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COPING WITH BLACK SWANS: PROFITING OF THE IMPROBABLE

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ABSTRACT

This paper studies whether beta is a valid risk measure and whether the constructed investment strategies are able to beat the market using a research period from 1973 until 2014. Beta still seems to capture risk properly for countries and industries as well as for countries, industries, developed and emerging countries separately. The investment strategies rely on the occurrence of black swans combined with beta-portfolios to cope with them. The 10%-threshold for defining black swans presents promising results with developed countries being able to provide the largest profits.

Keywords: *Black Swan, portfolio protection, negative beta*

1 INTRODUCTION

The recent phenomenon "black swan" received a lot of attention after the publication of Taleb's best seller book *The Black Swan: The Impact of the Highly Improbable*. The academic world reacted by constructing several research papers where black swans are the core of the investigation. However, combining the black swan theory with certain investments strategies appeared only occasionally. Most of those papers discussed the fact that black swans will have an enormous impact on built-up profits, but none of them posed the question of how to turn these losses around. Estrada & Vargas (2012) defined a black swan empirically which made it possible to detect the phenomenon and construct investment strategies based on it. Their results indicate that beta can be used to cope with those severe losses caused by black swans. Although beta has been a contradicted risk measure ever since its inception, we do not strive to solve the controversial debate on the Capital Asset Pricing Model (CAPM), but we want to assess whether beta is a proper risk measure and a possible tool for portfolio construction. Using a combined dataset on countries and industries from 1973 to 2014, we were able to answer our first research question positively: Is beta still a valid measure of risk? We tried to extend this research question, by using both the 5%- and 10%-threshold to define a black swan, to industries, developed and emerging countries separately.

Secondly, to be able to profit with beta portfolios in different market situations our investment strategies rely on the mean reversion theory. Through deciding to invest in the high-beta portfolios after the occurrence of a negative black swan, an investor should be able to profit even more from the recovery of the market. On the other hand, after the occurrence of a positive black swan, negative returns can be expected and low-beta portfolios should provide a downside protection. In addition to the research of Estrada & Vargas (2012), we constructed a fifth portfolio characterized by a negative beta that was based on data of the MSCI World Short index.

Intuitively, this would render profits instead of smaller losses in a declining market situation. In our research, we made a distinction between both strategies, the Strategy High-Low and the Strategy High-Negative. It should be mentioned that because of the limited data on the MSCI World Short index, we were obliged to use a combination of both the high-low and high-negative strategy. For convenience reasons, we will still call the combined new strategy, the high-negative strategy. Detailed results will always be shown for the different elements of the combination.

Concerning our first research question, the results show that no matter how a black swan is empirically defined and no matter where the geographical focus lies, high-beta portfolios do fall stronger than the market and much stronger than low-beta portfolios. This answers our first research question and it seems beta indeed still is a proper risk measure. Looking at the results of the investment strategies, we can clearly state that using the 5%-threshold is in none of the cases advantageous. However the 10%-threshold provides promising results and corresponds more strongly with Taleb's (2007) definition of a black swan. Over forty years, our investment strategy that uses high-beta and low-beta portfolios achieves a value of almost 1.5 times the market. Especially investing in developed countries does render extreme positive results compared to the benchmark, which is measured by the MSCI World index. The high-negative strategy experiences problems due to its limited time span.

The next two sections respectively discuss literature concerning black swans and beta. The subsequent section focuses on our data and methodology. We discuss our results in section 5, where we summarize, interpret and test for robustness, to finally end with a general conclusion and thoughts for future research.

2 BLACK SWANS

2.1 WHAT IS A BLACK SWAN?

“Remember that *you* are a Black Swan.” (Taleb, 2007, p.298) Nassim Nicholas Taleb has used this quote in his bestseller book named *The Black Swan: The Impact of the Highly Improbable*. According to Taleb (2007), the metaphor of black swan consists out of three main characteristics. If an event is rare, has an extreme impact and retrospective predictability we can refer to it as a black swan. The name black swan originates from the fact that in the past, people thought all swans were white. A white swan was considered normal, thus when people saw a black swan for the first time, it was totally unexpected.

In his book, Taleb (2007) talks about two kinds of societies: Mediocristan and Extremistan. Mediocristan is a society where events do not have a high impact and are rather easy to predict by using the Bell curve for instance. The opposite can be found in Extremistan, where nothing is predictable and where events can have very high consequences. With this comparison, Taleb wants to make it clear that the future cannot be predicted by the past and thus that rare events can happen. The rarity shows that the ability to forecast such an event is nearly impossible. Obviously the question poses itself of what can be defined as rare? For instance, someone who is a soldier in the army will not see a war as a rare event due to fact that this is his day job. However, a normal citizen will classify a war as exceptional. Of course, this is a general example to indicate how difficult it is to define the interpretation of rare. When you extend this interpretation into the financial sector, the recent financial crisis can be used as an example. Some people, like Nouriel Roubini, also known as Dr. Doom, predicted the financial crisis. So the occurrence of it was not a surprise to them and was thus not exceptional. It is rather difficult to draw the line but Estrada & Vargas (2012) define a black swan as a monthly return in the world market higher than or equal to 5% in absolute value. This definition makes it possible to conduct empirical research because now the characteristic rarity can be detected. The second characteristic, namely the extreme impact, can also be measured in the definition of Estrada & Vargas (2012) due to the fact that they are using the monthly return. The higher the monthly return, the higher the impact of the event. The fact that Estrada & Vargas (2012) look at the absolute value indicates that both negative and positive black swans can occur. Retrospective predictability, maybe better known as the hindsight theory, defines that people will always try to find an explanation why a certain event has happened and even express that they saw it coming.

“It is true that a thousand days cannot prove you right, but one day can prove you to be wrong” (Taleb, 2007, p.56) Taleb gives the example of a turkey that is being fed for a thousand days. Because of this, it statistically seems that the turkey will be living like this for a very long time. However the turkey is being killed the next day. This can be referred to as the surprise effect. If this effect is not present, the turkey could prepare himself so that horrible day would not happen. “Consider that if the WTC attack of September 11 2001 were a plausible risk then planes would have protected New York City and airline pilots would have had locks on their doors.” (Taleb, 2005, p.6) This shows that the unpredictable lies around the corner and that black swans can have consequences in different areas. For instance economical, financial or social. In our research, we focus on the financial consequences. This will be further explained in the Data and Methodology section. An example of a recent black swan that has occurred in the financial sector is the financial crisis that started in 2007. According to Marsh and Pfleiderer (2012), the financial model failure cannot be explained by a lack in technical know-how but is due to the transparency and disincentives for deploying competent models. People can insure themselves against these financial consequences but there will be someone on the other side who will have to bear this possible loss. In other words, people will have to cope with black swans. The financial crisis has showed that portfolio protection is of great necessity. Although risk and uncertainty are seen as synonyms for each other, these two concepts differ in several ways. This is why a distinction between risk and uncertainty is necessary due to the fact that it is directly connected to the phenomenon black swan.

