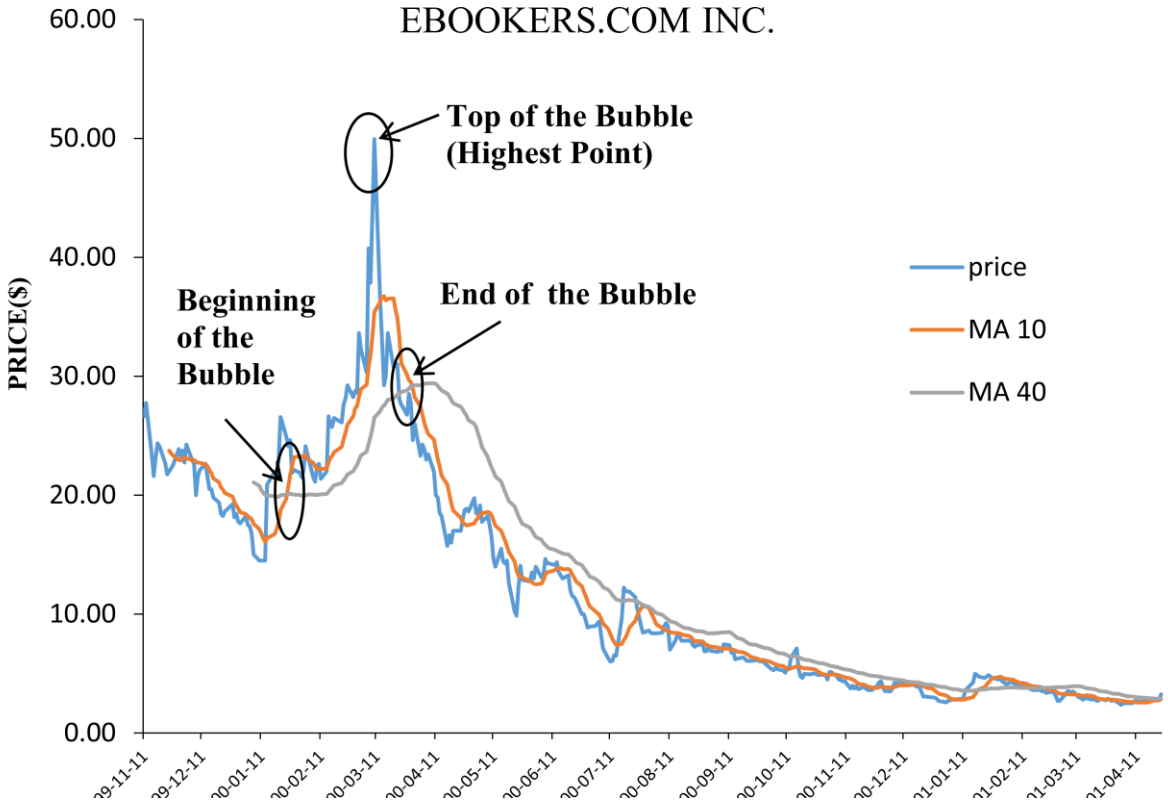
- This percent change must be at least 50% or more to considered as a bubble (if less than 50% the bubble does not exist).

2.2.4 Categorizing Bubble Size

Step 6: Recall that the bubble definition is based on the current stock price, if the price from the beginning point (step 2.a) faces more than a 100% and then decreases at least by 50% then this is defined as a bubble. The bubble can be categorised into three different sizes, based on the below condition:

- If the result of the percentage price change (upside) is between 100% - 199% and percentage price change (downside) is at least 50%, then it is defined as a *Small* Bubble Size.
- If the result of the percentage price change (upside) is between 200% - 299% and percentage price change (downside) is at least 50%, then it is defined as a *Medium* Bubble Size.
- If the result of the percentage price change (upside) is 300% and more, and the percentage price change (downside) is at least 50%, then it is defined as a *Large* Bubble Size.

Figure 2.1 Measuring Bubbles by Using Moving Averages to Identify the Beginning and the End of a Bubble.



Note: Using crossover moving averages to identify the beginning and the end of the bubble.

Source: CRSP

2.2.5 Calculating Bubble Asymmetry

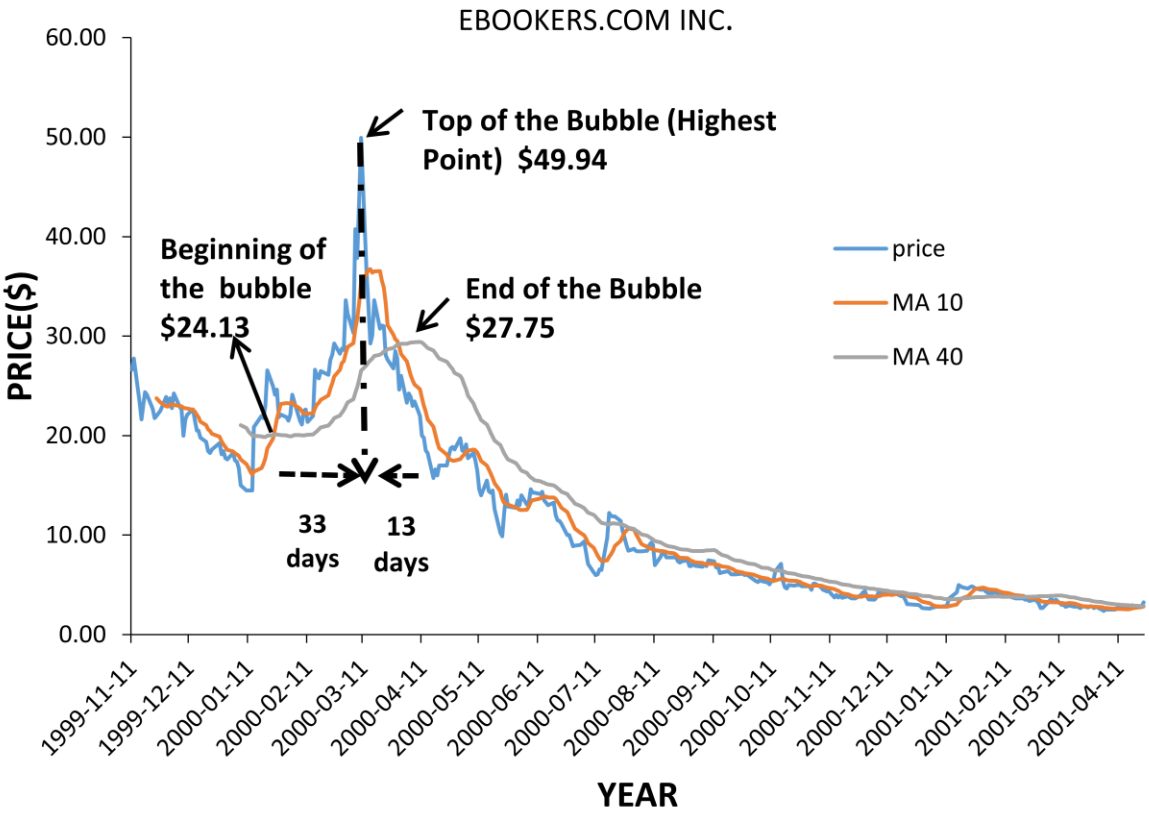
Step 7: Calculate *left* asymmetry, which is top of the bubble minus the beginning of the bubble divided by the length of time (number of days).

- Length of time: number of days between the beginning of the bubble and top of the bubble.
- The left asymmetry explains the steepness of the *left* side of the bubble.

Step 8: Calculate *right* asymmetry, which is top of the bubble (highest point) minus end of the bubble divided by the length of time (number of days).

Step 9: Calculate magnitude of the bubble asymmetry, by dividing left asymmetry by right asymmetry.

Figure 2.2 Calculating Bubble Asymmetry



Note: The magnitude of the bubble asymmetry is calculated by dividing the amount of left asymmetry (top of the bubble minus beginning of the bubble divided by number of days) over the amount of right asymmetry (top of the bubble minus end of the bubble divided by number of days).

CHAPTER 3

RESULTS

3.1 Identifying and Measuring Bubbles - Results

The first main result involves detecting bubbles. In this study, a bubble is considered to exist if the current stock price from the moving average starting point (beginning of bubble) increases more than 100% and then decreases by at least 50%. The first main result shows that out of the 40 companies, about 75% had bubbles based on the above definition. This means that price increased by at least 100% and decreased by at least 50%. Data used is shown in Table 2.1.

