Dot-com bubble 2.0?

An empirical analysis of market dynamics in the technology industry

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Abstract

On April 23rd 2015 the NASDAQ Composite Index, which traditionally lists more technology oriented companies than any other stock market index in the U.S., closed at 5,073 points, which is for the first time higher than the peak that had been reached during the dot-com bubble that burst 15 years ago in March 2000. As a consequence, there is a growing public interest in whether the present growth rates in the technology sector are to be seen as sustainable, or if growth rather appears to be inflated as during the dot-com bubble, which eventually had devastating consequences for the economy.

In order to avoid such an economic downturn from happening again, it is crucial to gain an understanding of whether or not a potential overvaluation can be identified in the technology industry. To our knowledge, there is no academic literature dealing with the current potential bubble development in the technology industry yet. Consequently, we explore how the current development compares to that during the dot-com bubble and whether current market valuations give rise to question if valuations are justified by accounting fundamentals.

To approach this, we analyze the development of the NASDAQ Composite and compare its relative performance to that of two other major U.S. indexes, namely the S&P 500 and the Dow Jones, over the last 15 years. To test more specifically for a potential bubble development in the technology industry, we focus on examining the relation between market valuation and traditional accounting fundamentals by using a high-tech sample over a fourteen-year timespan from 2000 to 2013. This is done by applying the value relevance model, which allows us to determine the explanatory power of traditional accounting fundamentals for company market values.

We find that important financial indicators of the NASDAQ Composite, such as P/E and P/B ratios, are currently much lower than they were during the dot-com bubble, indicating an index that does not appear to be as inflated as it was 15 years ago. However, we also find that the NASDAQ Composite shows significant accelerated growth compared to its peers, especially during the last three years. The NASDAQ Composite can therefore be regarded as heated.

In our value relevance analysis, we confirm results of previous researchers that documented an increase in the relation between market values and traditional accounting fundamentals after the dot-com bubble. This indicates that investors might have returned to more rational investment strategies after the burst of the bubble. By extending the model until 2013, we are able to document that the value relevance of accounting fundamentals displays a decreasing trend over the last three years, which is in contrast to the development during the years after the dot-com bubble. This implies that investors potentially acted less rational and might have used more irrational investment strategies during the last three years.

In conclusion, it can be resumed that the current development in the technology industry is not yet to be seen as a bubble, or close to a bubble. However, looking forward, if the trading behavior continues to develop more towards irrational behavior, as it might have during the last three years, a situation as during the dot-com bubble, might possibly occur over the next few years. This would be illustrated by a further decrease in value relevance of accounting fundamentals.

Keywords: Dot-com Bubble, Behavioral Finance, Value Relevance Model, NASDAQ Composite Index, Relevance of Accounting Fundamentals, Equity Valuation
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1. Introduction

On April 23rd 2015 the NASDAQ Composite Index, which traditionally lists more technology oriented companies than any other stock market index in the United States of America, closed at 5,073 points, which is for the first time higher than the peak that had been reached during the dot-com bubble that burst 15 years ago in March 2000 (Fortune, 2015). The crash of the stock market was preceded by a bull market during the late 1990s in which “the NASDAQ Composite Index became a real-time barometer on what was then explained as the ‘new economy’, a constellation of technology companies loosely centered around the accelerating Internet technology” (Quartz, 2015).

1.1. Background Dot-com Bubble

The dot-com bubble started to grow by investments in Internet companies and the NASDAQ Composite Index rose from under 1,000 points in 1995 to more than 5,000 points in early 2000. At that time companies were going public with initial public offerings (IPOs) and received enormous valuations, with stock prices sometimes doubling on the first day. However, in March 2000, the boom came to a crashing halt and the bubble began to pop. The American economy consequently slowed down and finally ended up in a full recession (Time, 2015).

There has recently been an increasing public interest in the aftermath of the dot-com bubble in 2000, after the NASDAQ Composite Index hit its all time peak slightly above 5,000 again in spring 2015. At the same time, also private companies operating in the technology sector, that are not listed on any stock market index - such as the NASDAQ Composite - received increased sums in funding from venture capitalists or other investors over the last 3-5 years (PWC, 2014). More than 80 startups, so called ‘unicorns’, including companies like Uber and AirBnB, are held privately and have received valuations above $1 billion based on multiples of revenues lately (Financial Times, 2015).

Both these developments do not go unnoticed and many newspaper articles start drawing parallels to the dot-com bubble era during the late 1990s, exploring whether the current market dynamics are to be interpreted as the development of another bubble in the technology industry. The Entrepreneur Magazine for instance published an article in January 2015, posing the question “will the Tech-Startup bubble burst in 2015?”. Similarly, Financial Times released an
article in March 2015, stating that the “dot-com history is not yet repeating itself, but it is starting to rhyme”. Furthermore, the *Forbes Magazine* published an article in March 2015 about the potential bursting of the next dot-com bubble, just after WhatsApp was acquired by Facebook for an astonishing reported price equaling $345 million per employee, amounting to a total of $19 billion in total in February 2014. Famous entrepreneur and investor Mark Cuban wrote in March 2015 in his blog that the current technology bubble is even worse than the dot-com bubble in 2000, due to the high concentration of investments in private instead of public companies. He regards this development as dangerous, because of the illiquid nature of such investments in private firms (Cuban, 2015).

### 1.2. Problem Discussion

With regards to the dot-com bubble in the late 1990s and early 2000s, there is an extensive body of academic literature dealing with dynamics and causes of the bubble bursting phenomenon. According to Valliere and Peterson (2004), many venture capitalists have been attracted to investments in Internet firms at that time because of the general hype caused by the possibility to make profitable investments in the industry. Too many investors were led to speculative investments due to media attention targeted towards the technology industry and most of the investors did not perform their own due diligence processes anymore as they usually would have done. Therefore, it was possible for many technology oriented startups to obtain substantial funding with the prospect to generate revenue at a later stage. The majority of these dot-com companies however failed to turn their business models into profitable and sustainable businesses, which ultimately led to the burst of the bubble (Valliere & Peterson, 2004).

Turning to the current situation, there is no existing academic literature dealing with the latest potential bubble development in the technology industry yet. Although a lot of articles have been published in the media on the topic of a potential stock market overvaluation and on a potential new bubble development, to our knowledge there is no research on an academic level yet that deals with the recent development. The possibility of a development of another bubble in the current technology industry can thus be identified as a research gap, which has not been analyzed yet.
1.3. Purpose and Research Question

The purpose of this paper is to investigate the potential of a new bubble development in the technology industry and thereby to fill the research gap that has been identified by providing an empirical analysis of market dynamics over the years. The following research question has been identified and will be answered in this thesis:

*How does the current development in the technology industry compare to that during the dot-com bubble in the late 1990s, and do current market valuations give rise to question whether valuations are justified by accounting fundamentals?*

Answering this question through conducting an empirical analysis will provide clarity on how to interpret recent growth rates in the technology sector. By doing so, it will also be possible to assess whether the present growth rates in the technology sector are to be seen as sustainable, or if growth rather appears to be inflated. Should the latter be the case, this might hurt the economy in the long run, as during the dot-com bubble, where many companies ultimately failed and were forced to file bankruptcy. In case that parallels between the dot-com period and the current trends in the technology sector can be found, it will be important to identify these parallels in order to avoid a similar market collapse. Ultimately, the objective is to clarify if the technology industry is currently heading towards a new bubble and to which degree market valuations are justified by accounting fundamentals.

The results of this macroeconomic thesis are likely to be of interest to academics, regulators and investors for a number of reasons. First, from an academic perspective, it is important to know how much of a firm’s market value can be explained by accounting fundamentals, such as income or capital expenditures, over the years after the dot-com bubble until now. Second, from a policy maker perspective, the most relevant concern is to develop warning signals that function as indicators as to whether it is likely that an abrupt rise in technology stock prices will be followed by a bursting bubble that would slow down the entire economy. Third, from an investor perspective, the results of this thesis might be useful for investment decisions. In particular, it is in the interest of an investor to know, whether or not traditional accounting fundamentals still have their merit for investment decisions during bull markets, when stocks are traded at multiples of their earnings.
1.4. Scope and Delimitations

The scope of this paper is to firstly give a brief description and analysis of what happened during the dot-com bubble, based on past research within the given field. A theoretical background on behavioral finance will also be given to allow an interpretation of the findings of this study. The new academic contribution of this paper will then be to connect learnings from previous studies to today’s situation in the technology sector by using established research methods in the analysis. This will be done in order to avoid similar economic failure as during the dot-com bubble from happening again. We thus aim to send warning signs in case any bubble tendencies in the current technology sector should be found through the analysis performed in this paper.

This will be achieved through applying established research methods to new data reaching until now, which has not been done yet to this point, and therefore adds a new perspective to existing academic research within the given field. Grounded on this, we will ultimately be able to assess to what extent the current development in the technology sector can be regarded as heated and if there is any tendency towards a bubble.

Our intention is not to find new insights about the previous dot-com bubble, which has been covered extensively in academia already. Therefore, we will apply a given model that has been proven valid by different researchers, rather than test the robustness of various regression models or try to further optimize the given model by adding or deleting variables. It is furthermore not the objective to perform an analysis of the entire economic development, but to focus on the high technology industry and whether bubble tendencies exist in this sector.

1.5. Outline

After giving a brief background on the topic and defining the purpose and the research question of the thesis in chapter 1, the paper will be structured as described in the following.

In chapter 2, a literature review will be given including the most relevant information on the beginning, burst and aftermath of the dot-com bubble period during the late 1990s and early 2000s. Further, theories and frameworks that can help to understand what exactly economic bubbles are, and also how they can form, will be dealt with. First, a definition of an economic bubble will be given. Second, in order to provide the reader with a comprehensive overview of
relevant theories, the efficient market theory, as well as behavioral finance theories will be dealt with, taking into account rational and irrational investment behavior. Third, a theoretical introduction to the value relevance model, which will be applied in the analysis in chapter 4, will be given.

In chapter 3 then, the strategic choices of the paper and the research design will be highlighted. The applied methods for the research in this study will be explained, which will make it possible for the reader to understand step by step how we conducted our analysis and why we consider this approach to be most suitable for our study. By providing transparency in the methodology section, we will also enable other researchers to replicate or extend our study in future research.

In chapter 4, the statistical results of our study will be presented. These results will form the basis for answering the research question that has been formulated. While the first part will present the statistical results of our NASDAQ Composite Index analysis, the second part will be focused on the statistical results of our value relevance analysis in the technology industry. Building up on the applied methods, a non-technology sample will also be analyzed using the same approach for benchmarking purposes.

Chapter 5 will consequently form our discussion section, in which the results described in chapter 4 will be interpreted and reflected upon in a holistic manner. By doing so, we will connect the results of the NASDAQ Composite Index analysis with those of the value relevance analysis, and determine how these combined results compare to those of other researchers. This will allow us to answer our research question that has been defined in the introduction of this paper, preliminarily based on the results of our performed analysis. Also, we will relate the results of our study to further macroeconomic developments that might also have an impact and should thus be considered in interpreting the results. Further, the implications of the study will be elaborated on.

In Chapter 6, the conclusion of the study will be given drawing on insights gained throughout the whole study, and the research question will be answered.

Finally, Chapter 7 will complete the study by taking into account limitations that were faced during the process of this research project, and also by giving recommendations for future research in the given field.
2. Literature Review

In chapter 2, we will focus on reviewing state of the art literature related to the given research topic. The chapter is divided into three main parts. First, the literature review of this paper will rely on the understanding of the beginning, the burst and the aftermath of the dot-com bubble in the late 1990s and early 2000s. Second, the theoretical framework of this paper will be based on relevant literature within the fields of behavioral finance and the general science of economic bubbles and crashes. Third, the theory of the value relevance model will be outlined to understand the model, which will be applied in chapter 4. The three parts are relevant for this study, because the research question is situated in the cross-section of all three fields.

2.1. Understanding the Dot-com Bubble

During the late 1990s, a euphoric attitude towards technology businesses was created that inspired many people to believe in the future of online business models. This euphoric attitude led to a rapid rise in equity markets due to speculative investments in Internet based companies and resulted in what today is known as the dot-com bubble. The following chapter provides an overview of the start, the burst and the aftermath of the bubble and elaborates on the economic downturn and its consequences.

2.1.1. Beginning of the Dot-com Bubble

The exact beginning of the dot-com bubble is subject to dispute in the academic literature (e.g. DeLong & Magin, 2006; Govetto & Walcher 2009; Goodnight & Green, 2010). Most economists identify the start of the dot-com bubble in the late 1990s from either the Netscape Communications Inc. IPO of 1995 or Alan Greenspan’s irrational exuberance speech of 1996 (DeLong & Magin, 2006).

The Netscape Communications IPO in August 1995 occasioned extraordinary excitement, after the young company went public. Their stock climbed within a few hours of the market’s opening from $28 to $75 per share, closing at $58.25 at the end of its first day of trading. This was a historic day on Wall Street, since the stock soared at a record high price and the company was among the first that went public before it even turned profitable (Harvard Business School, 1996). The company did not have years of operational experience and was solely traded on future expectations of value (Goodnight & Green, 2010). The IPO received a lot of media
attention and CNN Insight (2000) wrote after the burst of the bubble that it was the “unusual high demand for Netscape’s offering that was the birth of the bubble”. The Forbes Magazine (2002) came to a similar conclusion that the Netscape IPO was the beginning of the bubble since it “kicked off dot-com mania on Wall Street”.

The other start date of the dot-com bubble, which is discussed among economists, is December 1996, after Alan Greenspan, ex-chairman of the Federal Reserve System (Fed), held his famous _irrational exuberance_ speech. Speaking at an after-dinner audience at Washington D.C.-based American Enterprise Institute, Greenspan warned that the stock market might have taken speculative directions towards a macroeconomically significant bubble. Greenspan’s powerful speech had a strong impact on worldwide stock markets. In Asia the stock markets fell by 3% on average, the markets in Europe fell by 4% when they opened, and the US market decreased by 2% within the day after the speech (DeLong & Magin 2006).

By the late 1990s the IPO model, going public without making profits, used by Netscape proved to be extremely lucrative and many companies that went public saw record-setting price rises in initial offerings. Single day returns of more than 100% led investors and venture capitalists to believe that the dot-com field was not likely to undergo a price correction any time soon and encouraged them to invest more money in Internet firms than ever before (Goodnight & Green, 2010).

### 2.1.2. Burst of the Dot-com Bubble

The dot-com bubble was growing with tremendous speed, fostered by low interest rates in the late 1990s. In 1999, 446 firms went public through IPOs and achieved an average first-day return of 71%. Some companies were extraordinarily successful: Foundry Networks went public in September 1999 with a first day return of 525%, theglobe.com in November 1998 with 606%, and VA Linux in December 1999 with an all time record of 698% (PBS, 2001). Amazon.com’s share rose from its IPO price of $1.50 in May 1997 to $133 in late 1999, growing its market capitalization to a multiple of that of Wal Mart (Liu & Song, 2001).

During the period from September 1998 to March 2000 stocks on the NASDAQ Composite Index rose on average by 170% (Johnsson, Lindholm & Platan, 2002). One of the most known technology and Internet investors in the Silicon Valley, Roger McNamee of Integrated Capital Partners, admitted to the Fortune Magazine in 1999: “I buy these stocks because I live in a
In literature, the effect of initial price increases is often referred as the “feedback loop”, which stimulates ever-increasing investor interest. Investors, that are motivated by past price increases, bid up stock prices and thereby encourage more investors to do the same, so that the cycle repeats over and over again, resulting in an enlarged response to the initial precipitating factors (Shiller, 2005). In the two-year period from early 1998 until March 2000, the Morgan Stanley Index of Internet firms\(^1\) earned on average over 1000% returns on its public equity. At this point, the Internet sector accounted for 6% of the entire U.S. market capitalization of all public companies and for 20% of all publicly traded equity volume (Ofek & Richardson, 2003).

The durability of a bubble ultimately depends on novel stock purchasers that take the risk that assets that are bought today, are worth more tomorrow (Galbraith, 1994). During the dot-com bubble, new Internet and communication technologies attracted new investors (Goodnight & Green, 2010). Between 1995 and 1998, the number of inexperienced investors that invested directly in stocks rose by over 30%. From 1995 until 2000, investors opened 12.5 million new online brokerage accounts. This naturally implies that a lot of new and inexperienced investors started to trade, who might have been overconfident in their ability to pick technology stocks with fair value (Barber & Odean, 2001).

On March 10th 2000, the NASDAQ Composite Index closed at 5048 points, marking the peak of the dot-com bubble. The astonishing increase in share prices until early 2000 was followed by an equally dramatic fall in March 2000, letting the dot-com bubble burst (Goodnight & Green, 2010). The boom came to a crashing halt and the American economy ended up in a full recession (Time, 2015). In turned out that financial analysts were too optimistic about Internet stocks and their earnings forecasts were not rational (Liu & Song, 2001).

\(^1\) Morgan Stanley has published an index of Internet firms (MOX). The criteria for a company to be included in this list is that it must be considered as an Internet company with a pure focus on an Internet business model. Companies like Microsoft, Cisco and many other telecommunication firms are therefore excluded.
2.1.3. Aftermath of the Dot-com Bubble

In March 2000, U.S. technology stocks started to falter and the situation got worse throughout April 2000 as the downturn of stocks spread to other markets on a global level. The NASDAQ Composite Index dropped by 16% in April 2000. By February 2001, the NASDAQ was below 2,200 points and had lost more than half of its market value within one year (Johnsson et al., 2002). In October 2002, the NASDAQ had lost more than $5 trillion in market value within a period of two years (LA Times, 2005). By the end of 2000, 140 out of 400 publicly traded Internet companies were traded at a price below $2 a share. Investors typically use this value as a benchmark in order to identify companies that are anticipated to disappear soon (Liu & Song, 2001). The total market capitalization of U.S. Internet firms was estimated to be over $1 trillion before the bubble burst and dropped by almost 50% to $572 billion in December 2000 (Demers & Lev, 2001).

In 1999, there were 446 firms, which were Internet and technology related that went public through IPOs. Of these, 25% doubled their share price on the companies’ first day of trading. In contrast, in 2001, the number of IPOs dropped to 76 firms and none of these companies was able to double its share price on the first day of trading (Goodnight & Green, 2010). Many Internet companies have failed and companies were delisted from the stock exchange and went out of business. In total, 225 Internet firms filed bankruptcy in 2000 and 537 in 2001 (Rovenpor, 2004).