2.1.1 Risk & Uncertainty

Frank Knight, an American economist, was one of the first who made a distinction between risk and uncertainty. In his book *Risk, Uncertainty and Profit*, which was published in 1921, he defined what should be understood as risk and what as uncertainty. According to different sources, risks are the situations where the outcome is unsure but that are subject to the probability distribution. Although uncertainty also has an unsure outcome, it cannot be subject to the probability distribution but rather to an unknown probability model. Knight had his own terminology for these two definitions, namely objective (measurable) and subjective (unmeasurable) probability. Keynes’ definition of uncertainty follows the one that was introduced by Frank Knight. However, according to Paul Davidson (2012), founder and editor of the *Journal of Post Keynesian Economics*, Keynes’ concept of uncertainty has an ontological founding while Knight’s uncertainty concept has an epistemological founding. Ontology is about ‘what’ is true or ‘what is reality’. For instance: ‘Does there exist a god?’. Epistemology on the other hand is about the ‘methods’ of figuring out those ontological questions. For instance, finding an answer to: ‘How can I know that a god does exist?’. This is the easiest way to explain the difference between ontology and epistemology without going into too much detail. However, Andrea Terzi (2010) has a more specific explanation. “Models assuming epistemic uncertainty admit that no matter how skilfully agents attempt to acquire knowledge of a given economic reality, their propositions and decisions will inevitably be based on incomplete information. Uncertainty can be reduced by acquiring new knowledge of reality and, yet, the complexity of the system prevents agents from ever acquiring full knowledge." (Terzi, 2010, p.561) Taleb's black swans follow the Knightian view, the epistemological concept of uncertainty, because these events are so rare that even if they follow the statistical path they cannot be predicted. This is simply because there is not enough data on such events due to the fact that it lies in the long tail of the Bell curve.

"Models assuming ontological uncertainty admit that agents know they live in a constantly changing environment where the future is not predetermined by the past and that no apparent regularity can be considered a permanently acquired basis for statistical anticipation of the future. Although agents have no option other than using the past as their only source of knowledge, they know that nonpredetermined surprises are possible." (Terzi, 2010, p.562) The main difference between the two is that Keynes assumes that agents know that the future is uncertain and that they adapt their economic behaviour to this assumption by for instance save some of their earned money. In Taleb's assumption, the agents ignore the fact that the future cannot be predicted and is thus uncertain. Because of this, the economy lacks robustness.

"Uncertainty is a state of not knowing whether a proposition is true or false". (Holton, 2004, p.21) With this definition, Holton gives the example of a man who is about to roll a die. If the result is six, than he is going to lose 100 dollar. What is the risk, thus your subjective opinion, that he will lose that 100 dollar? Normally one would say it is one chance in six, but this can be wrong because the proposer neglected to say that the die is ten-sided. To make a clear definition of risk, exposure should also be mentioned. To be exposed to something, one needs to care. This shows that exposure is a personal condition and depends on the question: would I care? Holton (2004) makes it clear using an example: "Suppose it is raining. You are outdoors without protective rain gear. You are exposed to the rain because you care whether or not the proposition *it is raining* is true – you would prefer it to be false." (Holton, 2004, p.22) In his article, Holton tries to find a general definition for risk. He concludes that risk consists out of two components, namely uncertainty and exposure. This means that risk is the exposure to a proposition that is uncertain. Again, he clarifies it with an example, namely of a man who jumps out of an airplane without a parachute. If the man is sure that he is going to die, than there is no risk due to fact that the component, uncertainty, is not present.

2.2 BLACK SWANS IN THE FINANCIAL SECTOR

Due to our research we are specifically interested in black swans that have occurred in the financial sector or have influenced severe changes in the financial structure. Although black swan events can occur in a positive way, there are more examples available of the negative ones. Our goal is to cope with these rare events and try to find a way to make an investment portfolio ‘antifragile’. Below you will find three major negative black swans that have occurred in different eras and also one positive black swan.

2.2.1 The Great Depression

The Great Depression is the name given to the economic crisis in the 1930s. It is still a commonly used example of a severe crisis that shook the world. Black Tuesday is known as the day that triggered the Great Depression. On October 29, 1929, the U.S. stock market prices collapsed. However, although the consequences of the Great Depression could be easily determined, the causes are open for interpretation. There are two main points of view, starting with the demand-driven theories. These theories suggest that the depression was caused by a combination of overinvestment and underconsumption. Normally one should suggest that if consumption fell due to an increase in savings, the interest rate would decline which would lead to an increase in investment and saving would be less interesting. However, according to Keynes (1936), these assumptions can differ. In his book *The General Theory of Employment, Interest and Money*, he explains the fact that businesses often project their investment in the future. This means that if corporations suggest that the fall in consumption is a long-term problem, they will postpone their investments because the demand will not follow the increased production. This eventually caused an economic bubble that popped.
The second point of view insinuates that the Great Depression started as a common recession but due to a lack of good policy decisions by monetary authorities, for instance the Federal Reserve, this resulted in a worldwide economic crash. The fact that the money supply shrank caused several bank runs, which eventually led to a series of bank failures.

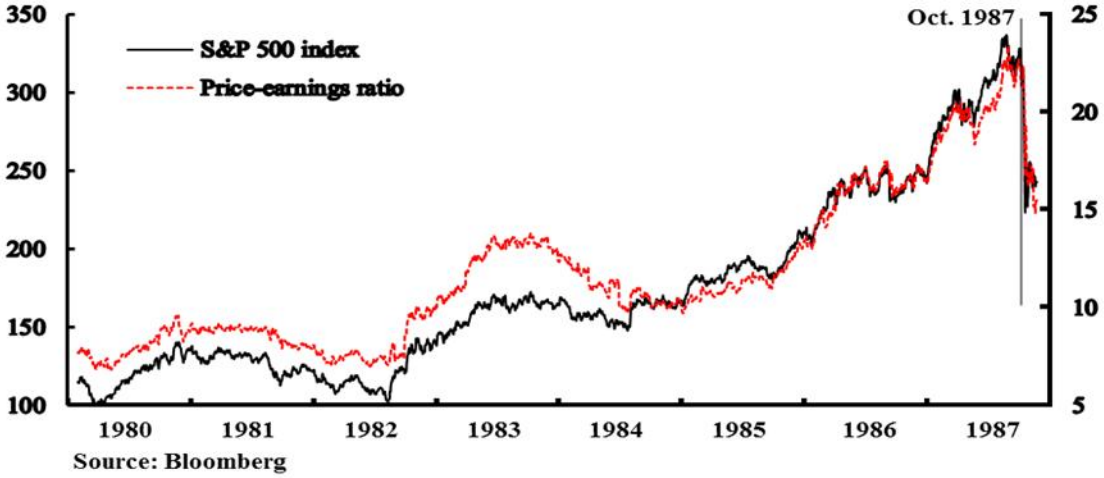
Another cause was the over-indebtedness prior to the Great Depression. Banks were lending enormous amounts of money compared to the deposits they received. Thus when the markets fell, calling back those loans did not work and depositors, who wanted to withdraw their savings, triggered multiple bank runs. According to Romer (1991) and several other economists like for instance Milton Friedman, the monetary developments (e.g. the increases in the money supply) were the foundation that ended the Great Depression.

2.2.2 Black Monday

October 19, 1987 can be referred to as Black Monday. On this Monday, stock markets around the world crashed. For instance, the Dow Jones Industrial Average (DJIA) declined with 22.61%. If we follow the definition of Estrada & Vargas (2012), we can clearly say that this can be called a black swan due to the fact that the MSCI World index has fallen with 9.84%. Not everyone was shocked by the enormous decline.

Bogle (2008) mentioned that Alan Greenspan, former chairman of Bear Stearns Companies, said “So markets fluctuate. What else is new?”

FIGURE 1: S&P 500 index vs. Price-earnings ratio



In the years prior to the market crash, the equity markets exhibit large gains. We constructed the above graph using market data retrieved from Bloomberg. The extreme bull market made the price increases exceed the earnings growth, which raised the price-earnings ratios. This shows that the market is overvalued and that a correction is not impossible. Program trading is seen as one of the different causes of the 1987 crash. One of those program trading strategies was ‘portfolio insurance’, which was designed to limit the losses that investors might face from a bear market.