3.1.1 Using Various Moving Averages to Define Bubbles - Results

In order to measure bubbles, it is critical to identify the beginning of the bubble and the end of the bubble, which is accomplished by using the crossing point of moving averages. Four time frames of moving averages are used: 10 and 40 days, 20 and 80 days, 30 and 120 days, and 40 and 200 days.

- In the analysis of 10 and 40 day moving averages, 63% of the companies (which is about 19 of the companies) are detected in this timeframe, and it indicates that beginning to the end of the bubble is less than 150 days. Also, in analysis for 10 and 40 day moving averages, companies are mostly categorized as small size bubbles.
- 20 and 80 day moving averages are used in some exceptional cases and only if the 10 and 40 day moving average can not find proper points (ending points) in less than 150 days. Observation shows that only a few cases are detected in this timeframe by using

20 and 80 day moving averages and the majority of these bubbles are categorized as small and medium size bubbles.

- 30 and 120 day moving averages are also used in this study, in the cases where the total duration of the bubble was between 150 days to one year. The result indicates that about five companies used this moving average to identify the beginning and the end of the bubble, and the companies are categorized in small and large size bubble.
- 50 and 200 day moving averages in this study are used, only in one case which had a total duration of more than one year from the beginning of the bubble to the end of the bubble, and the company is categorized as a large bubble size.

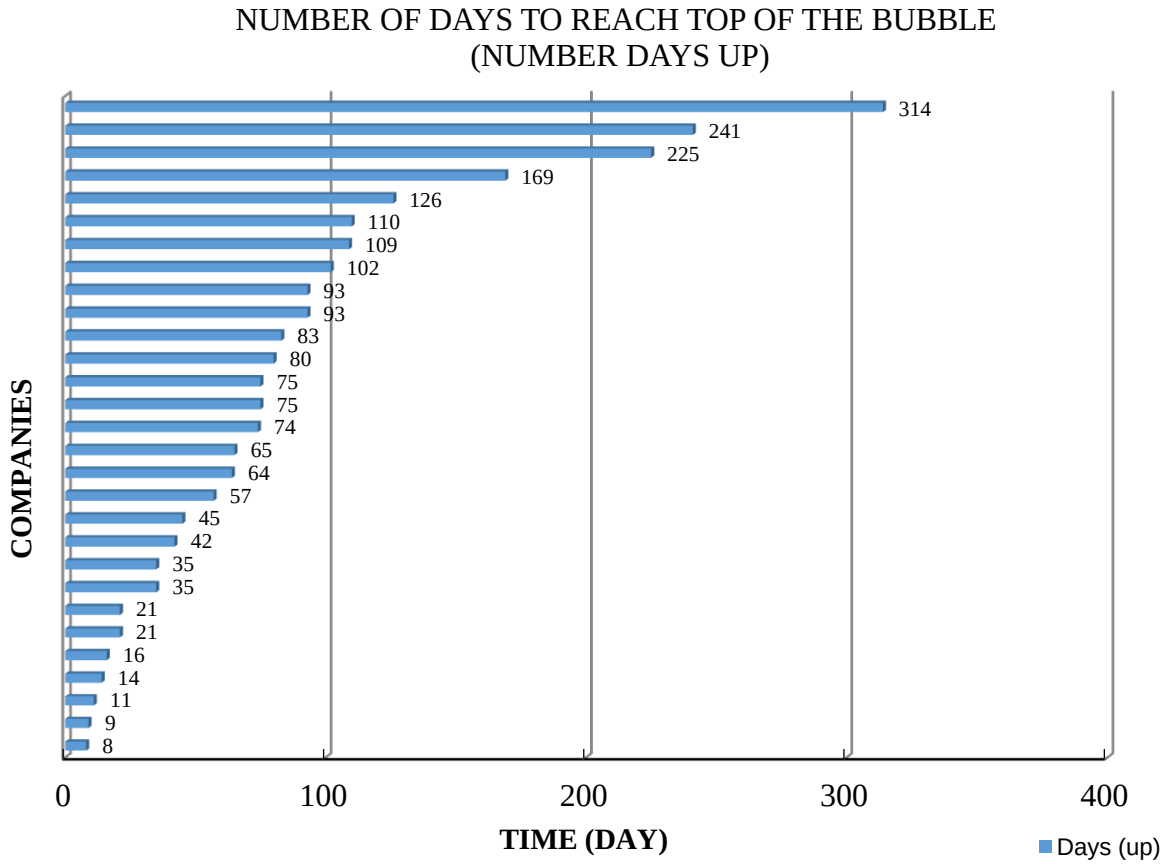
3.1.2 Number of Days to Reach Top of the Bubble and End of the Bubble - Results

To classify the time of a price rise from the beginning of the bubble to the top of the bubble, there are four periods: 1 to 100 days, 101 to 200 days, 201 to 300 days, and 300 to 400 days. It can be observed that 22 of these detected bubbles, which are the majority of the companies, had a price rise from the beginning of the bubble to top of the bubble between 1 to 100 days. Only four bubbles showed price increases from the beginning of the bubble to top of the bubble between intervals of 101 to 200 days. As for the increasing prices, there are only three bubbles that displayed this trait from the beginning of the bubble to top of the bubble in the interval 201 to 300 days, and there is only one bubble in the interval 300 to 400 days (Figure 3.1).

In addition, to classify price decreases from top of the bubble to the end of the bubble there are two periods: 1 to 100 days, and 101 to 200 days. These intervals show that 29 companies are categorized in the interval of 1 to 100 which means that, in 29 cases prices

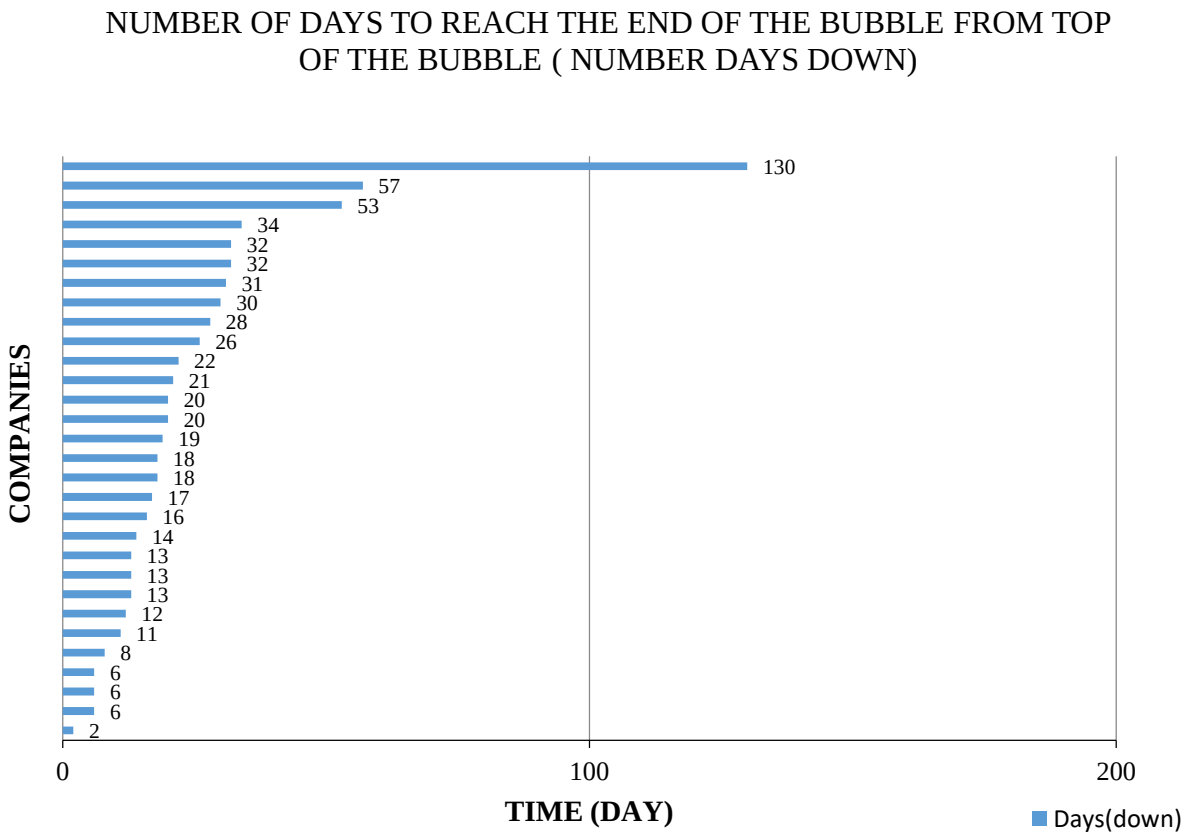
decrease in less than 100 days and only one case prices decrease from top of the bubble to the end of the bubble between 101 to 200 days (Figure 3.2).