The impact of the dot-com bubble on the economy and on employees has been significant. Due to the consequences of the dot-com bubble approximately 42,000 employees lost their job in 2000, while 99,000 were laid off in 2001 and found themselves in a highly competitive job market. The failure of Internet companies contributed to the slowdown of the entire economy because of the interconnection with other related business fields in consulting, advertising, and computer hardware and software (Rovenpor, 2004). Moreover, several supporting industries had to reduce their operations as demand for their services decreased.

The U.S. Securities and Exchange Commission (SEC) accused several companies and their managers of fraud through the misuse of shareholder equity. The telecommunication company WorldCom, which was found practicing illegal accounting methods to accelerate its profit growth on a yearly basis, committed one of the most significant frauds. When this information went
public, WorldCom’s share price collapsed and the corporation filed the third-largest bankruptcy in U.S. history (Crisis Watch Network, 2011). In September 2002, the former controller of WorldCom, David F. Myers, was found guilty of criminal fraud. He overstated revenues and understated expenditures and thereby committed one of the biggest accounting scandals in the U.S. history (Sidak, 2003).

Furthermore, the SEC fined many top investment firms, including Citigroup and Merrill Lynch, on the basis of fraud and misleading of investors. Specific abuses included IPO spinning and selective favoritism (Levine, 2014). As a result of the dot-com bubble, government regulators and legislators introduced the Sarbanes-Oxley Act in 2002 to bring confidence back into the U.S. stock exchange markets and to increase investor protection by enhancing tighter accounting and financial reporting standards for all publicly traded companies (Siegel, 2008).

The causes and factors that led to the burst of the dot-com bubble have been widely investigated in subsequent research (e.g. Glass, 2001; Perkins, 2001; Tapia, 2003; Valliere & Peterson, 2004; Levine, 2014).

First, it has been found that the lack of accurate business models that include market metrics such as revenue and cash flow have stimulated the development up to the burst of the bubble (Glass, 2001). During the bubble period many Internet firms were lacking focus on traditional finance metrics such as price-to-earnings ratio (P/E) or EBITDA-to-sales ratio. Several firms did not have an adequate positive free cash flow and rather relied on less conventional benchmarks such as the number of new users or number of clicks. As a consequence, some firms even grounded their IPOs on the basis of pageviews and customer retention rates that significantly differed from traditional metrics (Levine, 2014). Therefore, many technology oriented companies obtained substantial funding with the prospect to generate a positive cash flow at a later stage by giving investors the illusion of future success. However, the majority of these dot-com companies failed to turn their business models into profitable and sustainable businesses, which ultimately led to the burst of the bubble (Valliere & Peterson, 2004).

Second, many investors were led to speculative investments by the overwhelming hype targeted towards the Internet and the technology industry (Valliere & Peterson, 2004). Many analysts at large institutional banks wrote false investment recommendations and used high multipliers in their models for valuing Internet companies, which resulted in overly optimistic market valuations for most of the technology companies. Further, many investors failed to
conduct their own due diligence processes based on accurate market metrics. Realistic valuations from conservative analysts were rather ignored because of the overwhelming hype around Internet stocks (Levine, 2014).

Shiller (2005) proposes twelve structural factors that propelled the dot-com bubble in his book ‘Irrational Exuberance’. The factors include cultural and psychological elements, which contribute to irrational decision making processes in investments. These twelve factors are: the capitalist explosion and the ownership society that encourages to invest in stocks, cultural and political changes favoring business success due to the rise in materialistic values, new information technology, supportive monetary policy and the Greenspan put, perceived effects of the baby boomer generation on the markets, an expansion in media reporting of business news, the routinely overoptimistic estimates of financial analysts, the expansion of defined contribution pension plans, the rise of mutual funds, the decline of inflation that created the illusion of wealth and prosperity, the expansion of the volume of trade based on discount brokers and day traders, and the rise of gambling opportunities over the years.

Besides the failures of many corporations during the dot-com bubble, some companies proved to have intrinsic value such as Amazon.com and eBay Inc. that survived the crash following the dot-com bubble and became two of the most dominating players in today’s online e-commerce business. Moreover, Google Inc. emerged to become the leading technology company in Internet related products and services and nowadays builds the foundation for the prosperous Internet world (Levine, 2014). Within the last years, several Internet firms have become increasingly successful again. In 2014, ten information technology firms were among the 100 largest U.S. corporations by revenue (Fortune, 2014).

The latest success stories in the technology field give rise to the question of whether the industry is heading towards a new bubble. Although there has been a considerable amount of publication in media related to a potential new bubble emerging, there is no existing academic work yet that deals with the recent development. The possibility of a development of another bubble in the current technology industry can thus be identified as a research gap that will be further investigated.
2.2. Research on Bubbles

The structure of the following literature review part will be as follows. In section 2.2.1 the term of an economic ‘bubble’ will first be defined in order to gain an understanding of what it actually means. In 2.2.2 then, traditional efficient market theory will briefly be reviewed showing that bubbles have long been thought to be impossible to form and last in financial markets. In 2.2.3 behavioral finance concepts will be introduced to understand extreme market developments, which cannot be explained by the efficient market theory. Chapter 2.2.4 will finally be split into two parts reviewing concepts dealing with irrational and rational investors causing these extreme market developments. Overall, the objective of this chapter is to provide the reader with an understanding of how bubbles develop and why they can persist over longer time periods.

2.2.1. Defining Economic Bubbles

Bubbles and the way they come to exist in an economic context have been the subject of extensive research since many years. As a consequence there is a variety of definitions for the given term. Rosser (2000, p.107) for example gives the following definition: “A speculative bubble exists when the price of something does not equal its market fundamentals for some period of time for reasons other than random shocks. Fundamental is usually argued to be a long-run equilibrium consistent with a general equilibrium”. Brunnermeier (2008) gives a very similar but much shorter definition stating that “bubbles arise if the price [of an asset] exceeds the asset’s fundamental value”.

Even though these definitions are quite precise, Bhattacharya and Yu (2008) find that there is continued disagreement as some researchers posit that the rise and fall of Internet stocks during the late 1990s cannot be regarded as a bubble. Further, Bhattacharya and Yu (2008) find that the disagreement stems from the fact that it is difficult to determine an asset’s fundamental value, which is a combination of future cash flows and discount rates, of which neither can be determined without uncertainty; not even in retrospect.

Ofek and Richardson (2003) attempt to provide a practical solution to this academic dispute by analyzing reasonable upper limits of fundamental values. In their work they posit that if an asset’s price is greater than the discounted value of cash flows, then this price is almost certainly to be seen as the result of a bubble. In their work Ofek and Richardson assume that
the asset’s cash flows are the maximum any company has achieved in the given industry, while the discount rates are as low as possible or even zero.

Over the last couple of centuries there have been a number of episodes with extreme market developments. While the dot-com era is a more recent example, the following developments have already been observed long before. The ‘Dutch Tulip Mania’ (1634-1637), the ‘Mississippi Bubble’ (1719-1720) or also the extreme surge of stock prices before the ‘Great Depression’ in the late 1920’s/early 1930’s serve as historic examples (Brunnermeier, 2008). While some researchers, such as Kindleberger (2011), see these episodes as confirmation for the existence of bubbles, others, such as Garber (1990), still posit that assets were actually traded at prices equivalent to their intrinsic values, even during these extreme periods.

However, the majority of the researchers do not question the existence of the dot-com bubble in the late 1990s (e.g. Brunnermeier & Nagel, 2002; DeLong & Magin, 2006; Glass, 2001; Ofek & Richardson, 2003; Valliere & Peterson, 2004; Griffin, Harris, Shu & Topaloglu, 2011). In this study, we will also follow this reasoning and consider the situation in the late 1990s as a bubble in the technology industry.

2.2.2. Efficient Market Theory and Bubbles

Putting the phenomenon of bubbles into a larger economic context, it does actually appear paradoxical how it should be possible for bubbles to develop, as this contradicts a number of well-established economic theories. The efficient market hypothesis posits that individuals make rational and utility-maximizing investment decisions (Singh, 2012; Shiller 1998). According to the hypothesis, stock prices incorporate all past and current publicly available information and prices can be deduced as optimal estimates of true investment value. The hypothesis is grounded on the assumption that investors behave rationally and maximize expected utility accurately (Shiller, 1998). Therefore, the hypothesis posits that as soon as news that could have a positive or negative impact on the value of an asset becomes public, this information spreads very fast and the price of the asset is thereby adjusted without any delay (Malkiel, 2003). Following this rationale, there should thus be no difference between the price of an asset and the intrinsic value of the asset at any time.

An important feature of the efficient market theory is the proposition that price changes cannot be predicted, but happen in an entirely unsystematic manner. The perfectly efficient market,
thus only shows completely random price changes, which is a pattern that is often referred to as the random walk hypothesis. This means that future changes in asset prices are unpredictable (Lo, 2008). The random walk theory has been tested and supported by a number of researchers in practice (e.g. Cootner, 1962; Fama, 1963; Osborne, 1959), analyzing historical stock price data.

Additionally in line with this research is the so-called no trade theorem, proven by Tirole (1982) and Milgrom and Stokey (1982). The theorem relies on the assumptions that all agents in a market are rational and share identical beliefs and therefore speculative trading above or below the actual value of an asset will not happen (Scheinkman & Xiong, 2004). Furthermore, Tirole (1982) points to a general equilibrium in markets that makes it possible to reject the potential existence of bubbles.

This is the case as it is assumed that all actors in a market act in a rational manner and have access to the same level of information. A bubble under such conditions would mean that the allocation of resources is not pareto efficient. This is the case as the one who sells an asset that is overpriced through the existence of the bubble would be better off than the one who is buying the asset at a too high price. In such a setting, no rational trader would agree to buy the overpriced asset, which thus precludes the development of a bubble under the given circumstances (Tirole, 1982).

Fama (1965) on the other hand posits that traders in a market might only behave in a bounded rational manner. Nevertheless, he still concludes that there will be well-informed arbitrageurs in any case that will buy or sell the given asset, so that the price adjusts quickly. Through this market mechanism, the development of a bubble is thus avoided.

The notion of arbitrage is another important concept within the field of efficient market research. Arbitrage can be defined as an opportunity for an investor to design an investment strategy that allows him to capture risk free profit by exploiting market inefficiencies without the danger of any financial losses (Dybvig & Ross, 2008). An example of this could be the opportunity to borrow and lend money at diverging interest rates, which would allow for simultaneous trading and thus for a risk-free profit. Stocks priced above or below their intrinsic value would represent a similar

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2 A pareto efficient allocation can be defined as follows: “an allocation of resources in the economy is optimal if there is no other productively feasible allocation which made all individuals in the economy at least as well-off, and at least one strictly better off, than they are initially” (Lockwood, 2008).
opportunity for arbitrage seeking investors. In both cases, arbitrageurs would exploit the market inefficiency until the fundamental equilibrium is reached and prices are efficient.

Building up on this, there is another concept called backward induction, which is often used as a framework to explain why bubbles cannot emerge in efficient markets with rational investors. According to Allen, Morris and Postlewaite (1993, p.207), backward induction can be explained as follows: “Suppose that at time $T$ an asset is known to have a final payoff $P_T$. Then at time $T-1$ it must be worth the discounted present value of $P_T$, otherwise there would be an arbitrage opportunity. By extending this argument backward appropriately, it can be seen that at any point in time the value of a stock must be equal to the present discounted value of its future dividends”. Thus, there cannot be any market inefficiencies and bubbles are consequently precluded from emerging at any point in time.

In theory, the only case in which this logic does not hold true is when it can be assumed that the time horizon is of infinite nature so that the final payoff $P_T$ will actually never be paid out. Researchers, such as Samuelson (1958) or Camerer (1989), have developed models building up on the infinite horizon assumption, while others, such as Allen and Gorton (1993) as well as Bhattacharya and Lipman (1995), were able to show that theoretically bubbles can also develop within a finite time horizon. The condition that needs to be fulfilled in such a case though is that there is an unlimited number of trading opportunities within the given time frame.

However, during more recent years a new line of research, often referred to as behavioral finance, has emerged, which does not assume that investors always behave in a fully rational manner. Researchers in this field instead assume that traders frequently let their emotions and their sentiment influence their investment decisions (Baker & Wurgler, 2007). The following part will thus focus on behavioral finance topics, taking into consideration psychological factors as explanation for market developments, which are typically disregarded in conventional financial analysis literature (Fromlet, 2001).

### 2.2.3. Behavioral Finance

Behavioral finance is a relatively new concept in finance that seeks to combine the conventional market theory with behavioral and psychological factors of individuals in finance (Fromlet, 2001).
Olsen (1998) asserts that behavioral finance concepts are superior to traditional paradigms of finance, since these classical models are incomplete because they do not take into account individual behavior. By combining classical theories with psychological factors, behavioral finance has the potential to be a valuable supplement to academic research. Thereby, a more complete model that incorporates the idiosyncrasies of human behavior in financial markets is created (Singh, 2012).

As already explained, classical financial theory, such as the efficient market theory, assumes that individual investment decision-makers are rational and consistently seek to maximize their utility. In contrast, behavioral finance claims that the decision process of individuals is also subject to several cognitive illusions. According to the efficient market theory, bubbles cannot exist as the price of an asset always reflects exactly the intrinsic value of the given asset. If this should at any point not be the case, there will quickly be arbitrageurs benefitting from this temporal market inefficiency. The price of the asset is thereby pushed to its underlying value, which corrects the market to its balance again (Fama, 1965).

In reality however, this balancing apparently does not always work out perfectly since developments as that during the dot-com era would otherwise not exist. It seems paradoxical how it is possible for bubbles to develop despite the theories precluding their origination, assuming that all agents involved in the development acted in their best own interest and in a rational manner. There are various reasons for this discussed among researchers, which will be explained briefly.

Stock prices are generally influenced by new information, for instance about events, which depending on the interpretation of investors can either increase or decrease the stock price of the affected corporation. If an organization for example managed to hire a very skilled CEO, investors might interpret this information as an indication for an increasing future cash flow, through which demand and stock price of the company’s assets would be very likely to rise. If the company on the other hand hires a CEO that is regarded as unqualified by investors, then this would lead to a decrease of the company’s stock price (Warner & Watts, 1988). Therefore, the price of an asset includes investors’ expectations.

However, the problem about this mechanism is that investors and thereby financial markets overall seem to react inefficiently to publicly available information. Behavioral finance literature attempts to explain how emotions and further psychological factors can lead investors to
inefficient decisions, but also why rational traders in markets are not able to exploit such inefficiencies (Bloomfield, 2008). Behavioral finance theories include models in which some agents are inefficient, either because of individual preferences or mistaken beliefs. By doing so, traditional assumptions of expected utility maximization with rational investors in efficient markets do not withstand (Singh, 2012).

The result of such inefficiencies is that markets often tend to either over- or underreact to newly published information, which is likely to affect companies’ stock prices (Bondt & Thaler, 1985). It might be true as Fama (1998) posits, that the proportion of over- or underreactions to new information is roughly equal over long-term periods, meaning that the efficient market hypothesis holds true in the long-run. However, considering these over- or underreactions in the short- and medium-term, it is clear that stock prices do not always reflect information perfectly. Where does this inefficiency created through over- or underreactions in financial markets thus stem from?

Researchers within the field of behavioral finance have found a vast range of answers to this question and developed concepts in order to explain these inefficiencies. Most of these concepts build on psychology and how investors are influenced in their interpretation of information and how they make decisions leading to extreme stock market reactions. In the next section an overview of the most important concepts explaining the origination and persistence of bubbles will be provided, divided into two parts. In the first part, concepts with the assumption that investors are rational and aware of their actions will be reviewed, while the second part deals with irrational investors, who are not necessarily aware of their behavior.

In the development of a bubble, both groups of investors, rational and irrational ones, seek to maximize their profits and buy overpriced stocks. However, the main difference of both groups is that the former one is aware of the overvaluation, while the latter one is not.

2.2.3.1. Rational Investor Concepts

Assuming that all actors in a market act rationally and in their best own interest, it seems difficult to understand how bubbles can come into existence. The following concepts make it possible to understand such developments as market forces sometimes do not allow efficient pricing in reality. Also, rational investors sometimes seem to be better off accepting the development and persistence of bubbles.
**Riding the bubble**

Among researchers who suggest that rational investors might cause bubbles, Brunnermeier and Nagel (2002) find that investors during the dot-com boom were well aware of the existence of a bubble but still kept purchasing overpriced technology stocks and thereby further increased their prices up until March 2000. In their analysis, Brunnermeier and Nagel call these traders rational investors who deliberately decided not to “exert a correcting force on stock prices”, which would have prevented the bubble from coming into existence from the very beginning, or which would have let the bubble burst at a much earlier point (Brunnermeier & Nagel, 2002, p.2013). Hence, these rational investors might rather prefer to “ride bubbles for a while before attacking them, making the actions of rational investors destabilizing rather than stabilizing” (p.2014).

**Limits of arbitrage**

Even though it has been outlined before that any market inefficiencies should be exploited by arbitrageurs, according to efficient market theorists, such as Fama (1965), there are other strands of research dealing with the fact that there are certain limits of arbitrage. Shleifer and Vishny (1997) for instance argue that arbitrage can turn out to be ineffective under extreme circumstances so that assets are priced at levels far from their actual intrinsic values. Arbitrage thus does not appear to work in practice the way it is described in textbooks, which is due to a variety of reasons.

**Short sale constraints**

One of the most regularly cited reasons for the failure of arbitrage as market force leading to imperfect prices is the fact that traders experience short sale constraints in reality. Many efficient market theories do not take this into account (Miller, 1977). Short selling is a method used by traders to exploit arbitrage opportunities by selling stocks that they do not actually own yet, but plan on buying for a lower price in the future. The rationale behind this is that traders speculate on stocks being overpriced and by short selling such stocks, the trader is thus able to make a profit. While this mechanism works to a certain degree, many researchers have found that there are constraints making it less effective. Transaction costs such as the fee that needs to be paid to the current owner of the stock targeted by the short selling trader in order to lend the stocks to the trader would be such a constraint (Jones & Lamont, 2002). Apart from this, there is also a risk that short selling deals fail as stock loans can be recalled, and in many markets institutions impose a number of legal constraints, which make short selling much more difficult and thus less effective in forcing stock prices to its fundamental values.
Synchronization problem
Abreu and Brunnermeier (2003) also find that it might be difficult for rational investors who want to prevent a bubble from growing to do so, because this has to be done in a collective manner. Just one or a few rational investors trying to bring down the price of overvalued stocks will not be successful unless a sufficient number of other investors withdraw their investments from the bubble sector as well. Due to the spread out nature of investors in stock markets, achieving such collective action on purpose is very difficult. This synchronization problem, as Abreu and Brunnermeier call it in their paper, is one of the reasons why bubbles are so difficult to prevent at early stages despite the presence of rational investors, who theoretically could act as price correcting arbitrageurs as soon as any overpriced asset is identified.