“Under this strategy, computer models would suggest that the investor decreases the weight on stocks during falling markets, thereby reducing exposure to the falling market, while during rising markets the models would suggest an increased weight in stocks.” (Mark Carlson, 2006, p.4) The second program trading strategy was ‘index arbitrage’, which wanted to earn profits by creating a discrepancy between the value of a stock index and its value in a futures contract. This way, money could be easily earned due to the fact that if the value of the stocks was lower than the value in the futures contract, investors could buy the stocks and eventually sell the futures contract. Because computer technology became widely available, investors could use the program trading strategies more easily. Because those program trading strategies blindly sold stocks when markets were declining, it could have worsened the crash. However Richard Roll (1988) believes that the 1987 crash could not be caused by program trading due to the fact that there is virtually no evidence to support such a view. “If institutional structure of the U.S. market had been the sole culprit, the market would have crashed even earlier. There must have been an underlying ‘trigger’.” (Roll, 1988, p.20) He found that the crash was an international event that reached Asia, Australia, Europe and North America. It must be pointed out that program trading was only active in the United States.

How was it possible that markets like Asia and Europe declined with the same amount while program trading was not used over there? Richard Roll also found that the response coefficient, better known as beta, was the most statistically significant explanatory variable. Due to Black Monday, regulators developed new rules. These rules allowed exchanges to halt trading provisionally when the stock market suffered large price declines.

2.2.3 The Financial Crisis

According to Taleb, the recent financial crisis cannot be seen as a black swan because it was predictable. Of course the predictability depends on the person you ask. For instance, the terrorists who flew in the WTC towers knew that 9/11 was going to happen. However for other people, this was a total surprise.

This attack showed the severe consequences that a black swan is able to cause. The financial markets crashed and especially the airline companies and the tourism sector suffered heavy losses. Because of this fact, we are especially interested in finding a way to cope with black swans and how to manage an investment portfolio to eventually outperform the market. We already learned the fact that no one can forecast what will happen in the financial markets. Because of this, a lot of empirical research is accomplished to see if there are specific models that can help the investor in constructing their portfolio. Focardi & Fabozzi (2009) handled the issue if mathematics can or cannot be used in finance. They sum up three main reasons why mathematics should not be used in finance. The first one is the black swan issue, namely the fact that finance has unpredictable unique events. These rare events also have qualitative effects that cannot be quantified.

Thirdly, but not least importantly, is that the laws on finance keep changing. The first reason is contradicted by mentioning that physical laws also have an intrinsic uncertainty when it comes to individual observations. An example in finance can be that human behaviour is predictable on the macro economical level. However, when we try to forecast individual human behaviour, it is either extremely hard or even impossible. The authors want to clarify that black swans do also exist in physical sciences but no one questions the use of it. So we can conclude that using mathematics in finance is not the ideal thing to do but its use can be defended by stating that mathematics is also used in physics.

There was not a model that could foresee the financial crisis that started in 2007. Many economists consider this global crisis as the worst since the Great Depression of the 1930s. The consequences were huge. Banks had to be bailed-out by governments, large financial institutions collapsed, small businesses had to file for bankruptcy and people were evicted from their homes. It all started when the U.S. housing bubble popped due to the relaxed underwriting standards and the allowance of riskier mortgages to less creditworthy borrowers. This was referred to as subprime lending, the phenomenon where even people without an income could take a mortgage due to the fact that the mortgage was not linked at the subscriber, but at the house. Once the interest rate went up, those less creditworthy borrowers could not pay back their loan. This forced the lenders, namely banks, to sell the underlying equity. The effect was an excessive supply of real estate that led to a collapse in the housing prices, which eventually caused severe losses for those banks. Although the housing market is a rather small market, the consequences were huge. “This became known as the butterfly effect, since a butterfly moving its wings in India could cause a hurricane in New York, two years later.” (Taleb, 2007, p.179) You could also see it as a sort of snowball effect, namely due to the fact that the mortgages were securitized into mortgage backed securities (MBS) no one knew which banks precisely were in trouble. This is a security that is backed by a mortgage or a group of mortgages, which eventually led to a lack of transparency. This lack led to an enormous dent in the trust that banks had in each other, which dried up the interbank market. This meant that banks did not lend any money to each other with nationalization, bankruptcy and acquisitions as outcome. Like we already mentioned, stock markets crashed which meant that portfolio protection has become a necessary good.

2.2.4 The Internet Revolution

There are a lot of examples that cover the definition of a negative black swan. However, due to the fact that our investment portfolio also wants to take advantage of an enormous positive impact, being a positive black swan, we feel the need to discuss at least one example of it.

Without the Internet, the society would not be what it is today. Taleb (2007) also uses the Internet as an example of a positive or reverse black swan. It is clear to say that the Internet has had and still has a major influence in our lives. The reason why we have chosen this positive black swan, and not for instance the discovery of a medicine, lies in its nature. When the Internet became available for the broad public, it brought several developments with it. We are particularly interested in the economic developments, for instance the stock market. Imagine the world before the Internet, investors needed to call their brokers who were at the stock market exchange yelling to buy or sell their clients’ stocks or the fact that there was an extreme appearance of asymmetrical information. Today however, stock orders can be executed behind your computer and within minutes everyone has access to the same information. Everybody was so impressed with the ability of the Internet that everything that was related to it starting booming. This process led to a chain of positive black swans according to the definition of Estrada & Vargas (2012). This process can be seen in Table I in the <u>Data and Methodology</u> section, namely the fact that from January 1994 until June 1997, there were only positive black swans. This all led to an overvaluation of the Internet-related companies and eventually had a huge negative black swan as effect, which is discussed above.

2.2.5 Duration of a Black Swan

We thought it could be interesting to see how long it takes for a black swan to recover but there is still a lack of research concerning this subject. However, due to the fact that a black swan comes with a huge impact, one would assume that it takes a certain time to recover from it. Like for instance, taking the above three negative Blacks Swans, the average time to recover took several years. Thus, we asked ourselves if the Flash Crash that occurred on the 6^{th} of May 2010 can be referred to as a black swan.

2.2.5.1 The Flash Crash

On May 6, 2010, U.S. stock market indices, futures, options and exchange traded funds crashed enormously in a timeframe of only minutes. For instance, the Dow Jones Industrial Average tumbled about 1,000 points, which is around 9%, in only a few minutes. The most remarkable is the fact that it recovered too in those minutes. According to the report of the SEC and CFTC, who were authorized to lead an investigation to the Flash Crash, over 20,000 trades across more than 300 securities have been executed at prices which differed more than 60% of their price before the crash. No one knew what triggered this short crash. Although there were tensions concerning the debt crisis in Greece, someone or something must have caused this unique crash. "A large fundamental trader (a mutual fund complex) initiated a sell program to sell a total of 75,000 E-mini contracts[1] (value at approximately 4.1 billion dollar) as a hedge to an existing equity position." (SEC and CFTC, 2010, p.2)

Selling a large position can happen in several ways. The first one is using an intermediary, for instance a broker, to manage the selling of the position. Thus, selling the security in different phases so that the market does not get affected. The second option is the same process as above but without engaging an intermediary. The last one exists of an automatic execution program, namely a selling algorithm. It is this last technique that caused the Flash Crash according to the investigation of SEC and CFTC. Normally a selling algorithm takes into account the price, time and volume of a security but on the 6^{th} of May this sell algorithm only took the trading volume into account, which led to an execution of the position in only twenty minutes.

Due to this large sold volume, High Frequency Traders (HFT) and other traders started selling too which led to an even higher decline. Due to the fact that there were still no fundamental

[1] E-mini: "An electronically traded futures contract on the Chicago Mercantile Exchange that represents a portion of the normal futures contracts. E-mini contracts are available on a wide range of indexes." (Investopedia: http://www.investopedia.com/terms/e/emini.asp)

buyers, HTFs started to quickly buy and resell contracts to each other. It was only when the trading on those E-mini contracts was halted by an automatic Stop Logic Functionality that the buy-side increased and thus made sure that prices stabilized and eventually recovered. There is certain criticism on the report of SEC and CFTC. The recent publication of Michael Lewis' book (2014) named '*Flash Boys*' focuses on high frequency trading in the financial markets and immediately after its appearance, the FBI launched an investigation into the wonderful world of HFT.