Figure 3.1 Number of Days to Reach the Top of the Bubble from the Beginning of the Bubble.



Note: Number of days it takes to reach top of the bubble from the begining of the bubble.

Figure 3.2 Number of days to Reach the End of the Bubble From the Top of the Bubble.



Note: Number of days it takes to reach the end of the bubble from top of the bubble.

In this study, the shortest period that a bubble occurred, is in the case of Internet America Inc. This bubble took only 11 days from $10.13 to $21, which is a price increase of about 107%. Meanwhile, the price took about 2 days to drop from $21 to 11.13 which is about an 89% decrease. Digital Solution has the longest period of a bubble which took about 314 days to move from $1.20 to $10.35 and then crashed in 53 days to $5.69.

3.2 Categorizing Bubble Size (Small, Medium, Large) - Results

The second main result of the study categorizes bubbles into three levels, and the results show that about 63% of detected bubbles in this study are categorized as small size bubbles. This means that the price increase is between 100% and 199%, and the price decrease is at least a 50% drop. About 13% of total bubbles detected are categorized as medium-sized bubbles, which means that the percentage of the price increase is between 200% to 299%. Only 24% of the bubbles detected are categorized as large size bubbles, which are defined as percentage price increase of 300% or more (Figure 3.3). For instance, for Books A Million Inc., this is categorized as a large size bubble in Figure 3.4.

Figure 3.3 Categorizing Bubble Size

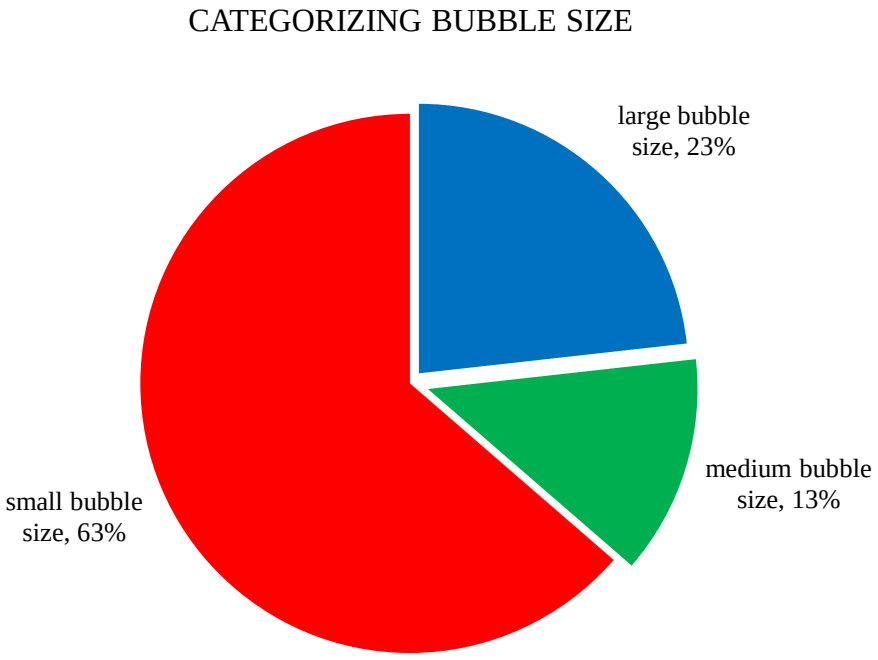
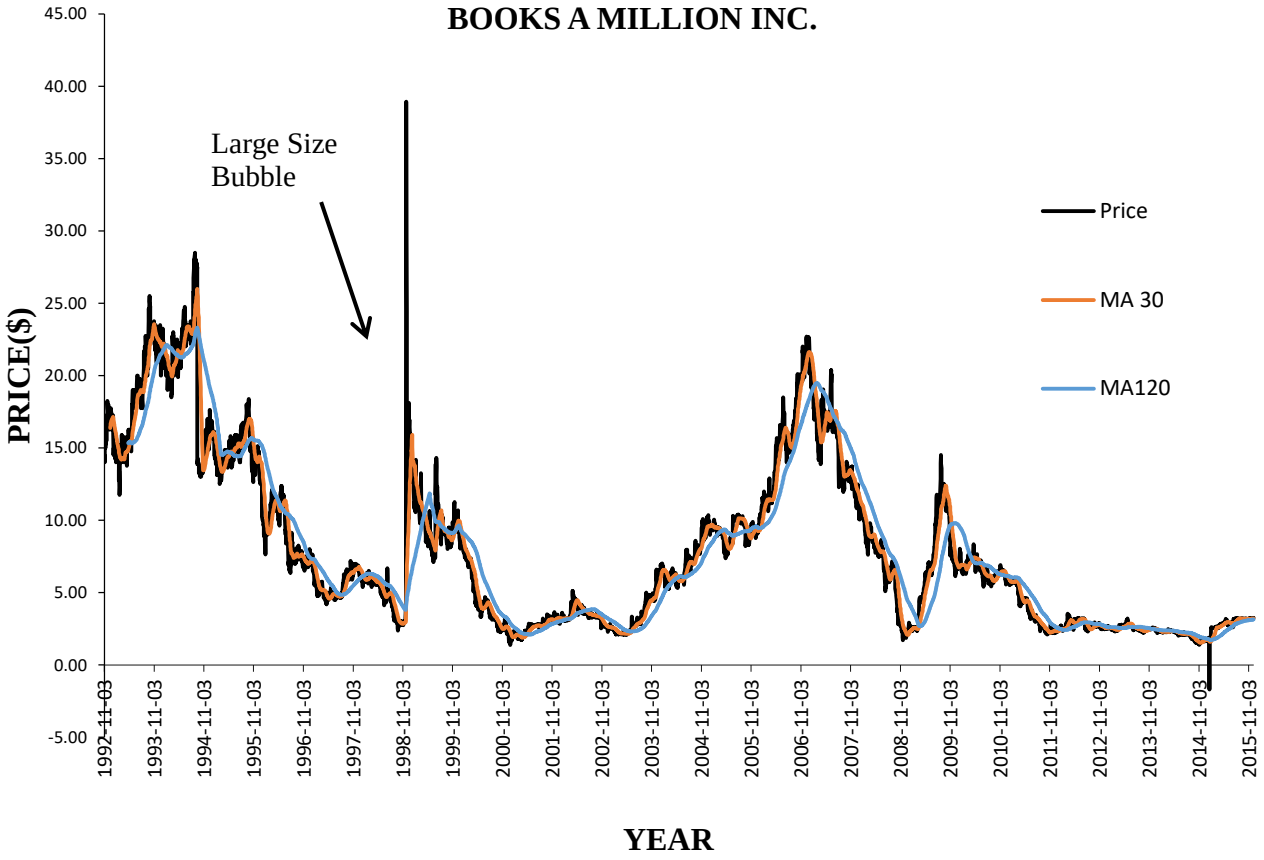