Risk of standing alone
In a similar manner DeMarzo, Kaniel and Kremer (2008) established the risk of standing alone model that highlights the fact that relative wealth concerns play an important role in explaining the emergence of bubbles. If rational investors care about their relative wealth in comparison to their peers, they may not wish to trade against the majority. Instead, they may wish to invest in an asset that everyone else in their peer group invests in. If this happens shortly before the burst of a bubble, this leads to substantial losses as investors’ relative wealth concerns make them follow the herd and afraid to trade against the crowd.

Herd behavior
Herd behavior has been widely covered in academic literature and might be the most generally recognized observation on financial markets in a psychological context (Dass, Massa, & Patgiri, 2008; Johnsson et al., 2002; Shiller, 2005). Herd behavior is observable when individuals conform to the majority of others by following their actions instead of taking their own independent decisions. The social influence of groups has an immense power on individuals. When individuals are confronted with the judgment of a large group of people, which might differ from their own judgment, then they often tend to change their answers (Jonsson et al., 2002).

This is to be seen as rational behavior, since individuals have learned in everyday life that when a large group of people is consentaneous in their judgments, they are most probably right. The common rationale is that it is unlikely that such a large group could be wrong (Shiller, 2005). In the same manner, herd behavior can play a role in the development of bubbles as there is a tendency of individuals to observe winners very closely, especially when strong results are
achieved several times. Individuals tend to follow these groups of winners, assuming that they know something, which in fact they do not know. This results in individuals gravitating towards similar investments, grounded almost only on the basis that many others are investing in certain assets. This behavior, although individually potentially rational, leads to group behavior that is irrational and might cause the development of a bubble (Jonsson et al., 2002).

**Relative scale performance**
Similar to this, Dass et al. (2008), argue that bubbles can be explained by herding among traders. Investors are induced to herd if the market and contract incentives for herding are strong. While social pressure of conformity leads to herding, another reason among traders is that their evaluations are based on a performance scale relative to other traders. Therefore, herding can be reduced by evaluating traders on an absolute performance scale, such as profits, instead of evaluating them on a relative scale to other traders.

**Asymmetric information levels**
Asymmetric information levels among investors in a market can be identified as another source of bubbles emerging and persisting over time. This is be the case as long as traders remain asymmetrically informed (Brunnermeier, 2008). In such cases, even though all agents involved act in a fully rational manner individually, the outcomes or the stock prices perceived as correct by some actors might differ from the stock's intrinsic value. This is the result of different information availability levels of each investor group.

Löfgren, Persson and Weibull (2002) find that situations in which sellers and buyers have asymmetric information levels emerge on a regular basis within the field of financial markets, but also in other areas of bargaining. Typically, a job applicant for example knows more about his abilities than his potential employer, who needs to take a decision based on his imperfect information level. In a similar manner, the seller of an asset might know more about the actual value of the asset than the buyer who might be unable to obtain the information he would need, in order to properly assess the value of the asset he wants to buy.

Joseph Stiglitz is among the most influential researchers, cautioning in several of his research papers about the importance to consider asymmetric information. Classical economic models though, such as the efficient market theorem, typically fail to take into account this consideration. According to Greenwald and Stiglitz (1990), classical economic models are
consequently often misleading when applying them to analyze economic developments and to give recommendations on what actions should be best from an economic point of view.

In two of their papers, Stiglitz and Weiss (1981; 1983) were for instance able to show that imperfectly informed banks should not increase their lending rate, as suggested by classical economic theories, but would rather benefit from rationing the volume of loans. As credit rationing is a very common practice, Stiglitz has been able to provide a much more realistic theory of credit markets than many other researchers, who purely relied on classical economic models.

Overall, assuming that all traders do actually act in a rational manner, Brunnermeier (2008) concludes that traders will only buy and hold an overvalued stock if the bubble can be expected to continue ad infinitum. As this appears unrealistic when considering historical developments, this implies that there has to be some degree of irrationality among traders, as the efficient market theory would otherwise hold true. The following part is thus a review of theories, dealing with irrational traders that buy stocks without actually realizing that these are overvalued, as they believe that they will be able to sell them for an even higher price in the future.

2.2.3.2. Irrational Investor Concepts

Assuming that investors are to be seen as irrational in their behavior, at least to a certain extent, helps to explain market trends that cannot be explained by traditional financial literature (Johnsson et al., 2002). As already elaborated, the term behavioral finance also includes research within this field, assuming that investors are not always acting rationally, contrary to the traditional efficient market hypothesis that is still defended by renowned academics such as Keynes, Friedman and Fama. The following concepts are among the most important ones to gain an understanding of behavioral finance and the impact of irrational investors.

Overconfidence and illusion of control

According to Fromlet (2001), investor overconfidence and the illusion of control are among the most relevant explanations for irrational investment decisions, as individuals often tend to be overconfident about their abilities. Also Shiller (2005) finds that overconfidence and wrong intuitive judgment are major roots for volatile markets. As he puts it, “many people think they know more than they do” (p.155). The classic behavioral characteristics of overconfidence lead many individuals to believe that they can always select the best investment. Furthermore, it also
leads many individuals to overestimate their predictive ability (Singh, 2012). There are psychological experiments proving this. The psychologists Fischhof, Slovic and Lichtenstein (1977) conducted an experiment in which they asked their participants to answer a simple factual question and to estimate the likelihood that their answer is correct. The results showed that people consistently overestimated the quality of their answers and actually expressed opinions on topics they knew little about (Shiller, 2005).

**Level of attention**

Another factor influencing the decision quality of investors is the level of attention on relevant data and information, or rather the lack thereof. As Barber and Odean (2001) point out, there is such an enormous amount of information available on a daily basis that makes it difficult for investors to know which information to put their focus on. They also find that investors might as a consequence of this ‘information overload’ tend to focus too much on current data, while past data could still be more relevant in order to make the right decision. These findings are confirmed by Daniel, Hirshleifer and Teoh (2002), who even find that investors might be led to focus their attention on less relevant data, due to the fact that other parties, such as brokers or analysts, could have an incentive to manipulate data or the evident importance of that data.

**Noise trading**

Related to this issue of investor attention is the topic of noise trading. Noise traders are to be seen as irrational investors causing non-efficient market transactions, as they erroneously believe to recognize stochastic market trends, which are in fact not to be recognized as such. These investors often make investment decisions without the use of any fundamental data. Noise traders are nevertheless sometimes able to earn higher returns than rational investors, and therefore can survive over long periods (De Long et al., 1990).

The reason for this is that noise trading in combination with the already mentioned concept of herd behavior can lead to entirely irrational market developments. As Johnsson et al. (2002) describe in their work, individuals often tend to conform with their environment when they need to take decisions. This behavior referred to as herd behavior means that investors might want to take a rational decision, however are not able to do so, because they see that the majority of their colleagues decide differently.

Other researchers even go as far as saying that the whole emergence of bubbles can be related back to herd behavior among stock traders who ‘infect’ one another with their irrational behavior.
and thereby push the market towards “equilibrium prices, which deviate from fundamental values” (Lux, 1995, p.881). It should be noted that while it has been mentioned earlier in this paper that herd behavior among investors can be regarded as rational trader behavior, this only holds true for individual investors who want to avoid ‘the risk of standing alone’. When judging the behavior of the collective, which are thus all traders herding together, the overall group behavior has to be seen as irrational (Jonsson et al., 2002).

**Heterogenous beliefs**

Scheinkman and Xiong (2004) on the other hand find that investors do not always follow the herd but have heterogeneous beliefs and consequent interpretations when receiving identical information, which is also likely to influence stock prices in an irrational manner. In their work, the authors identify investor overconfidence as a source of heterogeneous beliefs, meaning that individual investors believe too much that they are able to evaluate the given information better, relative to all other traders in the market. While some traders might thus estimate the value of stocks correctly, Miller (1977) posits that, if differences in estimations of stock values are sufficiently big, the market price is likely to adjust to the estimations of the more optimistic investors. Therefore, bubbles tend to build up with stock prices higher than the fundamental values of the stocks.

**Heuristics**

Heuristics is a process of problem solving and learning, which employs a practical approach that does not guarantee to lead to perfect results, but is often sufficient to reach the immediate target. The approach has become increasingly popular in financial markets. Based on the fact that more and more information is spread faster, due to the rise of information technology, life for decision makers in financial markets has become more complicated. This implies an increased use of the heuristic approach, which often results in a fast and selective interpretation of information, determined to a high extend by intuition (Fromlet, 2001).

For example, a trader has to interpret incoming information rapidly, after several critical economic indicators are published at the same time. The interpretation of these indicators may require heuristic decision-making rules, which might later have to be reconsidered. In this case the heuristic approach is inevitable due to time pressure, but not necessarily advantageous. Unfortunately, all too often heuristics leads to biases and results in suboptimal investment decisions (Singh, 2012). Therefore, heuristics can explain why markets are sometimes acting in
an irrational manner, which is contradictory to the theory of perfectly efficient markets (Fromlet, 2001).

**Anchoring**

Another irrational concept that can explain why markets sometimes behave overly volatile is anchoring. The concept of anchoring is built on the tendency that an individual attaches his thought to a reference point, which is called the ‘anchor’. This might be the case even though the anchor possibly has no rational relevance to the decision at hand. Often, the anchor is the most recently remembered price, because in the absence of any other information, past prices might be a good indication for today’s prices (Jonsson et al., 2002). As long as past prices are taken as a suggestion of new prices, the new prices tend to be similar to past prices (Shiller, 1998).

However, research shows that estimated past figures are often regarded as too important when considering their impact of the actual outcome (Fromlet, 2001). As an example, assume the stock of a company is trading at $100 per share. The company then announces a 200% earnings decrease, but its stock price decreases only to, say, $98 a share. The small decline happens because investors are anchored to the $100 per share price. They tend to believe that the earnings decrease is temporary, even if the company will most likely maintain its low earnings level (Singh, 2012). Therefore, the concept of anchoring is contrary to the previously mentioned concept of level of attention.

**Loss aversion**

Kahneman and Tversky (1991) developed a theory that explains how individuals behave when confronted with choices under uncertainty, like investing in a stock market. Their value function exhibits the asymmetry between the values that individuals put on gains and losses. The theory is based on the idea that the mental penalty associated with a given loss is about twice as heavy as the mental reward associated with a gain of the same size. In other words, losing $1 is about two times as painful as winning $1.

This can also be observed in financial markets as the phenomenon in which individuals tend to be reluctant to realize losses and may even take increasing risks to escape from a losing position. Further, it can also often be observed that individuals hold on to a losing position in the hope that the stock price will eventually recover to previous levels (Singh, 2012). Consequently, loss aversion can also explain why investors tend to hold declining stocks for too long during
bear markets and sell winning stocks too early during bull markets. This phenomenon, which can lead to stock market anomalies, is also known as the ‘disposition effect’ in literature (Shefrin & Statman, 1985).

Overall, concluding on literature on the topic of bubbles, it can be seen that there is a large number of concepts and theories. Many of these theories are very similar, either assuming that the investor is to be seen as rational or irrational, or even both to a certain degree. All the theories and concepts have in common, that they are able to explain stock market anomalies to some extent, which might lead to the development of a distorted market or a bubble in the market. In the next part, the value relevance model, a concrete framework that makes it possible to obtain an indication of how much market values of companies are based on accounting fundamentals will be introduced. A brief review of studies working with the model will be given, which serves as a background to better understand the value relevance analysis of the technology industry that will follow later in this paper.

### 2.3. The Value Relevance Model

The previous chapter raises the possibility that markets do not always behave in a rational manner. In fact, behavioral finance researchers claim that markets may even be driven more by human behavior characteristics than by market forces as classical financial theories would predict. Assuming that behavioral finance economists are at least to some extent correct in that the stock market behaves irrational from time to time, Morris and Alam (2012) argue that one of these times was during the dot-com bubble period. Therefore, the irrationality phenomenon could help to explain why bubbles sometimes arise and why traditional accounting information during these periods cannot explain to a large extent the market equity of these firms.

The impact of traditional accounting fundamentals on equity values during the dot-com bubble has been researched widely in academic literature (Brown, Lo & Lys, 1999; Collins, Maydew & Weiss, 1997; Core, Guay & Van Buskirk, 2003; Francis & Schipper, 1999; Lev & Thiagarajan, 1993; Ohlson, 1995). In general, researchers in existing empirical literature attempt to document how much of the firm’s equity can be explained by accounting fundamentals such as income, capital expenditures, and other related financial figures. However, during the period of the dot-com bubble, some researchers called the traditional relationship between accounting fundamentals and equity values into question.
The growing number of Internet users and e-commerce shops, as well as high price-to-earnings ratios of some companies, have led researchers to suggest that these developments were triggered by developments in the new economy period, in which equity valuations were different compared to those in previous periods. A minority group of researchers claimed that in the new economy period metrics, such as number of clicks or homepage views, were rather appropriate than traditional accounting fundamentals (Penman, 2003). Others, like Krugman (2004) and Stiglitz (2004), have argued that poor accounting standards have contributed to the inflated bull market before the dot-com bubble burst in the late 1990s.

In order to conduct an analysis to determine to which degree equity values of firms during a certain period of time are defined by accounting fundamentals or other factors, such as irrational investment behavior, various researchers have developed models, which can be applied for this purpose. Ohlson (1995) has been among the first ones to “model the market value of equity (price) as a function of current book value plus the present value of future earnings” (Morris & Alam, 2012, p.245). Ohlson (1995) developed the model in order to provide a basis for benchmarking and to make it possible to conceptualize the relationship between company market values and fundamental accounting variables as well as other information.

Other researchers (e.g. Brown et al., 1999; Collins et al., 1997; Core et al., 2003; Francis & Schipper, 1999; Lev & Thiagarajan, 1993) have subsequently altered this basic model in several ways turning it into a suitable tool to investigate the relationship between market equity values and fundamental accounting variables. For example, Core et al. (2003) studied a broad firm sample over 25 years, lasting from 1975 until 1999, to investigate whether, and to what extent, traditional proxies for future cash flows are relevant for describing equity values of firms operating in the new economy period.

As Balachandran and Mohanram (2011) put it, the measurement of value relevance can be interpreted as the share that financial information explains in relation to all other factors that have an impact on market value. Moreover, Lev and Zarowin (1999) find that conservative accounting methods, especially for intangibles, such as research and development (R&D) and advertising expenses, are potentially a reason for a decreasing value relevance. The international management consultancy ‘Stern Stewart’ for instance prepares adjusted balance sheets and income statements as they argue that “GAAP accounting is no longer what counts” (Balachandran & Mohanram, 2011, p.6).
Among the many studies investigating this topic, most documented results, which describe a significant decline in the linear relationship between earnings and stock returns during bubble periods and therefore an increase of behavioral investments. This relation shows that accounting fundamentals had less explanatory power for company market values during the dot-com bubble in the late 1990s and the early 2000s (Morris & Alam, 2012).

One of the latest studies on the topic of value relevance was performed by Morris and Alam (2012) in order to test the impact that accounting fundamentals have on market equity values before, during, and after the dot-com bubble period during the late 1990s. Specifically, they assessed the value relevance of accounting fundamentals during the period surrounding the dot-com bubble from 1995 to 2000. What Morris and Alam prove in their paper is that the value relevance of accounting fundamentals in the technology industry, as measured by the adjusted $R^2$, decreased consistently over the five to ten years leading towards the burst of the bubble in the year 2000. In this respect, the authors of the paper were able to confirm other authors (e.g. Binswanger, 2004; Core et al., 2003; Sinha & Watts, 2001) that similarly found a decline in value relevance of accounting fundamentals, which they relate to the bubble that built up during these years in the technology industry.

The new contribution that Morris and Alam (2012) achieved in their work is that by extending the given model to 2006, they were able to show that the accounting variables increased considerably again in value relevance in the technology industry during the years following the burst of the dot-com bubble in March 2000, expressed by an increasing adjusted $R^2$ of the model. These results are of interest for academics, since the decline in value relevance in the technology industry that has been identified by several academics in previous research appeared to have stopped and reversed in the post bubble period starting in 2000. Further, for investors, the decline in value relevance during the dot-com bubble, followed by the increase in value relevance after the collapse of the bubble, suggests that reliance on traditional accounting fundamentals for investment decision making still has merit in non-bubble periods.

The finding that the value relevance of accounting fundamentals in the technology industry increased again after the burst of the dot-com bubble was interpreted by Morris and Alam as an indication that investors may have returned to a more fundamental approach of equity valuation of firms, and thereby to less behavioral investment methods. These results tend to support the argument that during the dot-com bubble period the market may have behaved less rational
than it did before or after the bubble. Therefore, the results confirm the theories of several behavioral finance economists that markets behave irrational from time to time.

3. Methodology

This chapter focuses on the strategic choices of the paper and the research design. The methodology is based on the previously mentioned literature review and explains the process of how an answer to the research question in this study will be found. The data collection and research method will be outlined to allow a deeper understanding of this study. The research method will be based on quantitative data and the research design will be descriptive and explorative. Therefore, two different research designs will be applied.

The first part includes a NASDAQ Composite Index analysis of several financial indicators measured in December 1999, just before the bubble burst, and measured in December 2014 to observe and compare the current situation of the NASDAQ to the one during the dot-com bubble. The NASDAQ Composite Index was chosen, because of its nature to be strongly oriented towards the technology industry. Therefore, the NASDAQ Composite Index can serve as a first indicator, to what extent bubble developments can be observed in the technology industry. This descriptive research part will be used as a precursor to give valuable pointers as to what should be focused on in the second part.

The second and main part of the analysis then consists of the value relevance model used by Morris and Alam (2012) that has been introduced in the previous literature review. The design of the model will be replicated and extended with new data until 2014, which has not been done yet in academic literature. The study aims to determine the relationship between companies' market values and traditional accounting fundamentals. Moreover, the objective of applying this model is to assess whether or not indication can be found that the technology industry is heading towards a new bubble development and if corrective actions need to be taken. Ultimately, the study might be able to provide indication to what degree the market is currently developing in a rational or behavioral manner.