Going into more detail is not representative to our research because we are not interested in how such a crisis is caused but rather in how to cope with it or even profit from it. We need to ask ourselves the question if this can be referred to as a black swan. When we look at the three characteristics a black swan should possess, we can conclude that the Flash Crash is indeed rare. But the extreme impact and the retrospective predictability are not present. There was an extreme impact for a about a half an hour but its recovery was unique. It is possible that a lot of stop losses were activated during the crash but severe consequences for the public failed to occur. Due to the amount of research and the still uncertain cause of the Flash Crash, it seems unlikely that the retrospective predictability theory is applicable, being that people claim that they saw it coming.

These previous discussed four black swans, thus excluding the Flash Crash, have several things in common, but the fact that they are all aggravated by the herd instinct is quite interesting. This instinct, as well as the hindsight theory which is one of the three characteristics, is only one of the many features that belongs to the world of behavioural finance.

2.3 BEHAVIOURAL FINANCE

Models like the Capital Asset Pricing Model (CAPM) assume that investors are rational and risk averse. However, the past has proved that these assumptions are rather unrealistic. A simple example is the fact that millions of people buy lottery tickets while there is a practical zero chance of winning something. If people were rational and did not let their emotions take over, they would not participate into that kind of competition. This is where behavioural finance tries to explain these anomalies.

2.3.1 The Prospect Theory

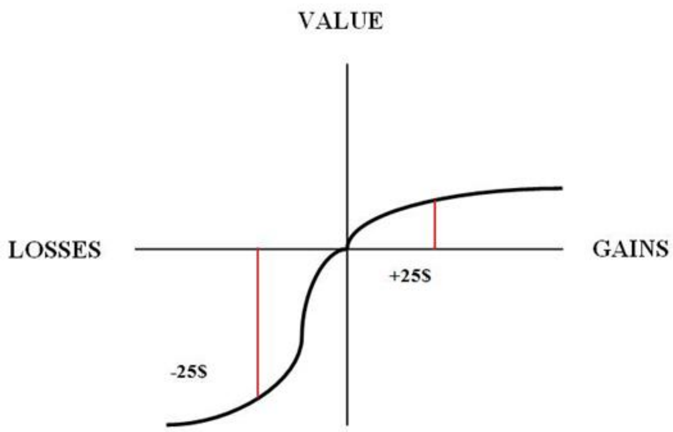
Psychologists Daniel Kahneman and Amos Tversky can be considered as the fathers of behavioural finance and economics. One of their most popular academic works, which was published in 1979, was *Prospect Theory: An Analysis of Decision under Risk*. This theory explains the fact that people do value gains differently than losses. This was a major finding because it assumes that people will base their decisions on the observed gains rather than the observed losses. Thus when a person is given two choices, the first one being expressed in terms of a possible gain, he/she will choose this one above the second choice, expressed in terms of a possible loss. An example should clarify this theory.

You need to choose between:

- *Gaining 50 dollar and then losing 25 dollar*
- *Gaining 25 dollar*

It is obvious that in both cases the end result is the same net gain of 25 dollar. Although the utility of both situations should be equal, people rather have a single gain of 25 dollar than first gaining 50 and then losing 25 dollar. This can be explained through the prospect theory, because losses do tend to have a higher emotional impact than a similar gain. In their study, Kahneman and Tversky (1979) use several questions where people have to choose between two propositions. For instance, the first problem is the choice between A, having 2,500 with a probability of 33%, 2,400 with a probability of 66% and 0 with a probability of 1% or option B, having 2,400 with certainty. Although one should suppose that the choice between the two depends on the person itself, namely if he/she is risk averse, the majority (82%) chose for option B. This can be explained through the fact that even if there is a reasonable chance of gaining more, people are going to choose for the lesser but certain gain. However, if they can limit their losses, they will be less risk averse and indulge in weighing the different possibilities. We made a similar figure of the value function that was first presented in Kahneman and Tversky (1979). We can clearly see that it is asymmetric which shows the unequal importance of gains against losses. In our example, a person needed to choose between gaining 50 dollar and then losing 25 dollar or gaining 25 dollar. Before analyzing the graph, it should be mentioned that not everyone would have such a course of value function. The most remarkable aspect is that the value that people assign to a gain is much lower than the value assigned to a loss of the same amount. In other words, the happiness connected to a gain of 25 dollar is far less than the pain linked to a loss of 25 dollar. "The disposition effect is the tendency to sell assets that have gained value ('winners') and keep assets that have lost value ('losers')" (Weber and Camerer, 1998, p.167)

FIGURE 2: The Value Function



If investors would be completely rational, they would go the other way around. In that case, they would ride the winners so that the gains could increase further and sell the losers so they can prevent exceeding losses. However, we already mentioned that the past has proven that investors are not completely rational and react rather emotional when it comes to investment decisions. The previously called disposition effect can be explained through the aspects of the prospect theory. According to Weber and Camerer (1998), the prospect theory has two features that can explain the disposition effect. The first being the idea that losses and gains are weighted differently by people and the risk-seeking behaviour when a gain is proposed with the chance of possible losses against the risk-avoidance when a certain gain is possible. We already discussed the first feature using the asymmetric value function.

The second feature can be referred to as what Kahneman and Tversky (1979) call 'the reflection effect'. Instead of proposing choices of only gaining, they investigated the behaviour when people needed to make a choice between different loss propositions. To make a clear comparison, they preserved the same amounts as proposed with the 'only gaining' choices. The conclusions showed that people act completely the opposite when it comes to losses. "The reflection effect implies that risk aversion in the positive domain is accompanied by risk seeking in the negative domain" (Kahneman and Tversky, 1979, p.268)

The prospect theory can be directly linked to our strategy that uses negative-beta portfolios. Through using this high-negative strategy we should be able to cope with losses better. Like we already mentioned when discussing the value function, people do value gains differently than losses. The loss of a certain amount does deliver more pain than the joy received from the same amount of gain. Because of this observation, the strategy that uses negative-beta portfolios wants to solve this problem by trying to avoid losses. We respond to the problem of downside markets, and thus having losses, by short selling the market.

This way, the emotional hazard that comes with these losses cannot influence the performance of the investment portfolio. The observation of the value function also shows us that people in general follow the prospect theory. For this reason, we can conclude that people all act in the same way when it comes to investment decisions. The latter can have major consequences which can be linked directly to the phenomenon black swan due to the fact that it can worsen the situation. This feature of behavioural finance can be referred to as 'herd behaviour'.