Figure 3.4 An Example of a Large Size Bubble



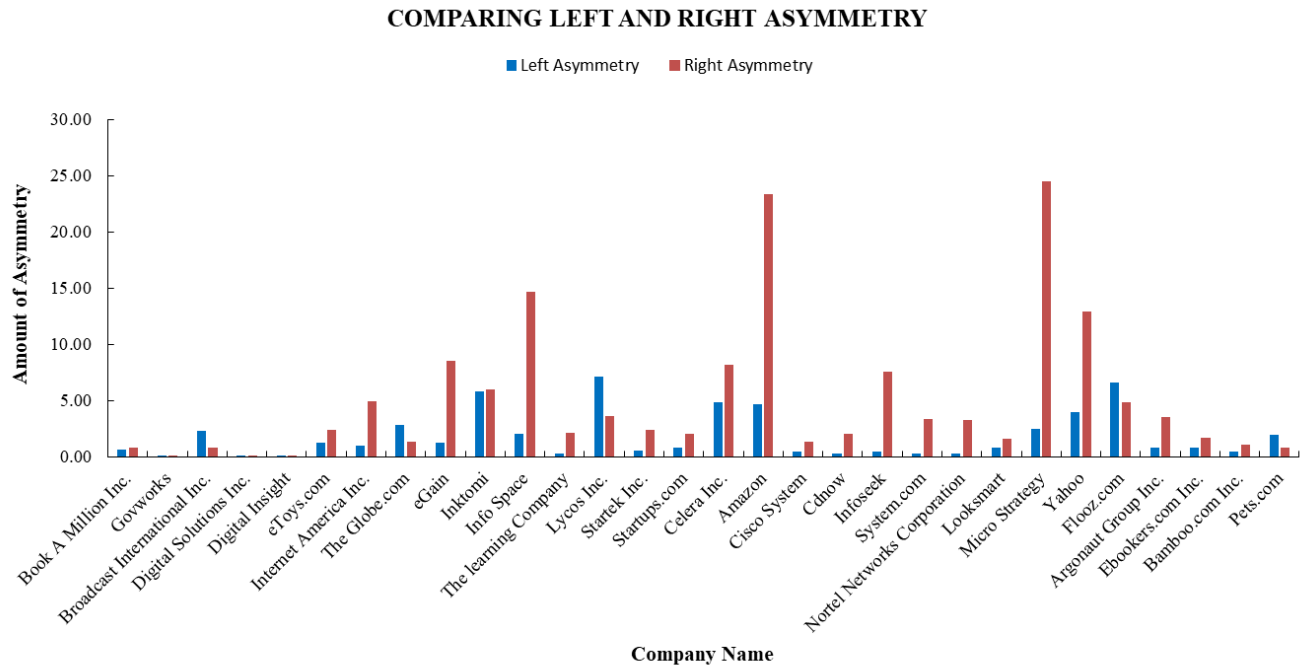
Note: Books A Million Inc. is categorized as a large size bubble.

3.3 Magnitude of Bubble Asymmetry - Results

3.3.1 Comparison of Left Asymmetry and Right Asymmetry - Results

The third main result of the study involves comparing left asymmetry and right asymmetry. In reviewing left and right asymmetry results, the left asymmetry is far smaller than right asymmetry (Figure 3.5). The average amount of left asymmetry and right asymmetry are about 1.83 and 5.28, respectively. The maximum and minimum amounts of left asymmetry are 7.10 and 0.03, and the maximum and minimum amount of right asymmetry are about 24.93 and 0.07. Table 3.1 shows bubble asymmetry results.

Figure 3.5 Comparing Left Asymmetry and Right Asymmetry



The degree of left and right asymmetry relies on two parameters: the price change and the length of time (number of days). The result is that, left asymmetry has the smaller amount in contrast with right asymmetry in 83% of the companies. Analysis shows that the number of days has a stronger effect than the price change on the amount of left and right asymmetry. The smaller amount of left asymmetry could be because the denominator of left asymmetry (which is number of days) has a larger value. In other words, the time (number of days) that it takes price to increase from the beginning of the bubble to top of the bubble is longer, and left side of the bubble has less steepness from the right side of the bubble in the majority of studied companies.

In the first part of the results it is mentioned that the beginning of a bubble to top of a bubble (upside) took in 4 intervals between 1 to 400 days. However, the decreasing price from the top of a bubble to the end of a bubble (downside) took in two intervals between 1 to 200 days. This analysis indicates that on the downside, the price decreases faster than the increase on the upside of the bubble. Likewise, the results demonstrate that 37% of the companies had left asymmetry greater than average left asymmetry which is 1.83 in this study. This implies that most companies had smaller than average left asymmetry, and shows that the price was rising gradually. The standard deviation is about 2.02 for left asymmetry with the variance of 4.10. Meanwhile, these values for right asymmetry are 7.10 and 50.01, respectively.

3.3.2 Paired T-Test (Comparing Mean of Left and Right Asymmetry) - Results

A paired T-Test is used to test if the mean of the left asymmetry is different than the mean of right asymmetry. Of the 40 companies, 30 companies are used in this test, which met the definition of the bubble used in this study.

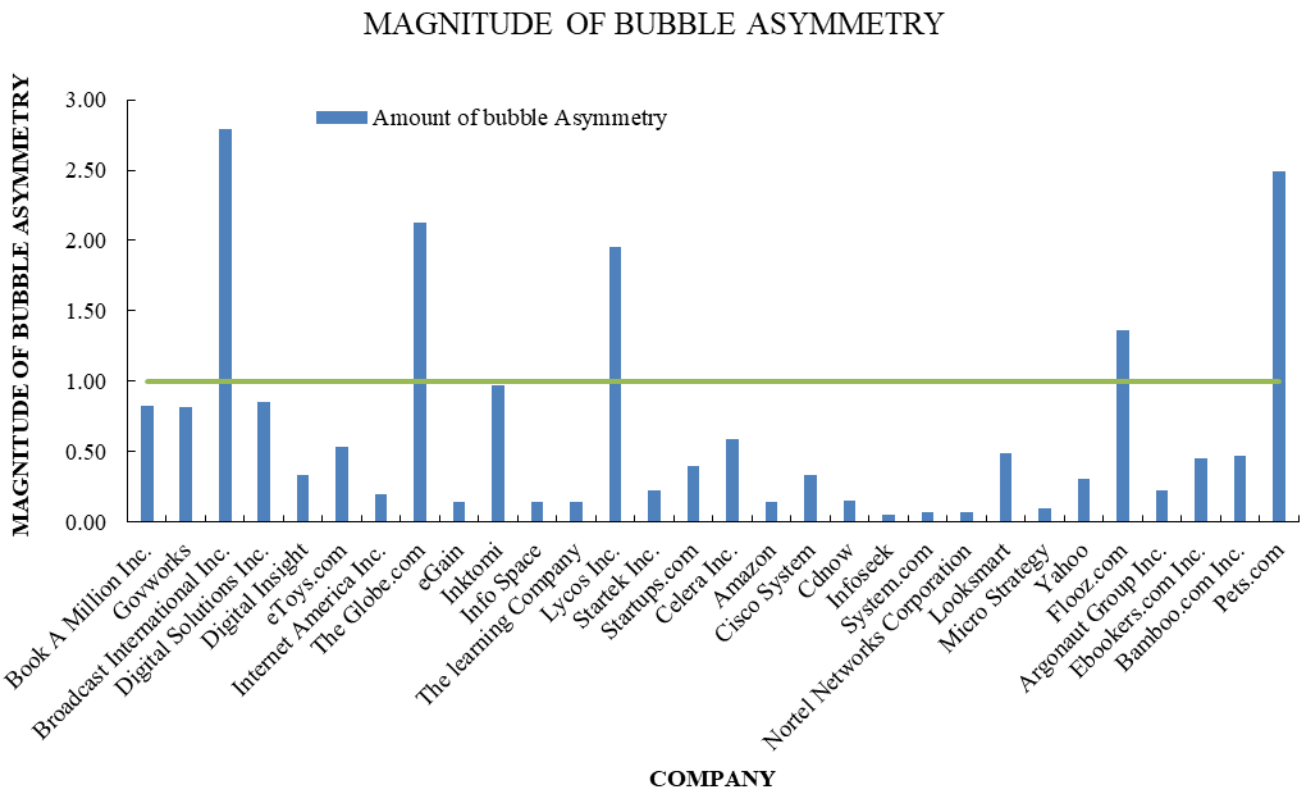
There was a statistically significant difference in the mean for left asymmetry (mean 1.832, standard deviation 2.058) and right asymmetry (mean 5.282, standard deviation 7.263). The T value was (29) = 2.8157 and the P value was 0.0087. The right asymmetry mean was 3.45 points higher than left asymmetry mean. T test results showed that the two means of left asymmetry and right asymmetry were statistically different at the 99 percent level or better.

3.3.3 Magnitude of the Bubble Asymmetry (Left Asymmetry Divided by Right Asymmetry) - Results

Recall that the magnitude of bubble asymmetry is calculated by dividing left asymmetry by right asymmetry (Figure 2.2). The average magnitude of bubble asymmetry is 0.66. A smaller magnitude of bubble asymmetry indicates that there is small left asymmetry or a large right asymmetry, including the effect of the length of time (number of days).