3.1. NASDAQ Composite Index Analysis

The research design of the NASDAQ Composite Index analysis is descriptive. The main objective of this research is to understand the data and the characteristics about what is being
studied rather than gathering the causes that are behind the development. Several potential bubble indicators of the current situation will be assessed, and compared to the former situation during the dot-com bubble. This type of research will be used to study current frequencies, averages and other statistical calculations of the NASDAQ Composite Index and other major indexes. The research consists of the following two sections: First, the NASDAQ Composite Index in 1999 vs. 2014 and second, the NASDAQ Composite Index vs. other major U.S. indexes.

The NASDAQ Composite Index analysis will mainly focus on today and the former dot-com bubble period. The first point in time will hence be December 1999, just before the bubble hit its peak and started to burst, while the second point in time will be December 2014, which reflects the current market situation. Several financial indicators will be analyzed to compare the former dot-com bubble situation of the technology industry to the current situation. Furthermore, the composition of the index in 1999 will be examined and compared to the composition in 2014. Therefore, the first part of the analysis provides a snapshot to evaluate different financial indicators in the technology industry of the dot-com bubble period and today.

The analysis of the NASDAQ Composite Index will start off with a graph of the index, showing its value from 1995 to 2014. This period has been chosen in order to show how the index developed towards the dot-com era before the burst in March 2000, and also to illustrate how the index developed after the burst of the bubble until now.

Further, the composition of the NASDAQ Composite Index will be studied by assessing how many components were listed then and now, and also by examining how many of the components that were already listed during the dot-com era, are still part of the NASDAQ Composite Index today. Apart from this, the average age of components will provide an indication of how mature the listed components are.

Also, analyzing the absolute- and average market capitalization of components allows us to evaluate the size of the components, and hence their volatility. Usually, it can be assumed that there is a negative correlation between the size of the market capitalization of a component and its volatility (Domowitz, Glen & Madhavan, 2001).

Moreover, by taking into consideration the ten biggest components of the NASDAQ Composite Index then and now, a snapshot of the dominating corporations will be given. This makes it
possible to see which types of companies are the largest ones in terms of market capitalization and how they changed over the years. Taking this further, it will be useful to compare the level of technology concentration among NASDAQ Composite components, which will be done by classifying the components according to the standard industrial classification\(^3\) (SIC) system. This allows to document to which degree the NASDAQ Composite Index is composed of technology companies and if this has changed since the dot-com era.

Besides that, it will also be useful to consider important ratios such as the price-to-earnings ratio (P/E) and price-to-book ratio (P/B), which are common valuation indicators for companies. Generally, high P/E ratios and P/B ratios indicate potentially overvalued stocks, whereas low P/E ratios and P/B ratios typically indicate undervalued stocks (Bondt & Thaler, 1985). Further indicators, such as the dividend yield and index earnings, will also be compared. These can be used to estimate future performance and might give evidence about companies’ fundamentals (Zaremba & Konieczka, 2014).

In order to allow for benchmarking, the development and performance of the last twenty years of the NASDAQ Composite Index will further be compared to the development and performance of the Standard & Poor’s 500 Index (S&P 500) and the Dow Jones Industrial Average Index (Dow Jones). All three indexes will be rebased at 100 points starting in 1995 to make a performance comparison possible over the years. The peer comparison is a widely used and accepted method for equity analysis (Little, 2015).

Thereby, the analysis aims to make a comparison between a more technology concentrated index and less technology concentrated index possible. By doing so, we can identify if potential bubble developments can be mainly seen in the technology industry or if they are present in other, non-technology oriented industries, as well.

First, we will present the three indexes during the dot-com bubble period (1995 until 2002). Second, we will present the indexes over the last ten years, including the current bull market (2005 until 2014). By dividing the comparison of the NASDAQ Composite Index with its peer indexes into two different time frames, it is furthermore possible to illustrate how the NASDAQ

\(^3\) The SIC system is a standard series of four-digit codes created by the U.S. government in 1937 to categorize business activities (SIC Code, 2015). In the NASDAQ Composite Index analysis, technology companies are defined as businesses in the following fields: prepackaged software, electronic computers, semiconductors, information retrieval and cable television.
Composite performed in relative terms to the Dow Jones and the S&P 500. Then, analyzing the same graph for the period from 2005 until 2014 enables us to point out similarities and differences in the development of the NASDAQ during the dot-com bubble and during recent years.

As a last part, to conclude the NASDAQ Composite analysis, several performance statistics of the NASDAQ Composite, S&P 500, Dow Jones and the NASDAQ-100\(^4\) will be analyzed. These include average annual price returns, average annual total returns, standard deviations, correlations with the NASDAQ Composite Index, market capitalizations, and P/E ratios for all four indexes. Comparing the four indexes on the basis of these indicators exhibits how the NASDAQ Composite Index compares in relation to its peers in terms of return and volatility over time.

### 3.2. Value Relevance Model

The second and main part of the analysis focuses on the value relevance model that has been developed by Core et al. (2003) and applied by Morris and Alam (2012). The methodology of the model will to a certain degree be replicated and further extended with new data until 2014. This study will be explorative and is based on quantitative data extracted from the publicly available databases Compustat and CRSP. The objective of applying the given model is to identify the relationship between the included companies' market values and traditional accounting fundamentals. Finally, the aim of applying this model is to evaluate whether or not indication can be found that the technology industry is heading towards a new bubble.

#### 3.2.1. Research Method and Model

The value relevance model has been applied by several researchers to test the impact of accounting fundamentals on market equity values during the new economy period. Morris and Alam (2012) applied the model analyzing the situation before, during, and after the dot-com bubble and discovered that the relevance of accounting information decreased consistently over the years preceding the burst of the bubble in 2000, and thereby confirmed the results of other authors (e.g. Binswanger, 2004; Core et al., 2003; Sinha & Watts, 2001).

\(^4\) NASDAQ-100 includes 100 of the largest U.S. domestic and international nonfinancial companies listed on the NASDAQ Stock Market based on market capitalization (NASDAQ, 2015).
Methodology

However, Morris and Alam (2012) also documented that after the collapse of the bubble in 2000, this trend reversed and that the accounting variables increased considerably again in value relevance until 2006 for the technology industry. To our knowledge, this model has recently not been applied anymore in academic literature to investigate the impact of accounting fundamentals on market equity values. Therefore, by applying the model and extending it until 2013 in our analysis we will provide valuable information, if the relevance of accounting information is currently decreasing again, as it was seen during the bubble period. By doing so, it will be possible to assess to what extent the technology industry is heading towards another bubble. To test if a potential change in value relevance of the model in the technology industry can also be observed in other industries, a comparison to the low-tech industry will be conducted.

We chose the year 2000 in this explorative study as the first year of the value relevance model since this is the year that the dot-com bubble reached its peak. The model’s year 2000 corresponds to firms with a fiscal year ending between June 2000 and May 2001. The dependent variable of the model corresponds to firms with a fiscal year ending between October 2000 and September 2001, as will be elaborated on later. The end of availability of current data determines the last fiscal year of this study, which consequently reaches until September 2014. Therefore, 2013 will be the last year of the model since it contains firm’s’ fiscal year data from June 2013 until September 2014. Even though we are mainly interested in the most recent development of the value relevance model, we have chosen a 14-year sample period to lessen concerns about shifts in the market development and to evaluate the recent years in an appropriate context.

Even though other researchers, such as Core et al. (2003) and Morris and Alam (2012), have used the value relevance model to study developments in the technology sector from 1975 until 1999 and from 1989 until 2006 respectively, we have chosen to study the more recent period lasting from 2000 until 2013. The reason for this is that we do not intend to test their results, but rather to employ their research model and extend it in order to gain new insights about current developments in the technology industry.

The study’s objective, like Morris and Alam’s (2012), is to select accounting fundamentals that empirically and theoretically allow to describe cross-sectional variation in equity prices, and therefore variables that are expected to be robust over time. Therefore, we will identify how
much variation of the dependent variable can be explained by variation in traditional accounting variables, and how much of that variation is caused by other factors that are uncorrelated with the independent variables in our regression model. Within our analysis, we take into consideration that a change in the relation between firm value and our independent variables may have occurred over the years. That means, we are seeking for indication in the development of the data to see as to whether valuations in recent years are unusual by comparing recent changes to changes over the entire 14-year period. However, the objective of this study is not to test the value relevance model against other constructed models, and therefore, not to maximize the fit and accuracy of any particular model.

Morris and Alam (2012) conducted their research until 2006, which included the bubble period as well as the post bubble period. The period that is overlapping from Morris and Alam’s (2012) and our model can be used as a reference point for comparison purposes. Therefore, this allows to cross check if the model that is applied in this study works appropriately and yields reliable results. The formulation of Morris and Alam’s (2012) model is appropriate for our study because it includes more detailed accounting and financial data points than previously used models (e.g. Brown et al., 1999; Collins et al., 1997; Core et al., 2003; Francis & Schipper, 1999; Lev & Thiagarajan, 1993).

Following the literature in accounting that implicitly or explicitly follows Ohlson (1995), in this study we regress the market value of equity on the book value of equity, current earnings, and proxies for expected earnings growth. Consistent with other studies, we restrict the sample to firms with positive book value in our study. The variable ‘income before extraordinary items’ will be used as the measure of current earnings, and a variable for loss years will be used because previous literature mentions differences in the valuation of profits and losses and therefore different slope coefficients will be allowed.

Furthermore, several proxies will be included for the expected growth in earnings. Collins, Kothari, Shanken and Sloan (1994) report that the loss in explanatory power can be reduced by including growth proxies in regression models of equity value. Therefore, advertising expenditures and R&D expenditures of each firm will be included in the model to capture expected growth in prospective earnings through investments in intangible assets. Further, capital expenditures of each firm will be included to capture expected growth in earnings
through novel investments in tangible assets. Finally, sales growth over the years for every firm will be calculated and included as an additional proxy for future earnings growth in the model.

The following is the empirical equation (1) of interest:

\[
MVE_{i,t+4m} = \alpha_0 + \alpha_1 (BVE)_{i,t} + \alpha_2 (IBX)_{i,t} + \alpha_3 (NEG_IBX)_{i,t} + \alpha_4 (RND)_{i,t} + \alpha_5 (ADVERT)_{i,t} + \alpha_6 (CAP_EX)_{i,t} + \alpha_7 (SALES_GR)_{i,t} + \epsilon,
\]

where MVE is the market value of equity for firm i four months\(^5\) after fiscal-year end \(t\) (obtained from CRSP by multiplying the number of common shares outstanding #CSHOQ and the share price monthly close #PRCCM); BVE is book value of equity for firm i at fiscal-year end \(t\) (Compustat item #60); IBX is net income before extraordinary items for firm i for fiscal-year \(t\) (Compustat item #18); NEG_IBX is net income before extraordinary items for firm i for fiscal-year \(t\) if <0, otherwise = 0 (Compustat item #18); RND is research and development expenditures for firm i for fiscal-year \(t\) (Compustat item #46); ADVERT is advertising expenditures for firm i for fiscal-year \(t\) (Compustat item #45); CAP_EX is capital expenditures for firm i for fiscal-year \(t\) (Compustat item #30); SALES_GR is one year change in sales for firm i for fiscal-year \(t\) (change in Compustat item #12).

Based on previous research, we expect a positive coefficient on each of the variables except for the variable NEG_IBX, which both Core et al. (2003) and Collins et al. (1997) found to be negative.

All variables except for market value of equity are measured at the end of the fiscal year. The variable market value of equity is measured four months after the end of the fiscal year (e.g. for a fiscal year of a firm ending between June 2000 and May 2001 the market value will be calculated four months later between October 2000 and September 2001) to ensure that the financial data has become publicly available.

In line with prior research, we use the adjusted \(R^2\) to measure the value relevance of accounting fundamentals (Brown et al., 1999; Collins et al., 1997; Hand, 2005; Ryan & Zarowin, 2003). The adjusted \(R^2\) is a statistical measure that shows how well the given data set fits the regression

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\(^5\) The four month lag for the market value of equity is usual practice in accounting research to allow the market to incorporate results of the previous fiscal year financial reports and to ensure that the financial data has become publicly available.
model and thereby exhibits to what degree the actual results are replicated by the model. The $R^2$ is always in the range between 0 and 1. The closer it is to 0, the lower the explanation power of the data, and the closer it is to 1, the stronger the explanation power of the data (Draper, Smith & Pownell, 1966).

However, Brown et al. (1999) warn academics that the use of per share or firm level data can lead to deceptive results when comparing the adjusted $R^2$ values from different samples unless the scale factor effect on the estimated coefficients will be controlled. Brown et al. (1999) exhibit that in two previous studies the adjusted $R^2$ values were rising, when the scale factor effect was not controlled. However, after controlling for the effect the values fell to the correct and specified level. Therefore, equation (1), as it has been shown above, is not suitable yet for the analysis we intend to perform. To control for this effect and to make equation (1) applicable for this study, we deflate the equation by the book value of equity to ensure that the adjusted $R^2$ values are well specified. Further, the approach of scaling by the book value of equity is consistent with several other valuation studies in the new economy period (e.g. Core et al., 2003; Morris & Alam, 2012; Rajgopal, Kothari & Venkatachalam, 2000).

The following is the deflated empirical equation (2) of interest:

$$MVE_{i,t} + 4m_{i,t}/BVE = \alpha_0 (1/BVE)_{i,t} + \alpha_1 + \alpha_2 (IBX/BVE)_{i,t} + \alpha_3 (NEG_IBX/BVE)_{i,t} + \alpha_4 (RND/BVE)_{i,t} + \alpha_5 (ADVERT/BVE)_{i,t} + \alpha_6 (CAP_EX/BVE)_{i,t} + \alpha_7 (SALES_GR/BVE)_{i,t} + \epsilon.$$  

Equation (2) will consequently be the one used in the value relevance analysis, performed as part of this paper. After having established the framework, the following part will now focus on the selection of the sample data and the processing of the data.

### 3.2.2. Sample Data Selection Method

As it has already been established in the previous section, the data required to apply the value relevance model to the current development in the high technology sector can be extracted from the Wharton Research Data Services (WRDS) system, provided and administered by the University of Pennsylvania.
Within the WRDS system there is a broad variety of databases available from which data can be obtained for research purposes. In the given case data needs to be extracted from the Compustat database as well as the CRSP database, which have also been used by other researchers such as Core et al. (2003) as well as Morris and Alam (2012), who used the same value relevance model in their respective studies.

The Compustat database is used in order to extract the independent variables for the value relevance regression analysis that have been explained in part 3.2.1, while the CRSP database is used to obtain the dependent variable of the applied model, the market value of each of the included companies. The data set used in our value relevance analysis has been extracted from the Compustat and CRSP databases in April 2015.

Fiscal years in the value relevance analysis in this study are defined according to Compustat database conventions, which is how other authors in the research field such as Core et al. (2003) and Morris and Alam (2012) handle the topic as well. According to these conventions, the model’s year 2000 for instance requires data to be extracted from the database lasting from June 2000 until May 2001. This adjustment of dates is required due to the fact that many companies do not finalize their financial reports until the end of a calendar year, but rather within the next months of the following year.

This procedure of working with data for each year lasting from June till May of the respectively following year is, however, only applied for the independent variables included in the given research model (1/BVE, IBX/BVE, RND/BVE, ADVERT/BVE, CAP_EX/BVE and SALES_GR/BVE). For the dependent variable, the market-to-book ratio (MVE/BVE), the four month lag has to be taken into consideration meaning that this variable is to be extracted from October 2000 until September 2001 for the year 2000 and likewise for each of the following years.

It should be noted though, that the MVE variable with the four month lag cannot be extracted as easily from any available database as this is possible for the other variables. Through Compustat the data is only provided on a yearly or quarterly basis. In order to obtain the required MVE data set at the right point in time, it is thus necessary to make use of the CRSP database, which is also available through the WRDS system. In the CRSP database, the MVE variable cannot be extracted directly; however, it is possible to download the stocks’ closing price (PRCCM) and the number of outstanding shares (CSHOQ) for all companies of interest.
After having done this and after exporting the described data set to Microsoft Excel, it is then possible to obtain the market value (MVE) variable for all included companies on a monthly basis by multiplying the closing price (PRCCM) with the number of common outstanding shares (CSHOQ). Whenever the closing price (PRCMM) for a specific month is missing for a company, the price of the previous month for that company has been used as a proxy. Having done this, it is subsequently necessary to match the MVE variables with the other independent variables in a manner so that the MVE variables are always four months ‘older’ than the other variables. Before using the MVE variable as the dependent variable in the regression model, the variable needs to be divided by the BVE variable, so that the model is deflated as described for the other variables in the previous section. The final dependent variable will then be denoted as MVE/BVE.

Since the aim of this study is to find out whether the current development in the technology sector might be interpreted as the development of another bubble, similar to that during the dot-com era, it is furthermore important to limit the data set to a suitable set of companies. This can be achieved by making use of the high-tech classification scheme, as shown below in Table 1, in order to ensure that only high-tech data is included. The classification scheme has been developed by Francis and Schipper (1999) on the basis of whether or not companies in a specific industry are likely to have a substantial amount of unrecorded intangible assets, which high-tech companies typically do.
Table 1: SIC Code Groups Classified as High-tech

<table>
<thead>
<tr>
<th>SIC Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>283</td>
<td>Drugs</td>
</tr>
<tr>
<td>357</td>
<td>Computer and office equipment</td>
</tr>
<tr>
<td>360</td>
<td>Electrical machinery and equipment, excluding computers</td>
</tr>
<tr>
<td>361</td>
<td>Electrical transmission and distribution equipment</td>
</tr>
<tr>
<td>362</td>
<td>Electrical industrial apparatus</td>
</tr>
<tr>
<td>363</td>
<td>Household appliances</td>
</tr>
<tr>
<td>364</td>
<td>Electrical lighting and writing</td>
</tr>
<tr>
<td>365</td>
<td>Household audio, video equipment, audio receiving</td>
</tr>
<tr>
<td>366</td>
<td>Computer equipment</td>
</tr>
<tr>
<td>368</td>
<td>Computer hardware</td>
</tr>
<tr>
<td>481</td>
<td>Telephone communications</td>
</tr>
<tr>
<td>737</td>
<td>Computer programming, software, data processing</td>
</tr>
<tr>
<td>873</td>
<td>Research, development, testing services</td>
</tr>
</tbody>
</table>


When using the listed SIC code groups to obtain data from the Compustat database, it should be noted that the database requires four-digit codes in order to provide the required data. The first three digits determine the industry group and the last digit that has to be added describes the division within the specific industries. For example, industry 283, which is generally denoted as 'drugs' contains four sub divisions with the codes 2833, 2834, 2835 and 2836 (SIC Code, 2015). In total the 13 SIC code groups contain 33 sub divisions that are thus the basis of our data set.