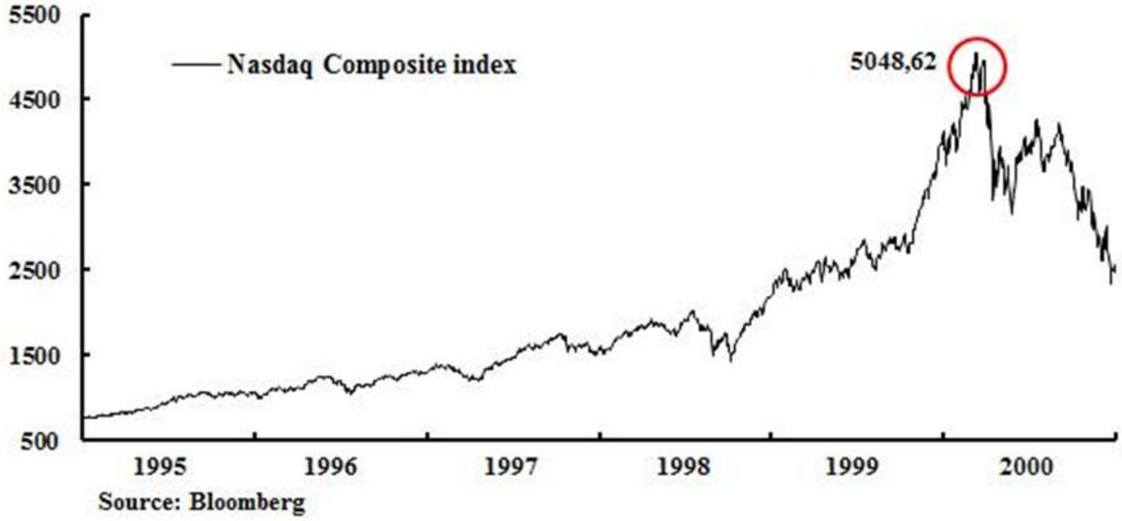
2.3.2 Herd Behaviour

Herd behaviour can be defined as the process where an investor changes his original investment decisions due to the adaption of the opinion of others. In other words and according to Bikhchandani and Sharma (2001), an investor herds when the knowledge that others are investing changes the investor's decision from not investing to making the investment.

There are several reasons why herd behaviour occurs. The first one is that the investor believes that it is unlikely that the others are wrong due to the fact that they represent such a large group. This person will probably assume that he does not have particular information that the others (the herd) do have. This is attached to the second reason, namely the fear of being an outcast. It is something that is already present in our childhood. For instance, how many kids did smoke a cigarette because of the pressure of the group, even if they knew that it was extremely bad for their health or that their mom or dad would be angry? People just feel the need to be accepted by the majority instead of being stubborn and stand for your own beliefs. According to Bikhchandani and Sharma (2001) there is still a third cause, which is the fact that if the investor eventually took the wrong decision, he/she will reverse their decision, either by the arrival of new information and/or experience, which will cause a herd behaviour in the other direction.

An example of such behaviour that led to a severe crisis is the dot-com bubble, which took place in the late 1990s. These were the years where technology, namely Internet was hot. Because of this, lots of Internet-related companies were founded and tried to find capital with venture capitalists or on the stock market. The problems with these companies was that they were different than the other, more traditional companies in the fact that most of their assets were intangible and that corporate earnings did not matter. As long as it was Internet-related, people wanted a piece of it because everyone was buying those companies. People who did not have any clue of what they were doing ran most of those companies. For instance, Pets.com was such a dot-com enterprise. They sold all kinds of pet supplies over the World Wide Web. Before even going public, they suffered severe losses due to a giant marketing campaign and the fact that they lost money on every sale they made. Imagine that your dog or cat falls without any food and that you order it via the Internet. Because of the fact that it can take a certain amount of time, your dog or cat has already starved to death.

FIGURE 3: Evolution of the NASDAQ Composite Index



However, all these signs did not stop the crowd of investing enormous amounts into companies like pets.com. Due to herd behaviour, the dot-com bubble was created and was ready to pop. According to Bloomberg, the NASDAQ stock index increased from 743.58 to 5,048.62, which is an all-time high, between 1995 and 2000. By early 2000, investors realized that they created a bubble and started selling their stocks. Again, because of the herd behaviour, this trend was strengthened and led to a severe market crash. To stay in line with our research, this can be referred to as a black swan.

By the record, an individual investor should try not to be tempted by the herd behaviour through using a clear investment strategy that does not jump on every hot trend. He/she needs to keep in mind that if everyone buys a particular security, it will become overvalued and will eventually burst.

2.3.3 Information Cascade

Another feature in the world of behavioural finance that can cause a black swan is information cascade. “An informational cascade occurs when it is optimal for an individual, having observed the actions of those ahead of him, to follow the behaviour of the preceding individual without regard to his own information.” (Bikhchandani et al., 1992, p. 992) Let us make this definition clear using an everyday example.

Imagine you and your partner are going out to eat a slice of pizza. There are two pizzerias in the same street. Based on what you have searched on the Internet, you prefer pizzeria X above pizzeria Y. However, when you arrive, you immediately notice the fact that nobody is dining there while the other pizzeria, namely Y, is crowded. Thus, if you assume that everybody in *pizzeria Y has a similar taste when it comes to pizza, you will be inclined to reverse your choice and eventually go to pizzeria Y instead of X.*

The example above can be explained as a result that you will probably be influenced by the fact that there is nobody eating in the first pizzeria. This will make you more cautious and thus more likely to reject too and will eventually lead to going to the other pizzeria. As the example shows, information cascade can appear in different sectors but, for our research, we are only interested in its appearance in the financial sector. Its occurrence in the financial markets can lead to speculation and extreme volatility, either for a specific asset or the whole market, which will lead to a bubble. It should be clear that such an information cascade can lead to the previous discussed feature of behavioural finance. According to Lin et al. (2009), the information cascade is not the only explanation for herd behaviour. They found that search cost, for instance transaction costs, play a vital role in the phenomenon of herd behaviour. In our study, we do not take transaction costs into account which means that our strategy is totally independent of those search costs.

In this segment about behavioural finance, we can conclude that it gained a lot of attention when it comes to explaining the unexplainable events that cannot be illustrated using rational logic. Due to the fact that investors are subject to different features of behavioural finance and that those features can cause Taleb's black swans, we believe that there is a direct link between the two and thus both need to be taken into account.

3 MEASURING SYSTEMATIC RISK

When reviewing the literature on beta over the last few decades, the validity of beta as a risk measure remains unsure. Beta was first used in the Capital Asset Pricing Model (CAPM) of Treynor (1961) and has since then experienced an ambivalent future. Before starting with the origin of beta and its historical background, it behoves us to first briefly define what beta actually signifies. A central trade-off within asset pricing is most definitely the return one can earn on an asset or investment, compared to the risk taken. The risk in this case refers to the possibility that results have a different outcome than what was originally expected (Grundy & Malkiel, 1995). For investors to be induced to hold riskier portfolios, they should be rewarded with a higher expected return. Risk can be measured in certain different ways.

The standard deviation in returns is one of those indicators, beta is another. While standard deviation measures total risk of an asset or investment, beta is defined as only capturing a part of the risk on an asset or investment. The asset(s) or investment(s) held, will further be called a portfolio. To understand which aspect of risk is captured by beta, we have to introduce the notorious CAPM expression of the risk-return trade-off, called the beta-return relation. This relation originated from the first CAPMs constructed by Sharpe (1964), Lintner (1965), Treynor (1965) and Mossin (1966) which is stated as follows: the risk premium earned on a portfolio will equal beta times the risk premium on the benchmark market portfolio. Beta thus measures systematic risk, analyzing the sensitivity of a portfolio against its benchmark. The birth of beta and the assumptions under which the CAPM-model is constructed will be thoroughly explained in the next segment. While this theoretical expression is clearly logically constructed, the acceptance of beta as a risk measure has known a turbulent past. Data from the 1960s and 1970s and early tests on the CAPM and its beta indicated that the widespread trust in beta was completely well-founded. However, this conformity in opinions did not last long. Research during the period following the birth of the Capital Asset Pricing Model started to find issues with the use of beta. These critiques were at first disregarded by the academic world, until the ground-breaking work of Fama and French (1992), which changed the outlook on the validity of beta completely. Early criticism focused only on the inability of beta to capture risk completely, and indicated several new variables which should be taken into consideration for measuring risk (e.g. Chen, Roll and Ross, 1986 & Lakonishok and Shapiro, 1986). But Fama and French (1992) described a full-scale absence of a beta-return trade-off. This critique could no longer be ignored and the years after the work of Fama and French (1992) seemed to be characterized as a cycle of periods with complete belief in beta, followed by dismissal of its validity. In his research paper, Grinold (1993, p.28) describes this cycle as “An academic battle to surface once a decade” and poses the question whether “A born again beta will be put to the sword once more”.