The magnitude of bubble asymmetry is classified into two categories: the magnitude of bubble asymmetry greater than one and the magnitude of bubble asymmetry less than one (Figure 3.6). The results indicate that 83% of the companies are categorized less than one (the steepness of left side is less than the steepness of the right side of the bubble). About 17% are greater than one (the steepness of the left side is more than the steepness of the right side of the bubble). In other words, 83% of the companies have a slow rise, and fast fall, and 17% of companies have fast rise and slow fall.

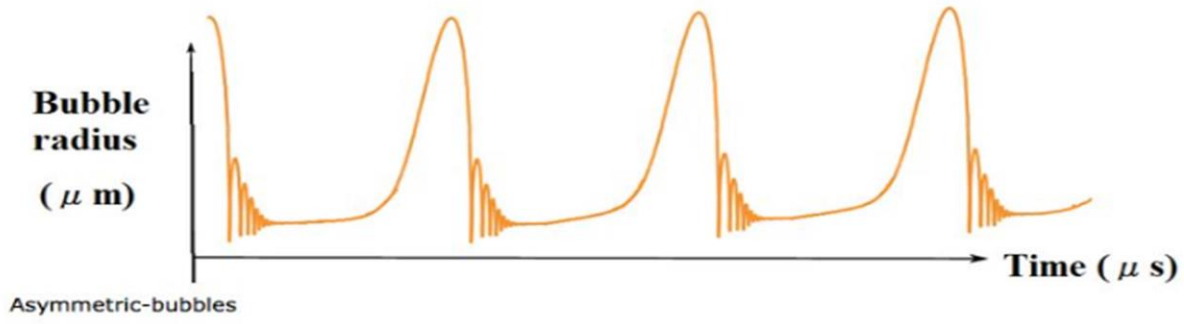
Figure 3.6 Magnitude of Bubble Asymmetry



These results are in agreement with the Soros theory of bubble shape (Roberts, 2013). As mentioned above, the magnitude of the bubble asymmetry in this study indicates that for 83% of the companies, prices increased slowly and decreased quickly.

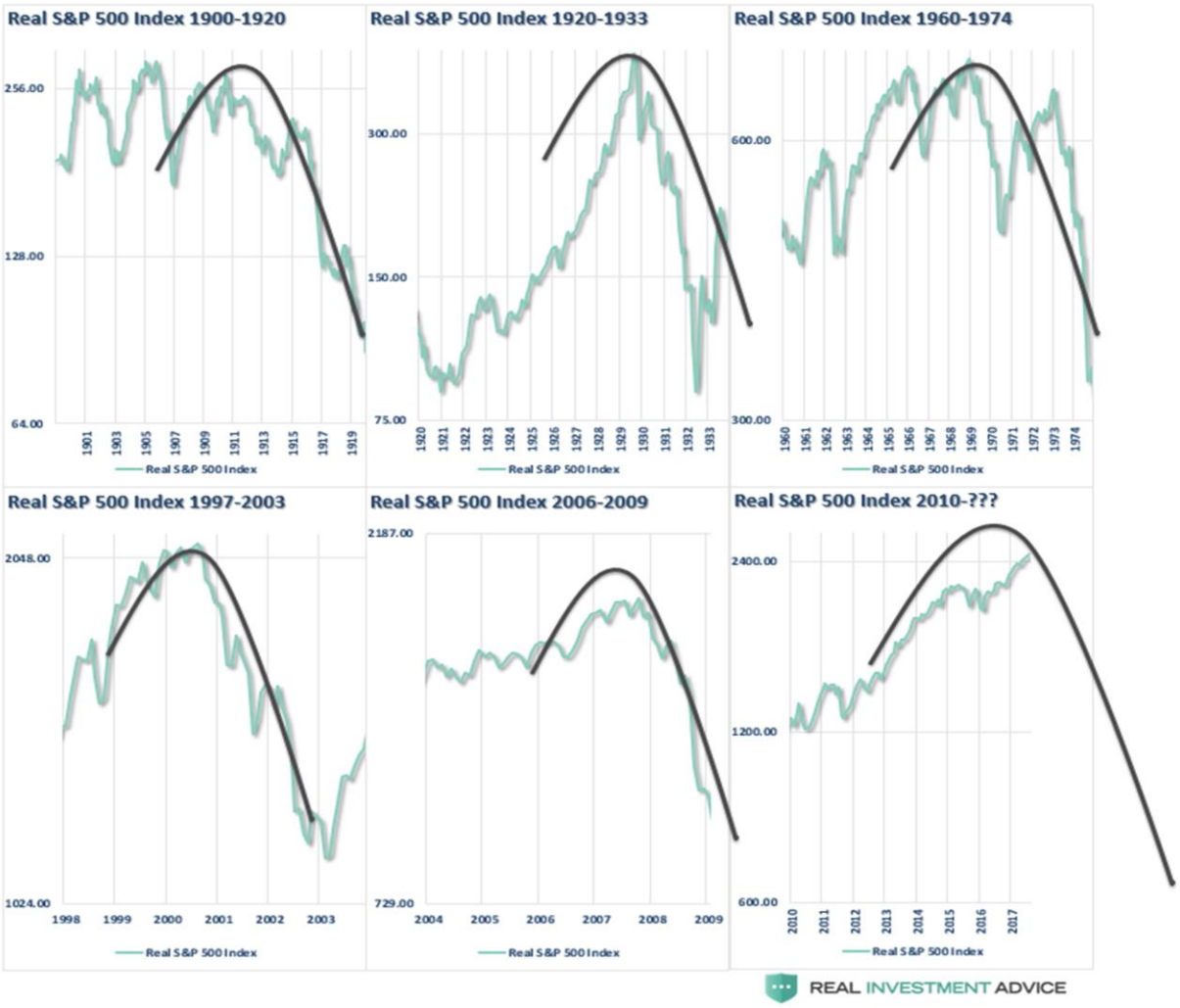
The Soros bubble theory explains that markets are not in equilibrium when there is a significant difference between market prices and fundamentals, and holds that psychology (emotion) plays a significant role in this difference. When the positive feedback develops, this causes a boom and bust process (Roberts, 2013). Based on the Soros theory of bubbles, the shape of the bubbles is asymmetric. In other words, the time takes to reach the boom is long and it starts out slowly, and then accelerates. In contrast, the time of the crash is short and steep (Roberts, 2013) (Figure 3.7). An example of an asymmetrical bubble shape is Shiller's market data back to 1900 (Roberts, 2013) (Figure 3.8).

Figure 3.7 The Shape of an Asymmetric Bubble Based on the Soros Theory of Bubble.



Source: Business Insider, Market bubbles are asymmetric (Roberts, 2013)

Figure 3.8 An Example of an Asymmetrical Bubble Shape Based on Shiller's Data on an Inflation-Adjusted Basis.



Source: Business Insider, Market bubbles are asymmetric (Roberts, 2013).

3.4 Summary of Results

In the first part of results, 30 bubbles are detected for 40 companies based on the definition of a bubble, as defined in this study. A bubble is defined as the current stock price increasing more than 100% and then decreasing by least 50%. The definition used in this research to a define bubble may also be used for other markets to identify and measure bubbles, though the percentages such as 100% and 50% may differ.

In the second part of results, the majority of companies were found to have small sized bubbles. In addition, the majority of the companies reviewed had bubbles that occurred in less than 150 days.

The third part of results shows that the amount of left asymmetry and right asymmetry are not equal due to different length of the time and different price changes. The amount of left asymmetry in the majority of companies (83%) is far smaller than right asymmetry, and indicates that price increases take longer than price decreases. The means (averages) of the left asymmetry and right asymmetry were found to be statistically different, based on a paired t-test

The magnitude of bubble asymmetry demonstrates that the increasing price (boom) is typically long and slow, while the decreasing price (bust) is typically shown to be short and steep. These results appear to be in agreement with Soros, on the shape of a bubble (Roberts, 2013).

3.4.1 Limitations and Future Study

In some cases for this study, some companies that had a relatively short time frame of data before the internet bubble began. Many of the companies had their initial public offering in one or two years or even a couple months before internet bubble.

Future research could expand this study to other stocks or commodities which have access to a larger data time period than the internet bubble.