After extracting the variables described above for all companies included in the SIC code groups provided in Table 1, a few steps need to be taken to ensure that the data set does not contain errors and regression results will not be overly influenced by extreme values. These steps have already been established by prior researchers and will be explained in the following:

First of all, like Brown et al. (1999), Collins et al. (1997) and Core et al. (2003) did it in their studies, it is important to exclude observations where the MVE or BVE variable is negative or missing. This is done to avoid errors, as everything needs to be divided by the BVE value to scale the equation as outlined in section 3.2.1.
Apart from this, again, following the approach of several prior researchers working with the value relevance model, such as Core et al. (2003), or also Morck, Shleifner and Vishney (1998), we set values for the variables RND, ADVERT and CAP_EX equal to zero if their values are not given.

Moreover, the so-called 'loss year variable’ needs to be created, which has been denoted with NEG_IBX in part 3.2.1. This is done by keeping only the negative values of the IBX variable extracted from Compustat, while all firm year observations with positive values in the IBX variable are set equal to zero.

Finally, the data set needs to be processed in a way that makes sure that extreme values do not distort the result of the overall sample. In the dependent variable, the market-to-book ratio, this is achieved by deleting all firm year observations in the lowest and highest 0.5% of each yearly sample respectively. Also, to make sure that outliers in the independent variables do not affect the regression too strongly, all independent variables are winsorized at the 1% and 99% level for every year. This is done in an equivalent way by Core et al. (2003) and Morris and Alam (2012) in their value relevance regressions. The practice of deleting values at the top and bottom 0.5% and winsorizing values at the 1% and 99% levels for every year ensures that an equal portion of observations are winsorized and removed for each data year sample.

Following all these steps in order to extract the required data for the defined high-tech group of companies, a total of 10,161 firm year observations has been downloaded from the WDRS system for the years 2000 to 2013. After deleting all erroneous observations and the lowest as well as highest 0.5% of the market-to-book ratios, a total of 8,153 observations remain, which is the final data set that the value relevance regressions for the technology industry in this study are based on.

Furthermore, the same approach is applied to extract a data set of low-tech companies, to test whether or not a different development in the value relevance of accounting fundamentals can be observed between high-tech and low-tech samples. In order to obtain data on companies that represent trends in the low-tech sector, the SIC codes given in Appendix 1 have been used to extract the data from the Compustat and CRSP databases.
4. **Empirical Data and Analysis**

In the following part of the paper, empirical data will be presented and analyzed, which will ultimately form the base to answer the research question that has been developed in section 1.3 of this paper. As outlined in the methodology section, the first part of the chapter will be devoted to the analysis of the NASDAQ Composite Index and the comparison to other indexes, while the second part will then be focused on the value relevance analysis in the technology industry, which will be extended based on empirical data reaching until 2014. Both analyses will attempt to assess to what degree developments in the market towards another bubble can be observed.

4.1. **NASDAQ Composite Index Analysis**

The analysis of the NASDAQ Composite Index will be divided into two parts. The first part focuses entirely on the NASDAQ Composite and its development since the dot-com bubble. The second part will go a step further, by comparing the NASDAQ Composite Index and its performance to that of two other major American stock indexes, namely the S&P 500 and the Dow Jones. While the first part of the analysis gives an understanding of the NASDAQ Composite during the dot-com bubble period and today, the second part provides a comparison between the more technology concentrated index, NASDAQ Composite, to other less technology concentrated indexes over time.

4.1.1. **The NASDAQ Composite Index 1995 to 2014**

The NASDAQ Composite Index is among the biggest stock exchanges in the United States and on a global scale in terms of its market capitalization and trading volume (World-Exchanges, 2015). Founded by the National Association of Securities Dealers (NASD), the index started trading in February 1971, as the first electronic stock market worldwide at that time (Terell, 2006).

Figure 1, shown below, displays the NASDAQ Composite Index’s development over the years from 1995 to 2014. As can be seen, the index moves up and down considerably over the years, starting at about 750 in 1995, reaching its preliminary peak during the dot-com bubble in March 2000 at 5048. The index then crashed down to a level of about 1200 until the year 2002, before the constant bull market, with the exception of the period during the financial crisis, brought up the index to 5000 again recently, in March 2015.
When analyzing the changes in the NASDAQ Composite Index, one should however be aware of the 20-year time horizon that Figure 1 shows. Analyzing changes on the index on a day-to-day basis is relatively simple, because over short time periods components do not change very much, only their prices do. This means for example that a change from 5000 to 5001 simply implies that the prices of some stocks on the index have increased leading to the overall growth.

However, analyzing the index’s development over longer periods is much more complex, due to its changing nature in composition. The fact that the index is currently at a similar level it had reached during the peak of the dot-com bubble in early 2000 therefore does not have to imply that the index is about to experience a rapid decrease, as it did 15 years ago. There is a variety of factors that have changed with regards to the NASDAQ Composite Index between the year 2000 and 2014. Some of the most important ones will be highlighted and explained in the following.
As can be seen in the data, summarized in Table 2, even though the NASDAQ Composite Index has similar values of 4,069 in December 1999 and 4,736 in December 2014 respectively, there are some other key characteristics that have changed over the given time-span. The number of components that are listed on the index has decreased almost by half from 4,715 to 2,583. Also, the number of components that was listed already in 1999 and still in 2014 is considerably lower. Only 1,023 out of the 4,715 components listed in 1999 were still on the index in 2014, which consequently implies that 78% of all components were delisted (NASDAQ, 2014).

Table 2: Key Metrics of the NASDAQ Composite Index then and now

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Value of Index</td>
<td>4,069</td>
<td>4,736</td>
<td>1.16</td>
</tr>
<tr>
<td>Number of Components</td>
<td>4,715</td>
<td>2,583</td>
<td>0.55</td>
</tr>
<tr>
<td>Total Market Capitalization ($B)</td>
<td>5,453</td>
<td>7,470</td>
<td>1.37</td>
</tr>
<tr>
<td>Average Market Capitalization ($MM)</td>
<td>1,157</td>
<td>2,892</td>
<td>2.50</td>
</tr>
</tbody>
</table>


The total market capitalization of all components listed on the NASDAQ Composite Index has grown from $5,453 billion during the dot-com bubble, to $7,470 billion in December 2014. Bearing in mind that the number of listed components has almost halved during the same time span, this consequently means that the average market capitalization per component has increased considerably. As can be seen in the last row in Table 2, this is true as the average market capitalization has increased from $1,157 million to $2,892 million. The average market capitalization per component has thus more than doubled, meaning that every component bears a substantially higher weight of the total index than during the dot-com era.

Table 3 shows the ten largest corporations in terms of market capitalization during the dot-com period in December 1999, and also the ten largest as of December 2014 respectively. Only four of the top ten companies of 1999 still remain among the ten largest ones in 2014. However, all of their market capitalization values are considerably smaller now than they were at the end of the 1990s. In sum, the market capitalization of these four companies was only 52% in 2014 of what it was in 1999. The fifth biggest company in 1999, WorldCom, on the other hand did not survive the crash of the NASDAQ Composite Index following the dot-com boom and went bankrupt in 2002 (NASDAQ, 2014).
It is furthermore interesting to note that there are three companies in the top ten list for 2014 that are not directly categorized as technology companies, as many companies are on the NASDAQ Composite Index. Amazon’s primary business segment is retailing, Gilead is a biotechnology company, and Comcast operates within media (NASDAQ, 2014). The index thus remains technology oriented overall; however, it does have an increasing number of firms listed that are not directly technology oriented. This trend cannot only be recognized among the biggest components, but also among the entire index.

As mentioned above, the NASDAQ Composite Index is commonly associated with several technology oriented companies. However, in 1999, 57% of all components in terms of market capitalization were classified as technology companies according to the SIC system, while this is only the case for 38% of the listed components in 2013. This can be explained by the fact that new entrants to the NASDAQ Composite do not have the same level of technology orientation as they had 15 to 20 years ago. The net result of this trend is that the current NASDAQ Composite has developed with a lower technology concentration than before, making it a much more diversified index with fewer technology oriented companies than during the dot-com bubble (NASDAQ, 2014).

Besides using the SIC system, the more up-to-date proprietary classification system, the Global Industry Classification Standard (GICS), that is offered by Standard and Poor’s, can be used. Similar results can be found in the GICS system, indicating that the current NASDAQ Composite Index has developed a lower technology concentration than during the dot-com bubble. Currently, 46% of the index by market capitalization belongs to the technology sector. However, the extent of technology orientation in the NASDAQ Composite is constantly decreasing over the years (NASDAQ, 2014).
Table 3: Top 10 NASDAQ Composite Components then and now

<table>
<thead>
<tr>
<th>Component</th>
<th>Market Cap. ($B)</th>
<th>Component</th>
<th>Market Cap. ($B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft</td>
<td>606</td>
<td>Apple</td>
<td>643</td>
</tr>
<tr>
<td>Cisco</td>
<td>360</td>
<td>Microsoft</td>
<td>382</td>
</tr>
<tr>
<td>Qualcomm</td>
<td>332</td>
<td>Google</td>
<td>361</td>
</tr>
<tr>
<td>Intel</td>
<td>277</td>
<td>Facebook</td>
<td>217</td>
</tr>
<tr>
<td>WorldCom</td>
<td>228</td>
<td>Intel</td>
<td>172</td>
</tr>
<tr>
<td>Oracle</td>
<td>151</td>
<td>Comcast</td>
<td>149</td>
</tr>
<tr>
<td>Dell</td>
<td>132</td>
<td>Amazon</td>
<td>144</td>
</tr>
<tr>
<td>Sun Microsystems</td>
<td>117</td>
<td>Cisco</td>
<td>142</td>
</tr>
<tr>
<td>Yahoo</td>
<td>103</td>
<td>Gilead Sciences</td>
<td>141</td>
</tr>
<tr>
<td>JDS Uniphase</td>
<td>75</td>
<td>Qualcomm</td>
<td>123</td>
</tr>
</tbody>
</table>


Besides the proportion of industries listed on the NASDAQ Composite Index, it is furthermore also interesting to consider the age of the listed companies. As already described in section 2.1, there has been a total of 446 IPOs in 1999 during the dot-com bubble in the United States, which resulted in a relatively ‘young’ average age of the listed companies. Over the years up to 2014, the number of IPOs per year has been much lower. In 2014, there has been a total of 288 registered IPOs (ValueWalk, 2015)\(^6\). The result of this lower IPO activity compared to 1999, leads to a higher average age of the current NASDAQ Composite components. In 1999, the average age was 15 years and in 2014 it was 25 years (JJ Burns, 2015). Overall, the companies on the NASDAQ Composite Index can thus currently be said to be much more mature than they were shortly before the burst of the dot-com bubble.

When analyzing the NASDAQ Composite Index over the years and comparing its current performance against its performance during the dot-com bubble, one also has to consider the valuation of its components to analyze if there is a potential overvaluation. In order to do so, it is useful to consider the components’ stock prices in relation to their earnings, which is a broadly used indicator, usually referred to as P/E ratio.

---

\(^6\) However, the year 20014 is the biggest year for the U.S. IPO market since 2000 (ValueWalk, 2015).
Table 4 provides the P/E ratios for the four companies that have been among the ten largest listed companies, both during the dot-com era in 1999 as well as in December 2014.

Table 4: P/E Ratios of Selected NASDAQ Composite Components then and now

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft</td>
<td>73</td>
<td>19</td>
</tr>
<tr>
<td>Cisco</td>
<td>166</td>
<td>19</td>
</tr>
<tr>
<td>Intel</td>
<td>35</td>
<td>16</td>
</tr>
<tr>
<td>Qualcomm</td>
<td>224</td>
<td>16</td>
</tr>
</tbody>
</table>


As can be seen in Table 4, the P/E ratios for all four single components have decreased significantly in 2014, compared to the level they had in late 1999. All of the four individual components shown in Table 4 have had similar developments, some with more extreme decreases, such as Qualcomm that brought down its P/E ratio from 224 in 1999 to 16 in 2014, and some with less extreme decreases, such as Intel whose P/E ratio fell from 35 in 1999 to 16 in 2014. This gives indication that firms of the NASDAQ Composite are currently not as much overvalued as they were during the dot-com bubble period. Also, for the overall NASDAQ Composite Index, the P/E ratio has decreased significantly from 152 in 1999 to 28 in 2014, as can be seen in Table 5.

Apart from the P/E ratio, which is the most important and most commonly used indicator to assess a potential over- or undervaluation of a stock, there are a number of further indicators that can also be used in a similar manner (Bodhanwala, 2014). The P/B ratio, dividend yield as well as index earnings are such indicators and are summarized in Table 5 below for 1999 and 2014 respectively.
Table 5: NASDAQ Composite P/E, P/B, Dividend Yield and index Earnings then and now

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P/E Ratio</td>
<td>152</td>
<td>28</td>
</tr>
<tr>
<td>P/B Ratio</td>
<td>6.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Dividend Yield</td>
<td>0.11%</td>
<td>1.28%</td>
</tr>
<tr>
<td>Index Earnings$^7$</td>
<td>27</td>
<td>167</td>
</tr>
</tbody>
</table>


As can be seen in Table 5, these indicators draw a similar picture, when comparing their values for 1999 and 2014, as the P/E ratios. The average P/B ratio for components listed on the NASDAQ Composite Index has decreased coming from a level of 6.7 in 1999 to 3.5 in 2014. Similar developments can also be observed considering the other indicators. The average dividend yield of listed companies has increased from 0.11% in 1999 to 1.28% in 2014, which shows that companies on the index still tend to pay relatively little dividends to their shareholders. However, the payout rate is a multiple of what it has been during the dot-com bubble.

Looking at the index earnings of NASDAQ Composite, it can be seen that the components listed in 2014 are much more profitable than they were back in 1999. At that time the companies just earned approximately 16% of what they earned in 2014 (27 in 1999 vs. 167 in 2014). This reflects the business model that many companies had during the dot-com bubble as described in chapter 2.1, where many corporations focused on growth rather than profitability. These companies hoped to achieve high earnings at a later stage; however, this did not succeed in many cases. The clear increase in earnings up to 2014 shows that such companies do not seem to be listed on the NASDAQ Composite Index anymore, at least not predominantly. The majority of listed companies rather seem to have relatively stable earnings nowadays.

Overall, based on the P/E ratios as well as the other indicators that have just been dealt with, it thus can be concluded that the valuation of the components listed on the NASDAQ Composite Index does not give the impression to be inflated as it was in 1999 during the dot-com bubble, or at least to a much lesser extent.

$^7$ “The Bloomberg index earning metric is determined by taking aggregate earnings for the set of components and dividing these by the index divisor.” (NASDAQ, 2014, p.6).
However, these indicators only touch the surface of the whole topic and are not yet sufficient to give a profound and qualified answer to the research question that this study aims to answer. In order to do so, the development of the NASDAQ Composite Index thus needs to be seen in a context that allows to assess the relative performance of the index in relation to its peer indexes. By doing so, it can be identified if potential bubble developments can mainly be seen in the technology industry or if they are present in other, non-technology oriented industries, too. This is what will be provided in the next section, where the NASDAQ Composite Index will be compared to two other major indexes, namely the S&P 500 and the Dow Jones.

4.1.2. NASDAQ Composite vs. S&P 500 and the Dow Jones

The previous chapter described the current NASDAQ Composite Index to be more mature, bigger in terms of market capitalization, and less technology oriented than it was 15 years ago. In the following section, the NASDAQ Composite Index and the performance it exhibited over the years since the dot-com bubble will be investigated further by benchmarking it against the S&P 500 and the Dow Jones. This allows a comparison between industries, due to the different nature of the indexes.

Figure 2 shows the NASDAQ Composite with the Dow Jones and S&P 500 before and after the dot-com bubble. All three indexes are rebased, so they have a value of 100 at the start of the shown period in January 1995.
While the market value of all three indexes rose during the dot-com bubble, the pattern of the NASDAQ Composite Index differs from the other two in an extraordinary fashion. Until the peak of the dot-com bubble in March 2000, the NASDAQ Composite’s value has increased about six and a half times, whereas the other two indexes have only increased about three times. In contrast, the S&P 500 and the Dow Jones show a very similar pattern with a smaller value increase during 1995 until 2000. After all, the dot-com bubble affected the NASDAQ Composite rather than the S&P 500 and the Dow Jones, due to its relatively high proportion of technology oriented components.

Figure 3 shows the performance of the same three indexes starting in 2005 until 2014. Again, all three indexes are rebased to the same value at the start of 2005 to make a performance benchmarking possible.
As can be seen in Figure 3, all three indexes tracked very closely during the bull market that preceded the financial crisis, and during the financial crisis itself. Since 2009 and the start of the crisis recovery, all three indexes have rebounded to pre-crisis levels and then continued to rise. However, the NASDAQ Composite Index distinguishes itself from the other two indexes through its fast growth since the recovery of the financial crisis. Especially within the last three years the gap between the NASDAQ Composite and the other two indexes has increased substantially.

The peer comparison of the long-term performance is a key tool for analyzing indexes (Little, 2015). It is important to consider a relatively long enough time span and therefore to choose a timeframe that includes both recent crises, namely the dot-com bubble of 2000 and the financial crisis of 2007 to 2008. Table 6 in the following provides performance statistics on the NASDAQ Composite Index along with the S&P 500, the Dow Jones, and the NASDAQ-100 over a 25-year period starting in 1990.