After an ambivalent past and a seemingly everlasting discussion between the supporters and adversaries of beta, it looks like current research has deferred from the cycle of belief-dismissal in beta, but focuses more on determinants of beta and its time-varying nature. In this research paper, we will focus only on the validity of beta and thus not elaborate any further on these two aspects of beta.

In the next segments we will first elaborately describe the CAPM and its beta. Then we will move on to the "Death of Beta" through the expressed critiques. The segment after that describes the research by supporters of beta in that period. In the last segment we will explain what a negative beta signifies, link beta's characteristics to the first segment that focused on the black swan phenomenon and explain how these two discussed topics are able to provide a structure for an investment strategy.

3.1 BIRTH OF BETA

In the period prior to the construction and acceptation of the Capital Asset Pricing Model (or Sharpe-Lintner-Black model), the variability in returns was commonly used to measure the risk of each security individually (Grundy and Malkiel, 1995). Having a high variance indicated a risky security, while low variance-securities were considered reasonably safe. This whole way of thinking was changed entirely by the insights of the CAPM. While earlier work regarded risk as a whole, the research following this new model proved that risk could fall apart into two ways of producing variability in returns. Only one of those two factors would have to be priced in the market as risk, because the other will not remain when several different securities are held in a portfolio. This last factor is called idiosyncratic risk, and signifies risk connected to an individual asset. Events such as a lawsuit for pollution, an inefficient CFO and other factors can all impact the returns of an individual security, but are so specific that their impact remains company-based. Since these events are so specific, in the entire spectrum of securities, positive and negative events are likely to cancel each other out (Grundy and Malkiel, 1995). The first risk factor, systematic risk, has a very different impact.

In constructing the CAPM, it was necessary to lay down several assumptions. These assumptions are obviously unrealistic, but are indispensible to assess validity of the model and to be able to leap to a more realistic environment (Bodie, Kane and Marcus, 2013). The two assumptions used for the model refer to the nature of the security markets and characteristics of investors. The security market on which assets are traded is perfectly competitive and equally profitable for everyone, is the first CAPM-assumption.

This hypothetical nature of the securities market is obtained, according to Bodie, Kane and Marcus (2013), by installing six market conditions:

- No investor is sufficiently wealthy that his or her actions alone can affect market prices.
- All information relevant to security analysis is publicly available at no cost.
- All securities are publicly owned and traded, and investors may trade all of them. Thus, all risky assets are in the investment universe.
- There are no taxes on investment returns. Thus, all investors realize identical returns from securities.
- Investors confront no transaction costs that inhibit their trading.
- Lending and borrowing at a common risk-free rate are unlimited.

The second assumption indicates that investors are alike in every way, except for initial wealth and risk aversion. This likeliness in investors is obtained, according to Bodie, Kane and Marcus (2013), by installing three conditions:

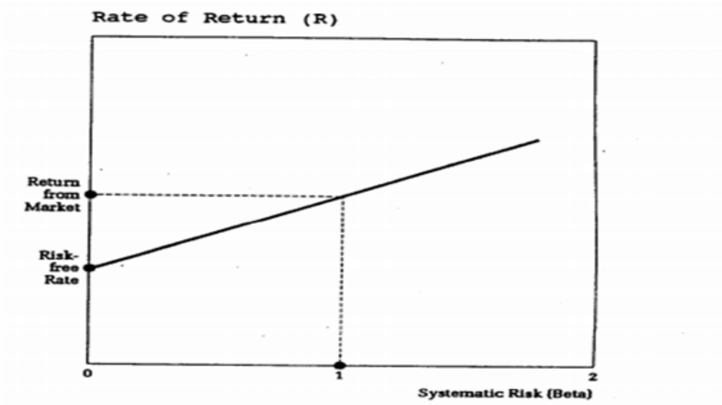
- Investors plan for the same (single-period) horizon.
- Investors are rational, mean-variance optimizers.
- Investors are efficient users of analytical methods, and by the second market condition they have access to all relevant information. Hence, they use the same inputs and consider identical portfolio opportunity sets. This assumption is often called homogeneous expectations.

These nine different conditions are generalizations by Bodie, Kane and Marcus (2013) of all conditions worked out in the papers first describing the CAPM. These two assumptions lead to a hypothetical world in which security markets are completely competitive and investors are mean-variance optimizers, choosing from identical efficient portfolios. In this hypothetical world, interesting insights can be found concerning the equilibrium state (Bodie, Kane and Marcus, 2013). Following all these conditions and assumptions, the prevailing equilibrium state provides four implications (Bodie, Kane and Marcus, 2013):

- The portfolio held by investors will be the market portfolio, which is an aggregation of all possible security combinations.
- The market portfolio will be the optimal risky portfolio. The amount invested in it will only depend on risk aversion of the investor, leading to higher or lower allocation in the risk-free asset or risky portfolio, following the portfolio theory of Markowitz (1959).
- The market portfolio will provide a risk premium, relative to its variance and depending of the investors' risk aversion.
- Individual assets will provide a risk premium, relative to the risk premium of the market portfolio and to the accompanying beta coefficient of the security.

This last implication introduces beta to the world of asset pricing, and brings us to the main point of interest. This beta is the coefficient that measures the sensitivity of a security compared to the market and is able to measure systematic risk. The first risk factor, idiosyncratic risk, can be diversified away, but systematic risk, because of its nature, will always remain. This means that investors need only be compensated for the systematic risk belonging to an investment. And in this case an individual security only adds to the total risk of a portfolio through its beta.

FIGURE 4: Risk and Return according to the Capital Asset Pricing Model



Alternately, the equation can be written as an expression for the risk premium, that is, the rate of return on the portfolio or stock over and above the risk-free rate of interest:

$R – Rf = \beta(Rm-Rf)$

Source: Gundy and Malkiel (1995)

This is what is described by the beta-return relation mentioned earlier and depicted in Figure 4: the risk premium of an asset, proportional to its beta. This trade-off induces a powerful economic insight. While high variance, but low beta securities would be viewed as very risky before the CAPM, they now tell a completely different story. With a beta of 0.5 for example, no matter how high or low the variance, the security would only run half the risk of the market (β=1).

At first, research following the period after the construction of the first CAPMs strengthened the beta-return trade-off theory (e.g. Fama and Macbeth, 1973). Evidence of individual stocks or mutual funds clearly indicated an existing relation between beta and return (Grundy and Malkiel, 1995). Later tests started to find flaws in the beta-return relationship, and issues with the construction of the model started to surface.

3.2 BYE BYE BETA?

As mentioned at the end of the previous segment, the first research papers examining the validity of the CAPM seemed encouraging. However, the more tests were published, the more challenging it became for beta to be used as a risk measure for securities. In the following paragraphs, we will first describe an important critique on the CAPM itself before discussing the three primary arguments used for discarding beta. The first two reasons mentioned in this line of research are in reference to the use of only one variable for explaining returns. In this case beta should be used together with other variables that would be able to explain returns. The third argument is of a more direct nature, and tries to discard beta as risk measure as a whole.

3.2.1 Roll's Critique

Apart from the three arguments against beta itself in the CAPM, there is one more noteworthy critique, by Roll (1977). In his research paper, Roll argues that actual testing of the CAPM is impossible due to the assumption laid down in the construction of this pricing model. Two statements on the market portfolio are made. The first statement has not received much attention in the academic world, therefore focusing on the second statement might prove more interesting. The second statement refers to the impossibility of observing the true market portfolio. In this true market portfolio, anything with value (all stocks, all other possible market instruments and even nonmarketable securities) should actually be taken into account (Grundy and Malkiel, 1995). The widely used S&P500 index is therefore very imperfect to measure this portfolio.