Table 3.1 Measuring and Categorizing the Bubbles, and Calculating Magnitude of Bubble Asymmetry, 1990-2005 – Results

Company Name	Moving Average	Beginning Point Highest Point Ending Point (Price)	Length of Time (Days)	Percentage Change (Increased & Decreased)	Bubble Exist/ Not Exist	Bubble Size	Left Asymmetry	Right Asymmetry	Magnitude of Bubble Asymmetry
Geo Cities	MA up:10-40 MA down:10-40	BP:25.75 HP:28.50 EP:14.25	UP:10 Down:15	↑:10% ↓:100%	not exist				
Books a Million Inc.	MA up:10-40 MA down:10-40	BP: 2.94 HP: 38.94 EP:12.94	UP:21 Down: 34	↑: 1224% ↓: 305%	exist	Large	0.63	0.76	0.83
Govworks	MA up:30-120 MA down:30-120	BP: 4.58 HP:14.51 EP:8.03	UP:110 Down:57	↑:316% ↓: 80%	exist	large	0.09	0.11	0.82
Broadcast International Inc.	MA up:10-40 MA down:10-40	BP:2.75 HP:38.93 EP:12.93	UP:16 Down:32	↑:1415% ↓:301%	exist	large	2.26	0.81	2.79
Digital Solution Inc.	MA up:20-80 MA down:20-80	BP:2.66 HP:6.78 EP:4.50	UP:74 Down:31	↑:155% ↓:51%	exist	Small	0.06	0.07	0.86
Digital Insight	MA up:50-200 MA down:50-200	BP:1.28 HP:10.35 EP:5.69	UP:314 Down:53	↑:709% ↓:82%	exist	Large	0.03	0.09	0.33
eToys.com	MA up:10-40 MA down:10-40	BP:44.12 HP:88.25 EP:50.38	UP:35 Down:16	↑:100% ↓:75%	exist	Small	1.26	2.37	0.53
Internet America Inc.	MA up:10-40 MA down:10-40	BP:10.13 HP:21 EP:11.13	UP:11 Down:2	↑:107% ↓:89%	exist	Small	0.99	4.94	0.2
The Globe .com	MA up:10-40 MA down:10-40	BP:27.50 HP:67.06 EP:44.38	UP:14 Down:17	↑:144% ↓:51%	exist	Small	2.83	1.33	2.13
eGain	MA up:10-40 MA down:10-40	BP:80 HP:178.75 EP:68	UP:80 Down:13	↑:123% ↓:163%	exist	Small	1.23	8.52	0.14

Note: For some companies, data may begin after 1990 and end before 2005, see Table 2.1.

Table 3.1 Continued

Company Name	Moving Average	Beginning Point Highest Point Ending Point (Price)	Length of Time (Days)	Percentage Change (Increased & Decreased)	Bubble Exist/ Not Exist	Bubble Size	Left Asymmetry	Right Asymmetry	Magnitude of Bubble Asymmetry
Liquid Audio	MA up:10-40 MA down:10-40	BP:124.75 HP:200.38 EP:84.49	UP:30 Down:6	↑:61% ↓:137%	not exist				
Inktomi	MA up:10-40 MA down:10-40	BP:121.13 HP:242.63 EP:135.06	UP:21 Down:18	↑:100% ↓:71%	exist	Small	5.79	5.98	0.97
Info Space	MA up:10-40 MA down:10-40	BP:56.75 HP:143.31 EP:55.25	UP:42 Down:6	↑:153% ↓:159%	exist	Small	2.06	14.68	0.14
Network.com	MA up:30-120 MA down:30-120	BP:31.75 HP:45.13 EP:19.38	UP:105 Down:35	↑:42% ↓:133%	not exist				
Info.com	MA up:10-40 MA down:10-40	BP:167.25 HP:261.06 EP:171.75	UP:17 Down:15	↑:58% ↓:52%	not exist				
The learning Company	MA up:10-40 MA down:10-40	BP:26.25 HP:60.25 EP:36.88	UP:109 Down:11	↑:130% ↓:63%	exist	Small	0.31	2.12	0.15
Lycos Inc.	MA up:10-40 MA down:10-40	BP:53.75 HP: 110.56 EP:38	UP:8 Down:20	↑:106% ↓:191%	exist	Small	7.1	3.63	1.96
Startek Inc.	MA up:10-40 MA down:10-40	BP:17.88 HP:68.13 EP:41.94	UP:93 Down:11	↑:281% ↓:62%	exist	Medium	0.54	2.38	0.23
Startup.com	MA up:10-40 MA down:10-40	BP:36.44 HP:74 EP:45.38	UP:35 Down:14	↑:103% ↓:63%	exist	Small	0.82	2.04	0.4
Celera Inc.	MA up:20-80 MA down:20-80	BP:37 HP:352 EP:106.13	UP:65 Down:30	↑:851% ↓:232%	exist	large	4.85	8.2	0.59

Table 3.1 Continued

Company Name	Moving Average	Beginning Point Highest Point Ending Point (Price)	Length of Time (Days)	Percentage Change (Increased & Decreased)	Bubble Exist/ Not Exist	Bubble Size	Left Asymmetry	Right Asymmetry	Magnitude of Bubble Asymmetry
Nasdaq	MA up:10-40 MA down:10-40	BP:128.50 HP:250 EP:111.50	UP:91 Down:8	↑:95% ↓:124%	not exist				
Amazon	MA up:10-40 MA down:10-40	BP:91.38 HP:354.94 EP:163.38	UP:57 Down:6	↑:288% ↓:117%	exist	Medium	4.62	31.93	0.14
eBay.com	MA up:10-40 MA down:10-40	BP:161.56 HP:243.75 EP:15.69	UP:19 Down:6	↑:51% ↓:57%	not exist				
Cisco System	MA up:20-80 MA down:20-80	BP:28 HP:60.25 EP:26.50	UP:75 Down:26	↑:115% ↓:127%	exist	Small	0.43	1.3	0.33
CD now	MA up:20-80 MA down:20-80	BP:31 HP:83.13 EP:39	UP:169 Down:22	↑:168% ↓:113%	exist	Small	0.31	2.01	0.15
Info Seek	MA up:20-80 MA down:20-80	BP:53.25 HP:105.26 EP:45	UP:126 Down:8	↑:101% ↓:134%	exist	Small	0.41	7.53	0.05
Double Click	MA up:20-80 MA down:20-80	BP:52.88 HP:85.75 EP:33	UP:89 Down:12	↑:62% ↓:260%	not exist				
System.com	MA up:30-120 MA down:30-120	BP:39.75 HP:91.25 EP:47.50	UP:225 Down:13	↑:163% ↓:186%	exist	Small	0.23	3.37	0.07
Nortel Networks Corporation	MA up:30-120 MA down:30-120	BP:41 HP:99.50 EP:33.50	UP:241 Down:20	↑:143% ↓:197%	exist	Small	0.24	3.3	0.07
Netspace.com	MA up:30-120 MA down:30-120	BP:51.56 HP:91.69 EP:42.50	UP:133 Down:39	↑:77% ↓:115%	not exist				

Table 3.1 Continued

Company Name	Moving Average	Beginning Point Highest Point Ending Point (Price)	Length of Time (Days)	Percentage Change (Increased & Decreased)	Bubble Exist/ Not Exist	Bubble Size	Left Asymmetry	Right Asymmetry	Magnitude of Bubble Asymmetry
Look Smart	MA up:20-80 MA down:20-80	BP:75.56 HP:149.06 EP:97	UP:93 Down:32	↑:105% ↓:54%	exist	Small	0.79	1.63	0.48
Micro Strategy	MA up:10-40 MA down:10-40	BP:40.88 HP:295 EP:148	UP:102 Down:6	↑:625% ↓:99%	exist	large	2.49	24.5	0.1
PSFweb	MA up:10-40 MA down:10-40	BP:225 HP:313 EP:113	UP:9 Down:8	↑:39% ↓:177%	not exist				
Yahoo	MA up:10-40 MA down:10-40	BP:115.25 HP:414.50 EP:142.37	UP:75 Down:21	↑:259% ↓:191%	exist	Medium	3.99	12.96	0.31
Flooz.com	MA up:10-40 MA down:10-40	BP:179.06 HP:475 EP:151.12	UP:45 Down:67	↑:165% ↓:214%	exist	Small	6.58	4.83	1.36
Thinking Tools Inc.	MA up:10-40 MA down:10-40	BP:12 HP:19 EP:13	UP:6 Down:18	↑:58% ↓:46%	not exist				
Argonaut Group Inc.	MA up:20-80 MA down:20-80	BP:64 HP:130 EP:31	UP:83 Down:28	↑:103% ↓:319	exist	Small	0.8	3.54	0.23
Ebookers.com	MA up:10-40 MA down:10-40	BP:24.13 HP:49.94 EP:27.75	UP:33 Down:13	↑:106% ↓:79%	exist	Small	0.78	1.71	0.46
Bamboo.com Inc.	MA up:10-40 MA down:10-40	BP:13.75 HP:44.88 EP:24.88	UP:64 Down:19	↑:252% ↓:80	exist	Medium	0.49	1.05	0.47
Pets.com	MA up:10-40 MA down:10-40	BP:4.34 HP:22.05 EP:7.76	UP:9 Down:18	↑:408% ↓:184%	exist	large	1.97	0.79	2.49

CHAPTER 4

THESIS SUMMARY

4.1 Summary

Problem, Importance, and Objective

The history of bubbles shows that there is no unique definition that defines financial bubbles. Among financial economists there is a debate on using the term bubble, and many theories have been proposed regarding bubbles. Bubbles can play a role in the economy, and the ability to understand and identify bubbles is important for policymakers and investors. The objective of this study was to construct a practical definition of bubbles for detecting and measuring financial market bubbles, with a focus on the late 1990's internet bubble.