<table>
<thead>
<tr>
<th>Metric</th>
<th>NASDAQ Comp</th>
<th>S&amp;P 500</th>
<th>Dow Jones</th>
<th>NASDAQ-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Annual Price Return</td>
<td>9.82%</td>
<td>7.30%</td>
<td>7.75%</td>
<td>12.47%</td>
</tr>
<tr>
<td>Avg. Annual Total Return</td>
<td>10.22%</td>
<td>9.49%</td>
<td>10.30%</td>
<td>12.65%</td>
</tr>
<tr>
<td>Std. Dev. Daily Price Returns</td>
<td>1.52%</td>
<td>1.16%</td>
<td>1.10%</td>
<td>1.80%</td>
</tr>
<tr>
<td>Correlation w. NASDAQ Comp</td>
<td>1.00</td>
<td>0.85</td>
<td>0.74</td>
<td>0.97</td>
</tr>
<tr>
<td>Market Cap. ($B) (12/2014)</td>
<td>7,470</td>
<td>18,850</td>
<td>5,000</td>
<td>4,900</td>
</tr>
</tbody>
</table>


Table 6 provides two metrics of annual return: While the average annual price return is based on prices only, the average annual total return also includes dividends. During the given 25-year period, the NASDAQ-100 clearly outperformed the other three indexes by yielding the highest average return, both in terms of total returns as well as price returns. Further, the table provides information about the short-term price risk, namely the standard deviation of daily price returns. Both technology indexes, the NASDAQ Composite as well as the NASDAQ-100 show higher volatility and therefore bear a higher risk for investors than the other two broad indexes.

In terms of correlation of daily returns, the correlation between the NASDAQ Composite and its close sibling NASDAQ-100 is very high with 0.97. The NASDAQ Composite exhibits much less correlation with the other two non-technology oriented indexes, particularly with the Dow Jones, which is based on their different nature of origin. While the NASDAQ Composite represents young growth companies to a large extent, the Dow Jones mainly represents mature blue chip companies. Moreover, the correlations of the NASDAQ Composite with the other non-technology oriented indexes have fallen in the last three years, a trend that has also been seen during the dot-com bubble in the late 1990s, as can be seen Figure 2 and Figure 3. (NASDAQ, 2014).

Further, Table 6 provides the current market capitalization as of December 2014 of the four indexes, showing a relatively small market value of the NASDAQ Composite and the NASDAQ-
100 compared to the S&P 500. In terms of market capitalization, the Dow Jones is also relatively small, as can be seen in Table 6. However, one has to consider that it consists of only 30 firms, making the current market capitalization per component considerably higher among the Dow Jones components than among the NASDAQ Composite and the NASDAQ-100 components.

Looking at the current P/E ratios, it can be observed that the NASDAQ Composite as well as the NASDAQ-100 have higher P/E ratios than the other two indexes, as of December 2014. The P/E ratios of the NASDAQ Composite and the NASDAQ-100 are, as already shown in section 4.1.1, much lower than they were during the dot-com bubble. However, compared to the other two indexes, the NASDAQ Composite’s and the NASDAQ-100’s P/E ratios are still relatively high. This is a sign for potentially overvalued stocks, even though different indicators might have different standard values for P/E ratios based on their industry focus. Furthermore, the NASDAQ Composite continues to pay fewer dividends compared to the other two indexes.

In conclusion, the section’s comparison exhibits a recent NASDAQ Composite that has hit its all time peak of 5048 during the dot-com bubble in March 2000. The current NASDAQ Composite seems to be more mature, bigger in terms of market capitalization, and less technology oriented than it was 15 years ago. The current P/E ratio valuations are much lower relative to their dot-com bubble values, indicating an index that is not as much overvalued as it was 15 years ago.

In comparison to other indexes, such as the S&P 500 and the Dow Jones, the NASDAQ Composite exhibits higher average annual returns as well as higher volatility than the other two indexes. The NASDAQ Composite distinguishes itself from the other two through its fast growth since the recovery of the financial crisis in 2008. Especially within the last three years, the gap between the NASDAQ Composite and the other two indexes has increased considerably.

Taking into account all the indicators that have been dealt with in this chapter, it has to be concluded that there are mixed results to evaluate if there is a potential overvaluation of the NASDAQ Composite Index. On the one hand, the valuation ratios of the NASDAQ Composite are currently substantially lower than they have been during the dot-com bubble, but on the other hand, the NASDAQ Composite shows a clearly steeper increase in value than its peer indexes during the last three years (see Figure 3).
Consequently, further empirical analysis is necessary to investigate the potential of a new bubble development in the technology industry and thus to answer the research question. The main limitation of this NASDAQ Composite analysis is that the index has an increasing number of firms listed that are not directly technology oriented. Over the period of 15 years, the concentration of technology companies in terms of market capitalization has decreased from 57% to 38%, making the index less appropriate to investigate a potential bubble in the technology industry. Therefore, the upcoming value relevance model will be applied to investigate a potential bubble development in the technology industry.

### 4.2. Value Relevance Model

The previous section focused on the NASDAQ Composite Index analysis and yielded mixed results. While the NASDAQ Composite shows a clearly stronger increase in value during the last years compared to its peers, other indicators, such as the P/E and P/B ratios, are considerably lower than they were during the dot-com era. Due to the decrease in technology concentration of the NASDAQ Composite Index, further analysis is required to determine more specifically for the technology industry, if a tendency towards another bubble development can be identified.

The value relevance model, which has been reviewed in section 2.3 will be applied in this chapter for the technology industry. The model is a tool that has already been used by various researchers to investigate the relationship between market valuation and traditional accounting fundamentals during several periods. According to the results of their studies, the explanatory power of fundamental accounting variables tends to be lower during bubble periods than during non-bubble periods (e.g., Brown et al., 1999; Ely & Waymire, 1999; Francis & Schipper, 1999; Lev & Zarowin, 1999). By extending the model until 2006, Morris and Alam (2012) found that accounting variables increased again considerably in value relevance during the years following the burst of the dot-com bubble in March 2000, expressed by an increasing adjusted $R^2$ value of the model.

Based on the methodology chapter 3.2, the following descriptive statistics, shown below in Figure 4, were computed for the high-tech sample with data from the CRSP and Compustat database. This will be the starting point for the value relevance analysis performed in this study for the technology industry.
As can be seen in Figure 4, the number of firm observations is constantly increasing over the years from 540 in 2000 up to 790 in 2013, except for the two years after the dot-com bubble and the year of the financial crisis in 2008. Also, the market-to-book ratio draws a similar picture when considering its development over the 14-year timespan. While the average market-to-book ratio of all included companies in this study was 10.63 in 1999\textsuperscript{8}, it fell over the next two years to 3.52 in 2001, which was due to the impact of the dot-com bubble.

Over the next few years then, the market-to-book equity ratio developed in a volatile manner and reached another low of 3.71 in 2008, which can be regarded as the result of the financial crisis. From 2008 then, with minor exceptions, the average market-to-book ratio steadily increased to a level of 5.89 in 2013, which is the highest value since the dot-com bubble. This increase of the average market-to-book ratio over the years might potentially be seen as a first

\textsuperscript{8} Note that this value is not shown in Figure 4 in order to provide consistency in the presented years in all graphs and tables.
Empirical Data and Analysis

indication that the stocks of the studied firms are currently overvalued. According to Core et al. (2003), high market-to-book equity ratios can usually be seen during bubble periods.

4.2.1. Change in Explanatory Power

Turning to the value relevance model, we use the adjusted $R^2$ value to measure the explanatory power of accounting fundamentals on the market value of companies in the technology sector. This approach has been used in a similar manner by several other researchers (Brown et al., 1999; Collins et al., 1997; Hand, 2005; Ryan & Zarowin, 2003). The purpose of the upcoming model is to identify, how much variation of the market-to-book variable can be explained by variation in traditional accounting variables, and how much of that variation is caused by other factors that are not among the independent variables, but are captured in the error term of the equation that our regression analysis is based on.

A lower level of explanatory power of the value relevance model is an indication that variation in the dependent variable can only be explained to some degree by variation in the independent variables, whereas a higher level of explanatory power of the model indicates that variation in the dependent variable can to a large degree be explained by the independent variables in the regression model. As already explained in section 3.2.1, the explanatory power of the regression model is stated by the adjusted $R^2$ value and describes how well the given data set fits the regression model. The closer the adjusted $R^2$ value is to 0, the lower the explanation power of the independent variables, and the closer it is to 1, the higher the explanation power of the data.

Extending the model until 2013, which, to our knowledge, has not been done yet by other researchers, provides valuable information of the current explanatory power of accounting fundamentals on the market value of companies in the technology industry. Note that 2013 is the last year included in this study due to data availability, since this year includes data until September 2014. Table 7 provides the annual adjusted $R^2$ values from 2000 until 2013, based on regression results of our deflated empirical equation (2).
Table 7: Comparison of Annual Adjusted $R^2$ Values 2000 to 2013 for High-tech Sample

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Adjusted $R^2$ Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>0.201</td>
</tr>
<tr>
<td>2001</td>
<td>0.251</td>
</tr>
<tr>
<td>2002</td>
<td>0.336</td>
</tr>
<tr>
<td>2003</td>
<td>0.386</td>
</tr>
<tr>
<td>2004</td>
<td>0.485</td>
</tr>
<tr>
<td>2005</td>
<td>0.420</td>
</tr>
<tr>
<td>2006</td>
<td>0.308</td>
</tr>
<tr>
<td>2007</td>
<td>0.330</td>
</tr>
<tr>
<td>2008</td>
<td>0.328</td>
</tr>
<tr>
<td>2009</td>
<td>0.613</td>
</tr>
<tr>
<td>2010</td>
<td>0.325</td>
</tr>
<tr>
<td>2011</td>
<td>0.418</td>
</tr>
<tr>
<td>2012</td>
<td>0.332</td>
</tr>
<tr>
<td>2013</td>
<td>0.260</td>
</tr>
</tbody>
</table>

Mean 0.357
Median 0.331
Minimum 0.201
Maximum 0.613

Source: Own creation based on Compustat and CRSP databases (2015).

As can be seen in Table 7, the lowest annual adjusted $R^2$ value for the entire sample is measured in 2000 with 0.201. The highest annual adjusted $R^2$ value is measured in 2009 with 0.613. While the lowest adjusted $R^2$ value in 2000 represents the situation right after the dot-com bubble burst in March 2000, the highest adjusted $R^2$ value in 2009 represents the situation just after the global financial crisis of 2007 to 2008. The mean of the annual adjusted $R^2$ value of the entire sample is 0.357 and the median is 0.331.

Figure 5 provides a graphical overview of the annual change in value relevance that has taken place from 2000 to 2013, based on the adjusted $R^2$ values from the yearly regressions of our deflated empirical equation (2) applied for the technology industry.
As can be observed in Figure 5, the adjusted $R^2$ values from our annual regression trend upward from 2000 to 2004, consistent with research from Morris and Alam (2012), who find an increase in value relevance after the burst of the dot-com bubble. The adjusted $R^2$ values increase steadily from 0.201 in 2000 to 0.485 in 2004. The increase over these six years, after
the dot-com bubble, could be interpreted as an indication of potentially more prudent investment decisions, which is signified by the fact that market values are increasingly based on the accounting fundamentals that are included in the model. This could be seen as a tendency that investors might not have invested in a speculative manner during these years, but rather tended to rely more and more on accounting fundamentals for their investment decisions, compared to the dot-com era.

Following this steady increase in value relevance, there is a subsequent decrease in value relevance from the adjusted $R^2$ level of 0.485 that had been reached in 2004 to a level of 0.308 in 2006. The following two years show relatively stable low adjusted $R^2$ values of 0.330 in 2007 and 0.328 in 2008. These adjusted $R^2$ values could be interpreted as a higher willingness of investors to move towards more speculative trading behavior, during the period lasting from 2004 to 2008, since less variation can be explained by changes in the independent variables. This potentially more speculative trading behavior might have been supported by the significant surge in the US subprime lending rates, starting in 2004\(^{10}\). The reason for this seemingly less rational trading behavior might have been that traders and institutions gained increasingly more confidence again after there had been a few years of economic recovery after the burst of the dot-com bubble in 2000.

In 2008 then, the financial crisis led to a worldwide economic downturn, which also affected the technology sector. This can be seen in Figure 5, as the adjusted $R^2$ value increased dramatically from 0.328 in 2008 to 0.613 in 2009. Overall, a U-shaped curve for the period from 2004 until 2009 can be observed in the adjusted $R^2$ values, which is also in line with results Morris and Alam (2012) obtained, when they performed an untabulated regression analysis for this period\(^{11}\).

This significant rise in value relevance of accounting fundamentals in 2009 could potentially be interpreted as a cautionary reaction of investors due to the negative experiences they might have made with speculative trading during the preceding period between 2004 and 2008. This could possibly be seen as an extreme reaction of investors to the losses they might have incurred during the economic breakdown, caused by the stock market crash and the financial

\(^{10}\) Information on US subprime lending data can be found in Appendix 3.

\(^{11}\) The annual adjusted $R^2$ values for this period are not shown explicitly in Morris and Alam’s (2012) paper. However, the authors mention that they observed a U-shaped development in adjusted $R^2$ values for the years during the financial crisis (p.249).
crisis in 2008. Following this extreme surge in value relevance in 2009, the adjusted R\(^2\) value for 2010 decreased to a rather modest value of 0.325, which is similar to the level it had during the three years from 2006 to 2008.

Finally, over the last three years a clear decrease in value relevance of accounting information from 0.418 in 2011 to 0.260 in 2013 can be observed. This trend is opposite to the one after the burst of the dot-com bubble in 2000 that illustrated an increasing trend in value relevance. The observed annual adjusted R\(^2\) value for 2013 is the lowest one since 2001, which was still part of the aftermath of the dot-com bubble, while the value for 2013 is the result of a constant decrease in value relevance over the last three years. Further, the value relevance of accounting fundamentals in 2013 is also lower than the levels reached during the seemingly more speculative trading period during the financial crisis of 2007 to 2008. The annual adjusted R\(^2\) value of 0.260 in 2013 is also significantly below the mean adjusted R\(^2\) value of the entire 14-year period that is 0.357, as can be seen in Table 7. Further, the value of 2013 is also clearly below the median value for the given years, which is 0.331.

To test if the decrease in value relevance observed in the high-tech sample can also be seen in other industries, a comparison to the low-tech industry is appropriate. By comparing the development of value relevance of accounting fundamentals between the high-tech and low-tech samples, it can be identified whether the downward trend over the last three years, which has been found in the analysis of the high-tech sample, is to be seen as a general market trend, or if it is restricted to the high-tech sample.

As can be seen in Appendix 4, the value relevance of accounting fundamentals for the low-tech sample was at a considerably higher level than it was for the high-tech sample in 2000, at the end of the dot-com bubble. This indicates that the market values of firms in the low-tech sample were explained to a higher degree by accounting fundamentals during the dot-com bubble, than they were for the firms in the high-tech sample. In the years following the burst of the dot-com bubble, the value relevance of accounting fundamentals increased more for the low-tech sample than for the high-tech sample. From 2003 then, the value relevance of accounting fundamentals for both samples, the high-tech and low-tech industry sample, correlated closely until 2010.

However, over the last three years, a clearly different development between the results of the two samples can be observed. While there is, as already described before, a downward trend of the value relevance of accounting fundamentals in the high-tech sample, the opposite is the
case in the value relevance of accounting fundamentals for the low-tech sample. From 2011, the value relevance in the low-tech sample rises from 0.556 to 0.687 in 2013. This indicates that the market value of the firms in the low-tech sample can increasingly be explained by accounting fundamentals. These findings indicate that the decrease in explanatory power of the accounting fundamentals over the last three years is not a general market trend, but rather specific to the technology industry.

The recently increasingly high market-to-book valuations documented in Figure 4, combined with the reduced adjusted $R^2$ values in the high-tech sample during the last three years, which can be seen in Figure 5, support the notion that current valuations are higher than in previous periods after the dot-com bubble. This also implies that the dependent variable, the market value, is characterized by a source of variation that is not well captured by the explanatory variables in our regression model. Therefore, the reduction in the explanatory power of the model goes along with an increase of unexplained variation in equity values, which is similar to Core et al.’s (2003) findings about the level of value relevance during the dot-com bubble.

Our finding of the downward trend of the last three years in the high-tech sample can be regarded as a warning sign, since the relation between fundamental accounting variables and market values is constantly falling in the technology industry. This movement could be interpreted as a tendency of higher willingness of investors to move towards more speculative and less rational trading behavior. Looking forward, if the trading behavior continues to develop more towards irrational behavior, as it might have during the last three years, a situation as during the dot-com bubble, might possibly occur over the next few years. This would be illustrated by a further decrease in value relevance of accounting fundamentals.