3.2.2 Beta Alone Does Not Suffice

The argument that beta does not tell the whole story of risk, falls apart into two critiques. Firstly, Chen, Roll and Ross (1986) argue that while beta can describe a risk-return relationship, there are still other macroeconomic variables that can indicate a systematic responsiveness.

In their research paper, Chen, Roll and Ross (1986) choose a set of economic state variables, that in their opinion, are likely candidates to measure systematic risk and are thus likely to explain returns. Of all theoretical selected variables, they find five significant variables. Industrial production, changes in risk premium and changes in the yield curve, unanticipated inflation and changes in expected inflation are able to influence returns through a dividend discount model. Industrial production influences company's cash flow, changes in risk premium and yield curve have an impact on the discount factor and changes in inflation can clearly influence the nominal value of cash flow. All these factors in their place impact prices and thus returns of different companies. It is important to note that while Chen, Roll and Ross (1986) also checked consumption and oil prices for significant effects, no evidence could be found to confirm their impact on returns. A third important factor that does not render significant results while used with these other economic state variables is the stock market index. Though normally this stock market index is able to significantly explain variability in stock returns, it is not able to do so anymore in a model together with the above described macroeconomic variables. This stock market factor is what the CAPM describes as the market index, and should, following the model, influence returns.

Secondly, Lakonishok and Shapiro (1986), argue that apart from systematic impacts, there are also various measures of unsystematic risk affecting returns. This argument relies on an assumed misspecification of the CAPM, where complete diversification should be possible for all investors, but transaction costs and trade barriers for small companies disable this possibility. In this case, investors in smaller companies should be compensated for bearing total risk instead of systematic risk. Regression analysis in the research of Lakonishok and Shapiro (1986), indicated, contrary the above described theory, that neither beta (as systematic risk measure), nor alternative risk measures such as variance or standard deviation (indicating total risk) are able to explain variation in returns. The authors also mention that there could be two possible reasons for not finding significant results for beta here, even when beta generally carries the right sign. They attribute this to the short time span of their research and to the possibility that standard levels of statistical significance might not be applicable. The one significant variable found in their regression analysis, is size. Not only does size qualify as a significant variable, there are also two important, noteworthy features of the size-effect. In examining downward and upward markets separately, Lakonishok and Shapiro (1986) find a larger size-effect in downward markets, which signifies a better performance of smaller firms in tougher economic times. They also find that overall, the performance of smaller companies is more impressive than that of larger companies. It seems that the small firm effect remains a puzzle. While the theory describes a trade-off following higher risk and higher return than average companies, only evidence for higher returns is found.

In short, these two arguments indicate that beta, as a risk measure, lacks efficiency and completeness (Pettengill et al, 1995). Our first argument wants to add systematic risk measures to the model and is supported by several different research papers. Other factors such as earnings yield (Basu, 1977), leverage (Bhandari, 1988) or book to market (Stattman, 1980) are able to find firm grounds to explain returns. Size-effects on the other hand show need for further use of unsystematic risk factors. The research of Banz (1981), who also finds a significant size-effect, further confirms this. The evidence supporting all these different factors, was expected to decrease the widespread use of beta, but this was not at all so. These first two arguments were generally ignored and beta was still considered a decent sole risk measure that remained convenient. Our third argument on the other hand, had more success in defeating beta.

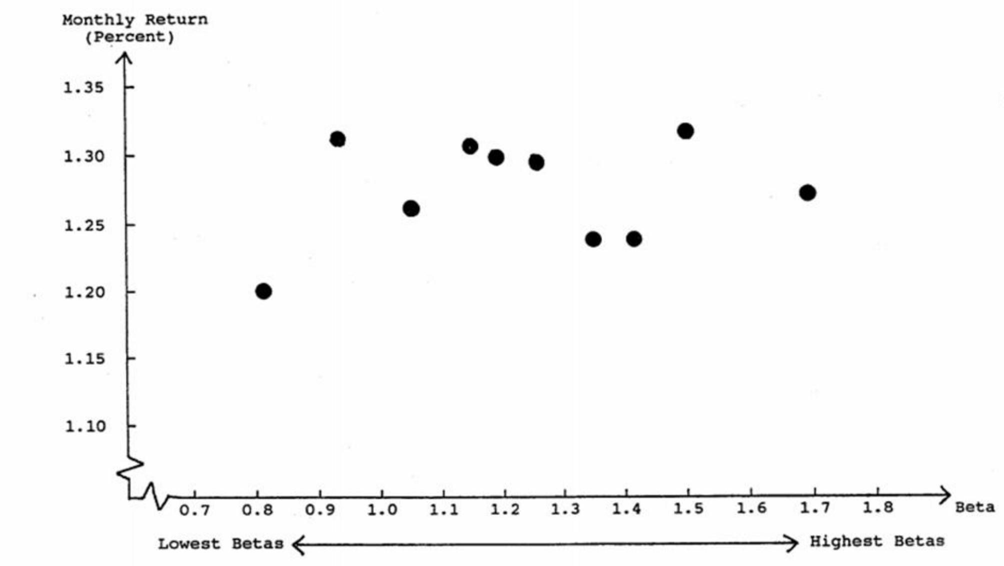
3.2.3 Beta Condemned

The death blow for beta only came with the research paper of Fama and French (1992). While earlier critiques on beta only found problems with the sole use of beta as risk measure, Fama and French (1992) find no evidence for an existing beta-return relation. This last critique could thus not be ignored. Based on the findings of Banz (1981), Bhandari (1988), Basu (1977) and Stattman (1980), Fama and French (1992) examine a time period starting in 1963. For this time span they devise a three-factor model, in which the market index, size and book-to-market value are considered.

While more than two other macroeconomic variables (e.g. leverage, earnings yield) seemed to indicate significant results in the past, Fama and French (1992) choose only size and book-to-market value, because these two variables seem to absorb the effects of leverage and earnings yield.

In their thirty-seven year time period, Fama and French (1992) find significant results for size and book-to-market value. The results of Fama and French (1992) again confirm that size-effects are definitely useful indicators for explaining returns. Theory surrounding these two risk factors was originally scarce. While at first the small firm effect was puzzling, a theory by Chan, Chen and Hsieh (1985) started to indicate an economic factor. Higher default risk should be considered, being a better counterpart in the trade-off against the higher return. Book-to-market value on the other hand, seemed to be a good indicator for the prospect of firms. A high book-to-market value for example, would signify low earnings on assets and thus a bad performing firm, which in turn leads to a riskier firm. While these first two variables find encouraging results, the same cannot be said about beta. In the examined time period, beta did not seem to explain returns. Fama and French (1992) find a flat beta-return relation. They try to give beta the benefit of the doubt and list two possibilities for the poor results of beta. Firstly, they attribute the poor results of beta to the possible correlation between beta and other explanatory variables, in which case estimates would not be able to discern effects from each other. The other possibility is that noise in beta estimation could provide imprecise results. They are quick to discard these two possibilities because of low correlations between variables and precise estimations through low standard deviations. The figure below clearly shows a lack of correlation between beta and returns.

FIGURE 5: Correlation between Beta and Return



Source: Fama and French (1992) in Grundy and Malkiel (1995)

In their follow-up research of 1993, Fama and French expand their research of 1992 in three ways. They do so by including bonds in the regression, while their previous paper only considered stocks. Secondly, they add more variables to the research that are necessary for bonds (e.g. term structure). And thirdly, they use a different approach, called time regression, because several stock variables will have no use in the regular cross section regression if bonds are added to the tests.