Data and Methodology

The data is from the common stock prices of 40 internet companies from the internet bubble which occurred mostly in the late 1990s. In the first part of the methodology, a bubble is defined as occurring when stock prices increase by more than 100% and then decrease by at least 50%. In the second part of the methodology, the size of a bubble is calculated and is categorized into three levels: small, medium, and large size bubbles. In the third part of the methodology, the magnitude of the bubble asymmetry is computed.

Results

In the first part of the results, this study was able to detect 30 bubbles from 40 technology companies in the late 1990's. Moving averages are used to identify the beginning and the end of a bubble. The analysis of moving averages shows that 10 and 40 day moving averages are the

most effective identifier. Results indicate that for the majority of companies, a bubble occurred in less than 150 days (from the beginning of a bubble to the end of a bubble).

In the second part of the results, the size of a bubble is categorized by measuring the bubbles, using the percentage increase and percentage decrease in price. These results show that 63% of the detected bubbles are categorized as small size bubbles, which means that the price increase is between 100% to 199%, and price decrease is at least a 50%. Also, only 37% of bubbles detected are categorized as medium and large sized bubbles. The internet technology bubble was a new paradigm which did not stay long and attracted investors mostly in the short term, and stock prices often doubled in value.

For the third part of the study, the magnitude of the bubble asymmetry is computed. The results show that the amount of the left asymmetry is much smaller than the amount of right asymmetry for the majority of the companies (83%). Analyzing the duration of bubbles (number of days) in the amount of left and right asymmetry in all of the companies shows that prices increased slower than prices decreased. A paired t-test indicated that the mean of the left side bubble asymmetry was statistically different from the mean of the right side bubble asymmetry.

The magnitude of the bubble asymmetry shows that the increasing price (boom) is typically long and slow, while the decreasing price (bust) is typically short and steep. The results of this study on bubble shape are in general agreement with the bubble theory of Soros (Roberts, 2013). This study may help investors and policymakers in their future decision making.

REFERENCES

Akram, Q. F. (2009). Commodity Prices, Interest Rates and the Dollar. *Energy Economics, 31(6), 838-851.*

Baffes, J., and Haniotis, T. (2010). Placing the 2006/08 Commodity Price Boom into Perspective. *World Bank, Policy Research Working Paper. No. WPS 5371.*

Bartholomew, K. (2015). Stock Market Crash of 1929 - Buying on Margin. *Awesome Stories. Retrieved September 16, 2017, from: https://www.awesomestories.com/asset/view/stock-market-crash-of-1929-buying-on-margin.*

Battalio, R., and Schuliz, P. (2005). Options and the Bubble. *The Journal of Finance, 61(5), 2071-2102.*

Bhattacharya, G., and Galpin, N. (2007). The Role of the Media in the Internet IPO Bubble. *Journal of Financial and Quantitative Analysis, 44(3), 657-682.*

Black, F. (1986). Noise. *Journal of Finance, 41(3), 529-534.*

Blanchard, O. J. (1982). Bubbles, Rational Expectations and Financial Markets. *National Bureau of Economic Research, Working Paper No. 945.*

Blinder, A., and Rudd, J. B. (2008). The Supply-Shock Explanation of the Great Stagflation Revisited. *National Bureau of Economic Research, Working Paper No. 14563.*

Boulton, J. (2014). 100 Ideas That Changed the Web. *London: Laurence King Publishing.*

Bris, D. L. (2014). What Is a Market Crash?. *Economic History Review, 71(2), 480-505.*

Carter, J., Rausser, G. and Smith, A. (2011). Commodity Booms and Busts. *Annual Review of Resource Economics, 3(2), 87-118.*

Chambers, D. and Dimson, E. (2016). Financial Market History: Reflection on the Past For Investors Today. *Research Foundation Publications, 2016(3), 1-279.*

Davies, G. (2014). How to Detect a Market Bubble. *Financial Times. Retrieved September 18, 2017 from: https://www.ft.com/content/0325cb5b-a16c-38db-8e23-1f50f4c6cccd.*

Day, C. (2008). Risky Business: Popular Images and Reality of Capital Markets Handling Risk-From the Tulip Craze to the Decade of Greed. *Penn State Law Review, 113(2), 462-525.*

Delong, J. B., Shleifer, A., Summers, L. H., and Waldman, R. J. (1990). Noise Trader Risk in Financial Markets. *The Journal of Political Economy, 98(4), 703-738.*

Delong, J. B. (2006). A Short Note on the Size of the Dot-Com Bubble. *National Bureau of Economic Research, Working Paper No. 12011.*

Dumskis, V., and Sakalauskas, L. (2012). The Mathematical Definition of Bubbles and Crashes. *Vu Institute of Mathematics and Informative. Retrieved November 18, 2017, from: http://www.su.lt/bylos/mokslo_leidiniai/jmd/2012_4_37/dumskis_sakalauskas.pdf*

Evanoff, D. D., Kaufman, G. G. and Malliaris, A. G. (2012). New Perspectives On Asset Price Bubbles. *Oxford University Press.*

Fama, E. F. (1970). Efficient Capital Markets: a Review of Theory and Empirical Work. *The Journal of Finance, 25(2), 383-417.*

Ferreira, A., and Eduardo, J. (2006). Periodically Collapsing Rational Bubbles in Exchange Rates: A Markov-Switching Analysis for a Sample of Industrialised Markets. *School of Economics, University of Kent.*

Frankel, J. A. (2006). The Effect of Monetary Policy on Real Commodity Prices. *National Bureau of Economic Research, Working Paper No. 12713.*

Frankel, J. A. (1986). Expectations and Commodity Price Dynamics: The Overshooting Model. *American Journal of Agricultural Economics, 69(4), 344-348.*

Garber, P. M. (1989). Tulipmania. *Journal of Political Economy, 97(3), 535-560.*

Gilbert, C. L. (2010). How to Understand High Food Prices. *Journal of Agricultural Economics, 61(2), 398-425.*

Girdzijauskas, S., Moskaliova, V., and Cepinskis, J. (2009). Formation of Economic Bubbles: Causes and Possible Preventions. *Technological and Economic Development of Economy, 15(2), 267-280.*

Giusti, G., Noussair, C. N., and Voth, H. J. (2013). Recreating the South Sea Bubble: Lessons From an Experiment in Financial History. *Barcelona GSE, Working Paper No. 710.*

Goetzmann, W. N. (2015). Bubble Investing: Learning from History. *National Bureau of Economic Research, Working Paper No. 21693.*

Godsiff, P. (2015). Bitcoin: Bubble or Blockchain. *In Agent and Multi-Agent Systems: Technologies and Applications, 38(2), 191-203.*

Gold, S. (2017). What is an Economic Bubble. *Schiffgold. Retrieved August 11, 2017, from: https://schiffgold.com/commentaries/what-is-an-economic-bubble/.*

Goodnight, G. T. and Green, S. (2010). Rhetoric, Risk, and Markets: The Dot-Com Bubble. *Quarterly Journal of Speech, 96(2), 115-140.*

Hale, T., and Galbraith, J. K (2003). Income Distribution and the Information Technology Bubble. *University of Texas Inequality Project, Working Paper No. 27.*

Hamilton, J. D. (2009). Causes and Consequences of the Oil Shock of 2007–08. *National Bureau of Economic Research, Working Paper No. 15002.*

Haruvy, E., and Noussair, C.N. (2006).The Effect of Short Selling on Bubbles and Crashes in Experimental Spot Asset Markets. *The Journal of Finance, 61(3), 1119-1157.*

Hatipoglu, O. and Uyar, O. (2012). Do Bubbles Spillover? Estimating Financial Bubbles in Emerging Markets. *Emerging Markets Finance and Trade, 48(sup5), 64 -75.*

Holt, M. T., and Enders, W. (2011). Breaks, Bubbles, Booms, and Busts: The Evolution of Primary Commodity Price Fundamentals. *MPRA, Working Paper No. 31461.*

Ironman, (Alias). (2010). Why the Dot Com Bubble Began and Why It Popped. *Businessinsider. Retrieved January 20, 2018, from: https://www.businessinsider.com/heres-why-the-dot-com-bubble-began-and-why-it-popped-2010-12.*

Irwin, S., Sanders, D. R., and Merrin, R. P. (2009). Devil or Angel? The Role of Speculation in the Recent Commodity Price Boom (and Bust). *Journal of Agricultural and Applied Economics, 41(2), 377-391.*

Jarrow, R., Kchia, Y., and Protter, P. (2011). How to Detect an Asset Bubble. SIAM Journal on Financial Mathematics, 2(1), 839-865.