4.2.2. Coefficient Estimates and Significance Levels

In order to ensure that the trends that can be recognized in our regression results for the technology industry are statistically reliable, it is important to consider the impact of each variable in the value relevance regression model for every year. Further, the significance of each coefficient for the entire period 2000 to 2013 as well as for every single year has to be taken into account. Below, in Table 8 an overview of the coefficient estimates, $t$-statistics and their respective significance levels from the regression for the technology industry can be found.
Table 8: Yearly High-tech Coefficient Estimates and their t-statistics 2000 to 2013

<table>
<thead>
<tr>
<th>Variable</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>(t-stat)</td>
<td>Estimate</td>
<td>(t-stat)</td>
<td>Estimate</td>
<td>(t-stat)</td>
</tr>
<tr>
<td>Intercept</td>
<td>1.959</td>
<td>5.050***</td>
<td>1.487</td>
<td>6.487***</td>
<td>0.202</td>
<td>0.490</td>
</tr>
<tr>
<td>1/BVE</td>
<td>6.975</td>
<td>2.854***</td>
<td>6.872</td>
<td>4.301***</td>
<td>8.875</td>
<td>3.248***</td>
</tr>
<tr>
<td>IBX/BVE</td>
<td>11.479</td>
<td>4.553***</td>
<td>11.341</td>
<td>6.270***</td>
<td>4.221</td>
<td>1.532</td>
</tr>
<tr>
<td>RND/BVE</td>
<td>7.362</td>
<td>7.834***</td>
<td>3.068</td>
<td>6.691***</td>
<td>4.814</td>
<td>5.735***</td>
</tr>
<tr>
<td>ADV/BVE</td>
<td>-3.160</td>
<td>-0.580</td>
<td>-1.539</td>
<td>-0.433</td>
<td>12.768</td>
<td>2.060**</td>
</tr>
<tr>
<td>CAP_EX/BVE</td>
<td>-0.014</td>
<td>-0.008</td>
<td>4.648</td>
<td>3.630***</td>
<td>13.050</td>
<td>4.601***</td>
</tr>
<tr>
<td>SALES_GR/BVE</td>
<td>-2.758</td>
<td>-1.500</td>
<td>14.070</td>
<td>5.181***</td>
<td>6.101</td>
<td>2.059**</td>
</tr>
</tbody>
</table>

** p-value < 0.05
*** p-value < 0.01
### Empirical Data and Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>2006 Estimate</th>
<th>(t-stat)</th>
<th>2007 Estimate</th>
<th>(t-stat)</th>
<th>2008 Estimate</th>
<th>(t-stat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.924</td>
<td>4.445***</td>
<td>1.393</td>
<td>4.912***</td>
<td>-0.809</td>
<td>-1.820</td>
</tr>
<tr>
<td>1/BVE</td>
<td>20.865</td>
<td>4.822***</td>
<td>28.812</td>
<td>7.769***</td>
<td>17.916</td>
<td>3.969***</td>
</tr>
<tr>
<td>RND/BVE</td>
<td>5.445</td>
<td>5.605***</td>
<td>2.747</td>
<td>4.439***</td>
<td>5.507</td>
<td>8.050**</td>
</tr>
<tr>
<td>ADV/BVE</td>
<td>-5.823</td>
<td>-1.188</td>
<td>13.770</td>
<td>3.087***</td>
<td>10.897</td>
<td>2.475**</td>
</tr>
<tr>
<td>CAP_EX/BVE</td>
<td>-1.374</td>
<td>-0.402</td>
<td>5.263</td>
<td>2.415**</td>
<td>11.701</td>
<td>4.871***</td>
</tr>
<tr>
<td>SALES_GR/BVE</td>
<td>14.803</td>
<td>2.782***</td>
<td>15.721</td>
<td>4.660***</td>
<td>27.996</td>
<td>3.611***</td>
</tr>
</tbody>
</table>

** p-value < 0.05  
*** p-value < 0.01

<table>
<thead>
<tr>
<th>Variable</th>
<th>2009 Estimate</th>
<th>(t-stat)</th>
<th>2010 Estimate</th>
<th>(t-stat)</th>
<th>2011 Estimate</th>
<th>(t-stat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.194</td>
<td>-0.450</td>
<td>1.064</td>
<td>2.597**</td>
<td>0.627</td>
<td>1.513</td>
</tr>
<tr>
<td>1/BVE</td>
<td>17.284</td>
<td>3.283***</td>
<td>9.670</td>
<td>1.858</td>
<td>-1.286</td>
<td>-0.235</td>
</tr>
<tr>
<td>RND/BVE</td>
<td>4.733</td>
<td>10.756***</td>
<td>7.008</td>
<td>8.642***</td>
<td>6.391</td>
<td>8.525***</td>
</tr>
<tr>
<td>ADV/BVE</td>
<td>6.795</td>
<td>1.036</td>
<td>13.695</td>
<td>2.372**</td>
<td>1.111</td>
<td>0.260</td>
</tr>
<tr>
<td>CAP_EX/BVE</td>
<td>11.928</td>
<td>3.275***</td>
<td>5.714</td>
<td>1.849</td>
<td>10.109</td>
<td>3.654***</td>
</tr>
</tbody>
</table>

** p-value < 0.05  
*** p-value < 0.01
Empirical Data and Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>(t-stat)</th>
<th>Estimate</th>
<th>(t-stat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.557</td>
<td>7.730***</td>
<td>1.893</td>
<td>5.291***</td>
</tr>
<tr>
<td>1/BVE</td>
<td>3.298</td>
<td>0.826</td>
<td>14.776</td>
<td>2.765***</td>
</tr>
<tr>
<td>IBX/BVE</td>
<td>5.146</td>
<td>2.820***</td>
<td>10.335</td>
<td>5.316***</td>
</tr>
<tr>
<td>NEG_IBX/BVE</td>
<td>-6.291</td>
<td>-3.290***</td>
<td>-12.280</td>
<td>-5.785***</td>
</tr>
<tr>
<td>ADV/BVE</td>
<td>1.034</td>
<td>0.290</td>
<td>-4.286</td>
<td>1.174</td>
</tr>
<tr>
<td>CAP_EX/BVE</td>
<td>5.262</td>
<td>2.865***</td>
<td>7.499</td>
<td>3.360***</td>
</tr>
<tr>
<td>SALES_GR/BVE</td>
<td>11.305</td>
<td>1.877</td>
<td>17.090</td>
<td>2.555**</td>
</tr>
</tbody>
</table>

** p-value < 0.05
*** p-value < 0.01

Source: Own creation based on Compustat and CRSP databases (2015).

The results shown in Table 8 indicate that most of the explanatory variables of the full sample for each year are statistically significant at the 0.01 percent level, which is signified by the three stars in the $t$-statistics column. The only explanatory variable that is more often insignificant than significant is the advertising variable.

As in prior research (Core et al., 2003; Morris & Alam, 2012), we find two surprising results of the yearly regressions. First, as can be seen in Table 8, NEG_IBX/BVE is the only coefficient estimate that is always negative, which both Core et al. (2003) and Morris and Alam (2012) found to be negative as well. This indicates that stock prices reflect expectations of investors that large losses, rather than small losses, might lead to higher future cash flows. The reasoning that lies behind this mechanism is the fact that present large losses initiate transitory changes in the future, resulting in increased prospective cash flows. Apart from few exceptions, all other explanatory coefficients tend to be positive, as we expected them to be. This means that, with the exception of advertising expense, all independent variables have a consistent positive relation with market value, with coefficients of the same sign in at least 12 of the 15 sample years.

The second coefficient estimate that can be observed as surprising is the intercept coefficient. The intercept coefficient can be interpreted in a statistical sense as the value our dependent
variable MVE/BVE takes, given the case that all independent variables are zero and therefore do not have any impact on the MVE/BVE variable. Under the assumption of rationality, it can be expected that the market value of companies is equal to the book value of companies in the absence of any influences from the independent variables. The MVE/BVE should therefore, under the assumption of rationality, be equal to 1, which would thus be the value we would expect for the intercept coefficients in our regression results.

However, taking the results for the intercept coefficients shown in Table 9 into consideration, it can be observed that these values diverge considerably from 1, with coefficient estimates reaching from -0.809 in 2008 to 2.557 in 2012. Interestingly, of these coefficient estimates, only those with values above 1 are statistically significant, but not those that are negative or below 1. This implies that the intercept coefficient is only significant in years, in which the market value is larger than the book value of equity without the influence of the independent variables.

Further, in untabulated results, we find that the intercept coefficient’s magnitude is significantly larger and consistently positive when the regression only includes the 1/BVE variable, as well as the two earnings variables. These findings show that adding further explanatory variables to a regression model can change both the value and the sign of the intercept (Trueman et al., 2000; Core et al., 2003).

The coefficient estimates, t-statistics and their respective significance levels for the low-tech sample can be found in Appendix 5. For both industry samples that we included in our analysis, the high-tech and low-tech industry sample, the F-test for every single year is highly significant at the alpha 0.01 level.

Table 9 shows the aggregated results for our regression model over the entire 14-year sample period for the technology industry. Looking at the regression results of the data set, allows us to assess the coefficient estimates and their significance on an aggregated level for the entire sample. This procedure is similar to the one in Morris and Alam’s (2012) study, who run aggregated regressions in their analysis as well.
Table 9: Coefficient Estimates and their t-statistics for High-tech Sample 2000 to 2013

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>(t-stat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.284</td>
<td>12.385***</td>
</tr>
<tr>
<td>1/BVE</td>
<td>13.157</td>
<td>15.074***</td>
</tr>
<tr>
<td>IBX/BVE</td>
<td>9.138</td>
<td>14.954***</td>
</tr>
<tr>
<td>NEG_IBX/BVE</td>
<td>-9.263</td>
<td>-14.322***</td>
</tr>
<tr>
<td>RND/BVE</td>
<td>5.751</td>
<td>32.457***</td>
</tr>
<tr>
<td>ADV/BVE</td>
<td>2.949</td>
<td>2.213**</td>
</tr>
<tr>
<td>CAP_EX/BVE</td>
<td>5.396</td>
<td>7.906***</td>
</tr>
<tr>
<td>SALES_GR/BVE</td>
<td>6.235</td>
<td>7.235***</td>
</tr>
<tr>
<td># of Observations</td>
<td>8,153</td>
<td></td>
</tr>
</tbody>
</table>

** p-value < 0.05
*** p-value < 0.01

Source: Own creation based on Compustat and CRSP databases (2015).

As can be seen in Table 9, the regression of the overall sample confirms the significance levels that could be observed in the individual regressions for each year in Table 8. All coefficients are highly significant (p < 0.01), except for the advertising variable that is only significant at the 0.05 level. Again, the NEG_IBX/BVE is the only negative coefficient estimate, which is also in line with the results of the yearly regressions shown in Table 8.

To briefly summarize our main findings of the value relevance analysis, we documented a clear decrease in explanatory power of accounting information over the last three years from 0.418 in 2011 to 0.260 in 2013 in the technology industry. This finding could be interpreted as a sign that investors tend to move from rational investment behavior towards more irrational investment behavior during the last three years. The results are statistically highly significant and will subsequently be used as the basis for the discussion chapter.


5. Discussion

In the previous chapter we performed the analysis and presented our results, which serve as the basis for the research question that we attempt to answer in this study. As explained in the introductory part of this paper, the dot-com bubble in the late 1990s started to grow through investments in Internet companies due to the general hype to make profitable investments in the technology industry. Consequently, the NASDAQ Composite Index rose from under 1,000 points in 1995 to more than 5,000 points in early 2000. At this time, many companies were going public through IPOs and received enormous valuations, with stock prices sometimes doubling on the first day. However, in March 2000, the boom came to a crashing halt and the bubble began to pop, because a large number of dot-com bubble companies failed to turn their business models into profitable and sustainable businesses. As a consequence, the economy of the United States slowed down and finally ended up in a full recession.

On April 23rd 2015, the NASDAQ Composite Index, which traditionally has a high concentration of technology oriented companies, closed at 5,073 points, which is for the first time higher than the peak that had been reached during the dot-com bubble 15 years ago in March 2000. Therefore, after the NASDAQ Composite Index hit its all time peak in April 2015, an increasing public interest arose, whether the technology sector is currently heading towards another bubble or not. The research question that we consequently dealt with in this study, has been formulated as follows:

*How does the current development in the technology industry compare to that during the dot-com bubble in the late 1990s, and do current market valuations give rise to question whether valuations are justified by accounting fundamentals?*

From our NASDAQ Composite Index analysis we have received mixed results. On the one hand, several financial indicators of the NASDAQ Composite, such as the P/E and P/B ratios, are currently much lower relative to their values during the dot-com bubble era, indicating an index that is not as much overvalued as it was 15 years ago. Further, the current NASDAQ Composite seems to be more mature, bigger in terms of market capitalization, and less technology oriented than it was 15 years ago.

On the other hand, the NASDAQ Composite clearly shows accelerated growth and higher volatility in relation to its peer indexes, the S&P 500 and the Dow Jones that serve for
benchmarking purposes. The index distinguishes itself from the other two through its strong development since the recovery of the financial crisis in 2008. Especially within the last three years, the gap between the NASDAQ Composite and the other two indexes has increased considerably.

Thus, from the NASDAQ Composite analysis it can be concluded that the current developments indicate a heated market situation. However, taking into consideration major financial indicators and comparing their levels to the dot-com era as well as to their peers, it seems exaggerated to call the current situation a bubble, or close to a bubble. Therefore, we assess the current situation of the NASDAQ Composite as a heated market, but not yet as a bubble development. Since the main limitation of the NASDAQ Composite analysis is that the index has an increasing number of firms listed, which are not directly technology oriented, further and more specific empirical analysis was necessary to investigate, whether a tendency towards another bubble development can be identified in the technology industry.

The value relevance analysis served to overcome this limitation, as it provides a more detailed focus on companies in the technology sector, due to the SIC code specification of technology companies. The purpose of the model is to identify how much variation of the market-to-book variable can be explained by variation in traditional accounting variables, and how much of that variation is caused by other factors that are not among the independent variables, but are captured in the error term of the equation, which our regression analysis is based on.

According to prior research, the linear relationship between earnings and stock returns for technology firms during the dot-com bubble declined constantly over the years until the burst of the dot-com bubble (Morris & Alam, 2012). This relation shows that accounting fundamentals had less explanatory power for the market value of technology firms during the dot-com bubble period. The results of our analysis confirmed the results of previous research, showing that the value relevance of accounting fundamentals was relatively low during the dot-com bubble period for technology firms.

Our results also confirmed Morris and Alam’s (2012) finding that accounting fundamentals for technology firms increased in value relevance again over the years that followed the dot-com bubble burst in 2000. This implies that the dependent variable, the market value, is characterized by a source of variation that is increasingly well captured by the explanatory variables in our regression model. The increase in value relevance for technology firms implies
that the independent variables in the regression model captured more and more variation in market values, indicating that investors might have used more rational investment strategies during the years after the burst of the dot-com bubble.

By extending the model until 2013, we were able to further explore how the value relevance of accounting fundamentals in the technology sector has developed over the last years. As this, to our knowledge, has not been done yet by other researchers, it provides valuable information of the current explanatory power of accounting fundamentals on the market value of companies in the technology industry.

Through the analysis, we were able to document that the value relevance of accounting fundamentals in the technology sector displayed a decreasing trend over the last three years, reaching from 2011 to 2013, which is in contrast to the development during the years after the dot-com bubble. Therefore, the reduction in the explanatory power of the model goes along with an increase of unexplained variation in equity values. The decrease in value relevance in the technology sector implies that the independent variables in the regression model captured less variation in market values, indicating that investors might have used more irrational investment strategies during the last three years.

To test if the decrease in value relevance of accounting fundamentals over the last three years, which was observed in the high-tech industry sample, can also be observed in other industries, we conducted the same analysis for a low-tech industry sample. The results of this analysis for the low-tech industry sample are shown graphically in Appendix 4. Over the last three years, the low-tech regression results show an upward trend of the explanatory power of accounting fundamentals, opposed to the downward trend that can be observed in the high-tech regression results. Therefore, the decreasing trend of the explanatory power of accounting fundamentals appears to be rather high-tech industry specific, than a general market trend.

Eventually, taking into account the results from our two analysis parts, the NASDAQ Composite Index analysis and the value relevance analysis, we find mixed results about the potential development of another bubble in the technology sector. While the NASDAQ Composite analysis provides indication of a heated market, but not of a bubble development yet, the value relevance analysis exhibits a decrease of explanatory power during the last three years, potentially indicating more irrational investment behavior among investors.
In order to answer the research question, we regard the results of the value relevance analysis as more relevant than those of the NASDAQ Composite analysis to answer the research question, due to the distinct focus of the value relevance analysis on the technology industry.

Based on this, our results of the value relevance analysis over the last three years can be regarded as a warning sign, since the relation between fundamental accounting variables and market values is constantly falling in the technology industry. This movement could be interpreted as a tendency of investors to move towards more speculative and less rational trading behavior. Looking forward, if the trading behavior continues to evolve more towards irrational behavior, as it might have during the last three years, a situation as during the dot-com bubble might possibly occur over the next few years. This would be illustrated by a further decrease in value relevance of accounting fundamentals.

**Efficient market theory and bubbles**

Linking the results of the analysis back to the theory that has been introduced in chapter 2 of this paper, the following findings can be documented. As has been exhibited in the paper, the technology industry faced a bubble during the late 1990s and early 2000s according to the majority of researchers. Also, the current development appears to drive the market towards a potential overvaluation. This means that the efficient market theory might fail to explain the high market valuations in the technology industry. This is the case because such developments would otherwise be prevented through market forces as the efficient market hypothesis posits that stock prices incorporate all past and current publicly available information and prices can always be deduced as optimal estimates of true investment value.

This hypothesis is based on the assumption that investors behave rationally and maximize expected utility accurately. Therefore, the efficient market hypothesis claims that as soon as new information that could have an impact on the value of an asset becomes public, the price of the affected asset will adapt accordingly without any delay (Malkiel, 2003). Because of this mechanism, there will be no difference between the price of an asset and its intrinsic value at any time. Further, if the mechanism of prices perfectly reflecting intrinsic values should fail at any time, there would be arbitrageurs, who constantly look for risk-free profit opportunities and thereby force market prices to their equilibrium level.

Putting the efficient market theory into a larger economic context, it does actually appear paradoxical how it should be possible for bubbles to develop, as their emergence is
contradictory to the theory. The described mechanisms of the efficient market theory did neither prevent the development of the dot-com bubble in the late 1990s nor do they appear to prevent the current development in the technology sector, which according to our performed analysis appears potentially overvalued.

**Behavioral finance and rational and irrational investor concepts**

Since the efficient market theory does not seem to hold true, it appears likely that behavioral finance mechanisms have been driving investor and market behavior to a certain degree during the dot-com bubble period, and possibly also during the last three years. This has led to market valuations that are to a lesser extent based on accounting fundamentals, as we have tested in our value relevance analysis. Such behavioral finance mechanisms include rational and irrational investor concepts, as outlined in the literature review of this paper in chapter 2.

As outlined in the literature review of this study, both groups of investors, rational and irrational ones, seek to maximize their utility and buy stocks that might potentially be overpriced. However, the major difference between the two investor groups is that the former group of investors is aware of the overvaluation, while the latter group is not.

While it is not possible to specifically determine on the basis of our results, to what extent rational and irrational investment behavior respectively have been driving potential bubble developments, it seems likely that both impacted the development during the dot-com bubble and during the last three years.

To give an illustration of rational investor behavior that is linked to the theories introduced in chapter 2, it is probable that a number of rational investors simply participated in the purchase of overpriced stocks during the dot-com bubble and the last three years to avoid the risk of standing alone. For example, the quote of Roger McNamee mentioned earlier in this paper shows that even rational investors during the dot-com era either had to participate in this speculative ‘mania’ to beat their benchmarks, as he put it, or faced the risk to go out of business. Some rational investors therefore avoided trading strategies that were different from those of their peers, even if they individually had chosen to follow more prudent investment strategies. As the renowned economist John Maynard Keynes was quoted in the paper *When Genius Failed* (2000) written by Roger Lowenstein: "Markets can remain irrational longer than you can remain solvent".
Similar, it is also likely that irrational investors had an impact on the developments both during the dot-com era, as well as during the development in the technology industry over the last three years. An example to illustrate this point is the fact that irrational investors are continuously suffering from overconfidence and illusion of control. For instance, during the dot-com bubble period, the increasing number of inexperienced investors, who started to trade on the stock market were overconfident in their ability to pick technology stocks with fair value, as has been explained in chapter 2 by referring to Barber & Odean (2001). The classic behavioral characteristics of overconfidence led many irrational investors to believe that they were able to select the best investment opportunities. Through this, investors overestimated their predictive ability during the dot-com bubble. Generally, experiments have shown that individuals consistently seem to overestimate their level of expertise and actually express opinions on topics they know little about.