Kindleberger, C. P., and Aliber, R. (2003). Manias, Panics, and Crashes. *New York: John Wiley.*

Kopsell, H., and Lienkamp, S. (2015). Dot-Com Bubble 2.0? *Retrieved May 2, 2018, from: http://studenttheses.cbs.dk/xmlui/bitstream/handle/10417/5469/stefan_lienkamp_og_hauke_koepsell.pdf?sequence=1.*

Kortian, T. (1995). Modern Approaches to Asset Price Formation: A survey of Recent Theoretical Literature. *Reserve Bank of Australia, Working Paper No. 9501.*

Kubicova, I., and Komarek, L. (2011). The Classification and Identification of Asset Price Bubbles. *Finance a úvěr-Czech Journal of Economics and Finance, 61(1), 34-48.*

Li, J., Chavasb, J. P., Etiennec, X., and Lia, C. (2017). Commodity Price Bubbles and Macroeconomics: Evidence From Chinese Agricultural Markets. *Agricultural Economics, 48(6), 755-768.*

Ma, T., Lee, K., and Lai, C., (2017). Rational or Irrational? A Comprehensive Study on Stock Market Crashes. *Retrieved August 3, 2017, from: https://ssrn.com/abstract=2905555.*

Markwat, T., Kole, E., and Van Dijk, D. (2009). Contagion as a Domino Effect in Global Stock Markets. *Journal of Banking and Finance, 33(11), 1996-2012.*

Meltzer, A. H. (2002). Rational and Irrational Bubbles. *Retrieved January 10, 2018, from: https://pdfs.semanticscholar.org/724a/20e4426b0dcbf46a750f61018deb1d1eb684.pdf.*

Merriam-Webster (2017). *Retrieved December 2, 2017, from: https://www.merriam-webster.com/dictionary/bubble.*

Mizuno, T., Ohnishi, T., and Watanabe, T. (2017). Stock Market Bubble Detection Based on the Price Dispersion Among Similar Listed Firms. *Institute of Economic Research, Working Paper No. 67.*

Mishkin, F., and White, E. N. (2002). U.S. Stock Market Crashes and Their Aftermath: Implications for Monetary Policy. *National Bureau of Economic Research, Working Paper No. 8992.*

Morris, J. J., and Alam, P. (2012). Value Relevance and the Dot-Com Bubble of The 1990s. *The Quarterly Review of Economics and Finance, 52(2), 243–255.*

Odlyzko, A. (2011). The Collapse of the Railway Mania, the Development of Capital Markets, and Robert Lucas Nash, a Forgotten Pioneer of Accounting and Financial Analysis.

Retrieved December 7, 2017, from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.167.1188&rep=rep1&type=pdf.

Ofek, E., and Richardson, M. (2002). The Valuation and Market Rationality of Internet Stock Prices. *Oxford Review of Economic Policy, 18(3), 265–287.*

Östensson, O. (2012). The 2008 Commodity Price Boom: Did Speculation Play a Role? *Mineral Economics, 25(1), 17–28.*

Patel, J., Shah, S., Thakkar, P., and Kotecha, K. (2015). Predicting Stock and Stock Price Index Movement Using Trend Deterministic Data Preparation and Machine Learning Techniques. *Expert Systems with Applications, 42(1), 259-268.*

Parker, K. (2016). What caused the Dot-Com Bubble in 1998-2000?. *Retrieved May 10, 2018, from: https://www.quora.com/what-caused-the-dot-com-bubble-in-1998-2000.*

Pastor, L., and Veronesi, P. (2003). Stock Valuation and Learning About Profitability. *The Journal of Finance, 58(5), 1749-1789.*

Pastor, L., and Veronesi, P. (2005). Was There a Nasdaq Bubble in the Late 1990s?. *Journal of Financial Economics*, *81*(1), 61-100.

Pindyck, R. S., and Rotemberg, J. J. (1998). The Excess Co-Movement of Commodity Prices. *The Economic Journal 100(403), 1173-1189.*

Rausser, G. (1985). Macroeconomics and U.S. Agricultural Policy. *Department of Agricultural and Resource Economics, University of California, Working Paper No. 358.*

Roberts, L. (2013). George Soros on Asymmetric Bubbles. *Business Insider. Retrieved July 20, 2018, from: http://www.businessinsider.com/george-soros-on-asymmetric-bubbles-2013-12.*

Roche, C. (2013). Anatomy of Bubbles and Crashes. *Pragmatic Capitalism. Retrieved September 15, 2017, from: https://www.pragcap.com. April 2013. https://www.pragcap.com/anatomy-of-bubbles-and-crashes.*

Scheinkman, J. A. (2014). Speculation, Trading, and Bubbles. *New York: Columbia University Press.*

Scherbina, M. A. (2013). Asset Price Bubbles: A Selective Survey. *International Monetary Fund, IMF Working Paper No.13/45.*

Schuh, E. (1974). The Exchange Rate and U. S. Agriculture. *American Journal of Agricultural Economics, 56(1), 1-13.*

Shetty, A. (2016). How to Detect a Market Bubble. *The Asian Age. Retrieved December 18, 2017, from: http://www.asianage.com/business/how-detect-market-bubble-652.*

Shiller, R. C. (2000). Irrational Exuberance. *Philosophy and Public Policy Quarterly, 20(1), 18-23*

Shiller, R. J., and Akerlof, G. A. (2010). Animal Spirits: How Human Psychology Drives The Economy, and Why It Matters for Global Capitalism. *New Jersey: Princeton University Press.*

Siebert, H. (1999). Some Lessons From the Japanese Bubble. *Kiel Institute for the World Economy, Working Paper No. 919.*

Siegel, J. J. (2003). What Is an Asset Price Bubble? An Operational Definition. *European Financial Management, 9(1), 11-24.*

Širůček, M. (2013). Impact of Money Supply on Stock Bubbles. *MPRA, Working Paper No.51476.*

Sornette, D., and Kaizoji, T. (2008). Market Bubbles and Crashes. *arXiv preprint. Retrieved September 15, 2017, from: https://arxiv.org/ftp/arxiv/papers/0812/0812.2449.pdf.*

Stiglitz, J. E. (1990). Symposium on Bubbles. *Journal of Economic Perspectives, 4(2), 13-18.*

Schwab. G. (2016). What Is a Short Put. *Investopedia. Retrieved December 15, 2017, from: https://www.investopedia.com/terms/s/short-put.asp*

Tokic, D. (2011). Rational Destabilizing Speculation, Positive Feedback Trading, and the Oil Bubble of 2008. *Energy Policy, 39(4), 2051-2061*.

Voth, T. and Temin, P. (2004). Riding the South Sea Bubble. *American Economic Review, 94(5), 1654-1668.*

Williams, O. (2017). Minsky's 5 Stages of a Bubble – Where Are We Now?. *Munknee. Retrieved August 25, 2017, from: http://www.munknee.com/minskys-5-stages-of-a-bubble-where-are-we-now/*

Zhang, X, R., Xu, J.G., and Li, Z. G. (2011). Financial Stability and Interest Rate Adjustment in Asset Price Boom-Bust Cycles. *International Conference on Electronics, Communications and Control (pp. 3453-3460).*