This concept of investors’ overconfidence and illusion of control could be one of the reasons for the decrease in explanatory power of accounting fundamentals in the technology sector during the last three years, that we were able to observe in our value relevance analysis. Again, while it is difficult to assess the exact impact that overconfidence among investors had in this development, it can be assumed that it is one of the drivers for the divergence of market values from accounting fundamentals in the technology industry.

In a similar fashion, it can be assumed that further rational and irrational investor concepts, such as those that have been covered in the literature review in chapter 2, also impacted the developments during the dot-com bubble and during the last three years. However, due to the design of the study, we are not able to identify if and to what extent the potential current overvaluation of the last three years in the technology industry is based on rational or irrational investment behavior respectively. An evaluation of where potential overvaluation stems from, would require much more detailed research with data on investors and their reasoning to buy certain stocks. Further, it would require investors to be conscious about the level of potential irrationality in their investment decisions, which might not always be the case. However, this is out of scope for this research project and should be investigated in future research.

---

12 Rational investor concepts covered in this study: Riding the bubble, limits of arbitrage, short sale constraints, synchronization problems, risk of standing alone, herd behavior, relative scale performance and asymmetric information levels.
Irrational investor concepts covered in this study: Overconfidence and illusion of control, level of attention, noise trading, heterogenous beliefs, heuristics, anchoring and loss aversion.
Impact of low interest rates

It should also be taken into account when interpreting the results of our analysis in this study, that there are a number of further macroeconomic factors that impact the development of investor behavior and thereby stock prices. Financial markets are to a certain degree steered by central banks whose main objectives are to secure price stability by controlling inflation and thereby to facilitate economic growth. In order to achieve these objectives, central banks can engage in expansionary or contractionary monetary policy, depending on the strategy of the monetary policy. Doing so effectively requires them to apply ‘steering tools’ such as the control of money supply and determining the level of interest rates in a way that stimulates price stability and thereby economic growth.

Typically during recessions, signified by low economic activity and high unemployment levels, central banks make use of expansionary monetary policy by increasing the money supply and decreasing the cost of borrowing money through lowering interest rates. This is done in order to stimulate economic growth and development. On the other hand, during times of extreme economic growth, low unemployment and high inflation, central banks typically employ contractionary monetary policies by reducing the money supply and increasing interest rates, with the intention to keep inflation at reasonable levels and to avoid the potential sudden distortion of asset values (Ahiabor, 2013).

Currently, most central banks in developed economies apply expansionary monetary policies to stimulate the economy by buying government bonds and thereby to increase money supply and lower market interest rates. Therefore, interest rates have reached extremely low levels during the last years, which can render expansionary fiscal policy ineffective. By applying the monetary policy of quantitative easing, the development of the economy can further be fostered by purchasing assets of longer maturity and thereby lowering long-term interest rates even further. This expansionary monetary policy has recently been applied by central banks in several developed economies, for instance Japan, United States and the European Union (BBC, 2015).

As a result of such expansionary monetary policies, the current level of interest rates in many economies is historically low. Figure 6 gives an overview of interest rates for the Eurozone, the United States of America, Japan and Great Britain.
When central banks apply an expansionary monetary policy and thereby lower the interest rate, as it has been the case since the financial crisis in 2008, which can be seen in Figure 6, safe investments such as government securities, treasury bills, state bonds and fixed income securities may become unattractive for investors, due to the high correlation of their return with the current interest rate. In other words, these investments become less desirable for investors since the return of the investments is typically very low during times of low interest rates. If we assume investors to be rational, a lower interest rate will thus move investors from risk-free investments to stock market investments, where high returns are also possible in times of low interest rate levels. As has been investigated in prior studies, the interest rate has a significant negative correlation with equity share prices (Alam & Uddin, 2009).

This low interest rate is naturally a macroeconomic factor that is important to take into consideration when trying to understand investor behavior in the stock market over the last few
years. We can assume that the low interest rate is possibly one of the drivers for the overvaluation in the technology stock market, as investors look for other investment opportunities than safe government securities, treasury bills, state bonds and fixed income securities. Both analyses included in this study, the NASDAQ Composite Index analysis and the value relevance analysis, are likely to be affected to a certain extent by the low current interest rate levels.

For the NASDAQ Composite Index analysis, it is probable that the values of the NASDAQ Composite, the Dow Jones and the S&P 500 increased as an effect of the low interest rate. However, what remains unexplained by the low interest rate is the fact why the NASDAQ Composite Index has shown accelerated growth in comparison to it’s peer indexes over the last couple of years, since it can be assumed that the interest rate level lets investors move their money towards the stock market in general, but not specifically towards the NASDAQ Composite Index. In the same manner, the low interest rate has potentially reduced the explanatory power of accounting fundamentals in the value relevance analysis for the market values during the last three years.

In conclusion, besides the already discussed factor of irrational investors, the low interest rate could potentially be identified as another potential driver that led to the downward turn of the explanatory power over the last three years in the value relevance analysis.

**Implications**

Our results of the heated NASDAQ Composite Index and the decreasing value relevance of accounting fundamentals over the last three years in the technology industry have implications for at least three groups. These groups are policy makers, academics and investors.

First, from an academic perspective, it is important to know how much of a firm’s market value can be explained by accounting fundamentals, such as income or capital expenditures, during certain economic periods. In our study we were able to confirm the results of previous studies, which showed that the value relevance of accounting fundamentals tends to be lower during bubble times, such as during the dot-com bubble in the late 1990s. Further, we were also able to confirm Morris and Alam (2012) in their finding that the value relevance of accounting fundamentals increased again during the years after the burst of the bubble in 2000. By extending the model from 2006 until 2013, we were able to show that the value relevance of
accounting fundamentals has decreased again over the last three years, which could be regarded as a sign of a potential new bubble development in the technology industry. Therefore, the explanatory power of accounting fundamentals for firms’ market values is increasingly limited.

Second, from a policy maker perspective, the most relevant concern is to develop warning signals that function as indicators as to whether it is likely that the overvaluation of stocks and the decrease in value relevance of accounting fundamentals will potentially be followed by a bursting bubble in the technology industry, which would have a significant negative impact on the economy. Therefore, policy makers could use the results of our study or even apply the value relevance model and extend our study in the future, to identify a potential bubble development in the market. By doing so, policy makers might be able to better adapt their political strategies to current economic developments, which could help to facilitate economic growth more effectively. Also, the risk of a sudden economic downturn through the burst of a bubble could be minimized. Thereby, it is potentially possible to avoid considerable economic losses.

Third, from an investor perspective, the results of this thesis might be useful for investment decisions. In particular, it is in the interest of an investor to know, whether or not stocks are overvalued and if traditional accounting fundamentals still have their merit for investment decisions during bull markets, when stocks are traded at multiples of their earnings. The results of this study could serve investors in a way that some stocks of technology oriented companies could possibly be regarded as overvalued since their market value is to a lesser extent based on accounting fundamentals. Further, it seems that several investors currently might tend to be irrational in their investment strategies. Therefore, investors should be cautious not to participate in herd behavior and in other irrational behavioral finance concepts, since this might heat the market even further.

However, all three mentioned groups should note that several indicators that we have studied in the NASDAQ Composite Index analysis, such as the P/E ratio and P/B ratio, did not seem particularly high. Even though the current developments in the technology sector might potentially be seen as partly irrational, it cannot be said with certainty that there is, or that there will be, a bubble soon.
6. Conclusion

To conclude this study, we found mixed results concerning the potential of a new bubble development in the technology industry and whether or not market valuations are justified by accounting fundamentals.

Through the NASDAQ Composite Index analysis, we found a heated market situation, as the NASDAQ Composite showed accelerated growth relative to its peers over the last three years. However, taking into account major financial indicators and comparing their levels to those during the dot-com era as well as to those of peer indexes, it seems exaggerated to call the current situation a bubble, or close to a bubble. Since the concentration of technology firms in the NASDAQ Composite has decreased over the years we applied the value relevance model with technology specific SIC codes to overcome this limitation. Thereby we were able to explore more specifically for the technology industry, whether or not a potential development towards another bubble can be found.

Through the value relevance analysis, we were able to confirm prior research showing that the explanatory power of accounting fundamentals for market values in the technology industry was relatively low during the dot-com bubble. Our results also support Morris and Alam’s (2012) finding that accounting fundamentals had increasingly more explanatory power for the market value of technology firms over the years that followed the dot-com bubble burst in 2000. By extending the model until 2013, we were further able to document that the value relevance of accounting fundamentals in the technology industry displayed a decreasing trend over the last three years reaching from 2011 until 2013, which stands in contrast to the development during the years after the dot-com bubble. The finding of a decreasing explanatory power of accounting fundamentals over the last three years indicates that the market value is characterized by a source of variation that is not well captured by the independent variables in our regression model. Therefore, this decrease in value relevance potentially implies that investors did not act fully rational and might have used more irrational investments strategies during the last three years in the technology industry.

In conclusion, taking into account all results and factors discussed in this study, it can be resumed that the current development in the technology industry is not yet to be seen as a bubble, or close to a bubble. However, certain similarities to the dot-com bubble in the late
1990s can be recognized, as discussed in the analysis. These similarities are that the NASDAQ Composite Index shows accelerated growth compared to its peer indexes and that the value relevance of accounting fundamentals decreased simultaneously over the last three years in the technology industry. Looking forward, if the trading behavior continues to develop more towards irrational behavior, as it might have during the last three years, a situation as during the dot-com bubble, might possibly occur over the next few years. This would be illustrated by a further decrease in value relevance of accounting fundamentals.

7. Limitations and Future Research

Even though our study is built up on well established and tested research methods, there is a number of limitations that need to be considered when interpreting the results of our research.

Outdated SIC codes
First, with regards to our value relevance analysis, it is a challenge to include industry specific companies from the technology sector from the Compustat and CRSP databases. In our analysis we have used the standard industry classification system, SIC, by the U.S. government to identify companies from the technology industry. This approach has been used to follow the same methodology of previous researchers, and to make our results comparable to their results. However, the SIC system is not completely up-to-date anymore and has been replaced by a new classification system, the North American Industry Classification System (NAICS) in 2004. While the SIC codes are still widely used among researchers and industry experts, the U.S. government does no longer support and maintain the system. In some instances, there are several SIC codes that match a single NAICS code and as a consequence of this, SIC codes do not seamlessly convert into NAICS codes (Department of Revenue, 2015). Due to the difficulties in matching SIC and NAICS codes, and in order to make our results comparable to those of previous researchers, we decided to use the SIC code system, even though it is not updated anymore by the U.S. government.

Quality improvement of accounting fundamentals
Also, since our analysis is based on financial indicators and accounting fundamentals, it is crucial to remember that the quality of these fundamentals might vary over time, which could have an impact on our results. In our case of the value relevance model, it can probably be assumed that the quality and accuracy of accounting fundamentals has improved since the
early 2000s as regulations on accounting standards have become tighter in response to several companies falsifying their balance sheets during and after the dot-com era in the late 1990s and the early 2000s. Scandals that happened at companies, such as Enron, WorldCom, and Tyco International also caused distrust among investors in accounting fundamentals and led to a revision of regulatory standards.

As a consequence of these scandals and the negative impact they had on the economy, regulators introduced new accounting standards with the ambition to prohibit such scandals from happening again. The Sarbanes-Oxley Act of 2002 (SOX) was passed by the U.S. Congress to protect the public from potentially fraudulent accounting activities of multinational firms, which could otherwise lead investors to execute wrong investment decisions (Goodnight & Green, 2010). The act further increased criminal penalties for executives who violated the stricter regulations (Engel, Hayes & Wang, 2007).

As a consequence, it is likely that the improvement of regulatory standards since the early 2000s has generally increased the explanatory power of accounting fundamentals in our value relevance model over the years. In relation to our findings, this implies that the actual level of explanatory power that we found for the recent three years could potentially be assumed to be even closer to the low level that has been reached during the dot-com period. However, since we do not analyze how much the quality and accuracy of accounting fundamentals has improved over the years, it is not possible to estimate the extent to which this factor has an impact on our findings.

**Omission of privately held companies**

In our analyses, the NASDAQ Composite Index analysis and the value relevance analysis, we focused exclusively on publicly held companies, which consequently implies that the results of our study might not be representative for the entire technology sector. We had to accept this limitation in this study, because the data required for the types of analysis that we performed is only available for public companies, since privately held companies are not obliged to publish extensive financial information (American Accounting Committee, 2006).

However, it seems likely that there might be some indicators for a potential bubble development in privately held companies operating in the technology sector, since several private firms have received increased sums in funding from venture capitalists and angel investors over the last years. More than 80 privately held startups, including companies like Uber and AirBnB, have
currently received valuations above $1 billion based on multiples of their revenues (Financial Times, 2015). Over the last three years, venture capitalist funding in the United States has increased to $48.3 billion in privately held companies in 2014, compared to $27.6 billion in 2012. Of these investments, Internet-specific companies captured $11.9 billion in 2014, making it the highest level of Internet-specific investments since the dot-com bubble in 2000 (PwC, 2014). According to industry experts such as Mark Cuban, this can be seen as a dangerous development due to the nature of illiquid investments, which is based on the high concentration of investments in private instead of public companies.

**Recommendations for future research**

To assess the potential development of a bubble in the technology industry in the future, we recommend other researchers to continuously extend the value relevance model, which will allow tracking the development of the explanatory power of accounting fundamentals on a yearly basis. Since the availability of data at the current point allowed us to perform the value relevance analysis until 2013, it would be interesting to perform the next regression as soon as the complete data set becomes available for 2014, which will be the case in September 2015. In the same manner, the model can always be extended on a yearly basis in September of the subsequent years. By applying this approach, it could be determined whether or not the trend of a decreasing value relevance of accounting fundamentals in the technology industry continues.

Further, we would recommend future researchers to investigate the reasons that lie behind the changes in the explanatory power of accounting fundamentals in the value relevance analysis. Thereby, it would be possible to determine to what degree the developments can be attributed to rational or irrational investment behavior, and also to other factors such as the prevailing level of interest rates, or the quality of accounting fundamentals. In order to practically assess for instance to what extent the development can be attributed to rational or irrational investment behavior, it would be necessary to collect data on the motivation and rationale of investors when purchasing an asset.

Moreover, future studies would require data on how much investors take the prevailing level of interest rate and a variety of other factors, which might influence the investment decisions of investors, into account. This could for example be done by collecting data through a survey among investors. However, it can be expected that it is difficult to generate a reliable and complete data sample from investors, since it would require investors to be totally aware of the
reasons for their actions, which might often not be the case. Also, differentiating between the various factors and determining to which degree each of them has an impact on the decisions of an investor is difficult in practice.
8. References

Articles, Books, Journals and Studies


References


Online Sources:


References


References


## 9. Appendices

**Appendix 1: SIC Code Groups classified as Low-tech**

<table>
<thead>
<tr>
<th>SIC code</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>101</td>
<td>Iron Ores</td>
</tr>
<tr>
<td>102</td>
<td>Copper Ores</td>
</tr>
<tr>
<td>104</td>
<td>Gold and Silver Ores</td>
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<tr>
<td>109</td>
<td>Misc. Metal Ores</td>
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<tr>
<td>145</td>
<td>Clay, Ceramic and Refractory Minerals</td>
</tr>
<tr>
<td>154</td>
<td>Nonresident Building Construction</td>
</tr>
<tr>
<td>161</td>
<td>Highway and Street Construction</td>
</tr>
<tr>
<td>162</td>
<td>Heavy Construction (eg. Highway)</td>
</tr>
<tr>
<td>173</td>
<td>Electrical Work</td>
</tr>
<tr>
<td>201</td>
<td>Meat Products</td>
</tr>
<tr>
<td>202</td>
<td>Dairy Products</td>
</tr>
<tr>
<td>203</td>
<td>Preserved Fruits and Vegetables</td>
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<tr>
<td>204</td>
<td>Grain Mill Products</td>
</tr>
<tr>
<td>206</td>
<td>Sugar and Confectionary Products</td>
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<td>207</td>
<td>Fats and Oil</td>
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<tr>
<td>208</td>
<td>Beverages</td>
</tr>
<tr>
<td>209</td>
<td>Misc. Food and Kindred Products</td>
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<td>223</td>
<td>Broadwoven Fabric Mills, Wool</td>
</tr>
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<td>227</td>
<td>Carpets and Rugs</td>
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<tr>
<td>229</td>
<td>Misc. Textile Goods</td>
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<td>249</td>
<td>Mis. Wood Products</td>
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<td>Paper Mills</td>
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<td>Paperboard Containers and Boxes</td>
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<td>267</td>
<td>Misc. Converted Paper Products</td>
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<td>275</td>
<td>Commercial Printing</td>
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<td>276</td>
<td>Manifold Business Forms</td>
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<tr>
<td>279</td>
<td>Printing Trade Services</td>
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<tr>
<td>322</td>
<td>Glass and Glassware Pressed or Blown</td>
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<tr>
<td>324</td>
<td>Cement and Hydraulic</td>
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</table>
329 Misc. Nonmetallic Mineral Products  
331 Blast Furnace and Steel Products  
333 Primary Nonferrous Metals  
334 Secondary Nonferrous Goods  
335 Nonferrous Rolling and Drawing  
341 Metal Cans and Shipping Containers  
342 Cutlery, Handtools and Hardware  
344 Fabricated Structural Metal Products

Source: Javorcik and Saggi (2010).

Appendix 2: Morris & Alam's Annual Adjusted $R^2$ Values 1989 to 2006 for High-tech Sample

![Graph](image)

Source: Morris and Alam (2012).

U.S. Subprime Share of Mortgage Originations

Appendix 4: Annual Adjusted $R^2$ Values 2000 to 2013 for High-tech & Low-tech Sample

Source: Own creation based on Compustat and CRSP databases (2015).
### Appendix 5: Yearly Low-tech Coefficient Estimates and their t-statistics 2000 to 2013

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<td>(t-stat)</td>
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<td>5.899***</td>
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** p-value < 0.05
*** p-value < 0.01
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Source: Own creation based on Compustat and CRSP databases (2015).