The results reached by this other method of regression are in line with their first research paper. Again size-effects and book-to-market value are significant variables, they can thus be qualified as proxies for sensitivity to common risk factors. Evidence shows that smaller firms suffer smaller impacts of negative market situations (e.g. the 1980-1982 depression) and therefore experienced higher returns. On the other hand, small firms overall have lower earnings on assets and this signifies a worse performance and thus a riskier firm. Adding this to the increased risk connected to defaulting, a small-firm risk-return trade-off can be realistic. The same is also true for firms with high book-to-market value. This indicates a low price, relative to their book value, and thus lower earnings on assets. Worse performance again leads to higher risk. It is important to note that when only size and book-to-market variables are used, no significant results can be found. Fama and French (1993) find that this time, the market factor does influence returns in the three-factor model, and that this factor model (the market factor, size and book-to-market value) reaches the best results.

For bonds, Fama and French (1993) find that only term structure, capturing interest rate risk, is a significant variable that captures variation in bond returns. Furthermore, term structure through bond returns influences stock returns. Although term structure is significant, it still cannot fully reject the hypothesis that corporate and government bonds have the same long term expected return. Adding term structure to the three-factor model does not strengthen the explanatory power, but decreases it strongly.

3.3 BETA LIVES AGAIN

During the period after the publication of the different critiques on beta, and especially after the research papers of Fama and French (1992, 1993), the supporters of beta have tried their all to restore beta to its former glory and return it to the scene of asset pricing. “Reports of beta’s death have been greatly exaggerated”, based on the famous quote by Mark Twain discussing his presumed death, is the title of only one of the published articles in that time period that perfectly captured the current time spirit. The supporters of beta in their turn have expresses several different arguments to decrease the criticism formed on its validity. Three arguments are being used to question the results of Fama and French (1992).

Firstly, several different papers (e.g. Kothari, Shanken and Sloan, 1995; Chan and Lakonishok, 1993) attribute the results of Fama and French (1992) to biased results due to high standard errors. This would mean the tests performed by Fama and French would have very low explanatory power. Kothari, Shanken and Sloan (1995) emphasise that, while the hypothesis that beta is zero cannot be rejected completely, the possibility of a large number of economically significant positive values cannot be rejected either.

Secondly, the work of Black (1993) finds that the significant results found by Fama and French (1992) to do with size-effects and book-to-market value may be due to data mining. This accidental significance could related to the lack of theory first relating to the size of companies and their book-to-market value. Furthermore, Black (1993) gives the example of the work of Banz (1981), on which part of the Fama and French- (1992) research was based. In the work of Banz (1981), the size-effect saw its first light and smaller companies clearly outperformed average companies. However, in examining the period after his study, no such results could be detected and smaller companies again marked mediocre results. Fama and French (1992) try to find a theory surrounding the small company effect, and expand it in their follow-up research, but finding an explanation after the fact remains of empirical nature. The same situation applies to the book-to-market value. Gomes, Kagan and Zhang (2003) examined this subject even further and found that the significance of the size- and book-to-market effect could be due to the correlation between these two variables and beta itself. In this case both variables might seem significant through capturing the market variable that actually relates to returns. The flat relation between beta and return is also examined in the work of Black (1993) and the author attributes this non-correlation to two possible situations (already mentioned as well by Black in 1972 and Black, Jensen and Scholes in 1972). One, the origin of borrowing restrictions, because these might induce higher low-beta returns contrary to the CAPM (see for example Black 1972, Paxson 1990 on this subject). And two, relating to the critique constructed by Roll (1977) that the used market indices as market portfolio do not suffice and so again that low-beta stocks seem to reward investors with higher returns on average.

The third argument for the continued use for beta originates from another angle. Grinold (1993) described the attack on the CAPM and considers beta “an innocent bystander”. The multiple roles played by beta do almost universally depend on the existence of the CAPM. Predicted beta, conditional and unconditional returns all require the CAPM’s support. Beta as risk measure however, is able to exist on its own.

While these three arguments already render strong evidence to support the case of beta, Black (1993) continues to add that even if the results of Fama and French (1992) are actually correct, beta still has a role to play. Portfolio managers may still find beta useful because it would mean that by using leverage, portfolios could be brought to the market level of risk and returns could actually be higher than the market. If all these arguments are not yet enough for the maintained use of beta, there are also many research papers (e.g. Chan and Lakonishok, 1993; Fletcher, 2000) that continue to find significant relations between beta and return. We can therefore conclude this segment with stating that the use of beta is certainly not unfounded, and it can still be a useful tool in portfolio management.

3.4 NEGATIVE BETA

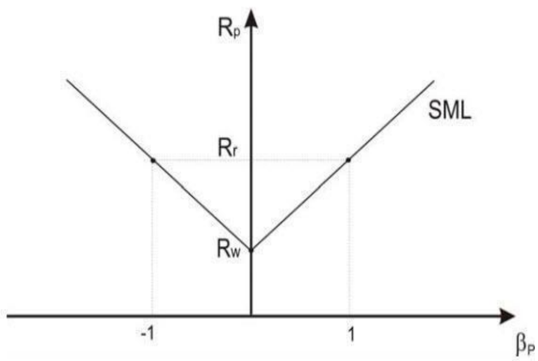
A lot of ground has been covered since the introduction of beta. We have discussed the birth of beta through the CAPM and the stance of its adversaries. Later on, the evidence in favour of beta started to take the upper hand again. At this point, we want to take the time to discuss one more aspect of beta that is relevant to our investment strategy, before ending this segment.

We have seen that beta, as a systematic risk measure, indicates a sensitivity to movements in the market portfolio. This portfolio would possess a beta of 1, seeing as it would react one-to-one with itself. Securities or portfolios with a beta of lower than 1, would indicate a less strong reaction against market fluctuations, and therefore qualify as a defensive security or portfolio. On the other hand, when a beta of higher than 1 can be found, this security or portfolio can be called cyclical, because it would react stronger than the market. These are two possibilities for the outcome of measuring beta. There are also two more, specific cases we want to elaborate on.

A beta of 0 would indicate a zero-correlation with the market portfolio, and therefore move independently from it. These kind of securities or portfolios can be very useful in portfolio management, because they would be influenced less by what is happening on the market. The other specific situation especially worth mentioning, is when the measured beta is smaller than 0. This provides an even more useful insight in portfolio management. A negative beta could in various cases, defend a constructed portfolio against market crashes, because it would move conversely with it (Bodie, Kane and Marcus, 2013). This is also the reason we added a negative beta portfolio to our strategy, more information on how we did this will be explained in the Data and Methodology part of our research.

We have already seen the breakdown of the CAPM where beta measures the impact of the excess market return, being the return above the risk-free assets. This leads to the assumption of the security market line (SML), which can be represented by a straight line. However, this positive relation between beta and expected return has one problem. When a negative beta occurs, one should accept a lower expected return than that of risk-free assets. This does not correspond to the reality because having a negative beta includes a certain risk. For instance, having a negative beta of 1 corresponds to the same risk as having a positive beta of 1. Cloninger et al. (2004) discuss these mistakenly assumptions in their research, stating that investors' acceptance of negatively correlated assets according to the market does not signify that they are willing to accept lower or even negative returns on their portfolio. Instead they believe that there exist a V-shaped SML. The interpretation of this V-shaped SML is rather simple, namely that betas with the same absolute value will have similar expected returns on securities. Wolfski (2009) does find the same conclusion as Cloninger et al. (2004) in the Polish capital market.

FIGURE 6: Adapted Security Market Line



Source: Cloninger et al. (2004)

In the non-academic world, negative betas are frequently used by investors to cope with a bear market. Short selling is a technique where an investor sells a security that he/she does not own, though promised to deliver. So at a particular moment, the investor will buy the actual securities at the market price to deliver them. If he/she can buy those securities at a market price that is lower than the price at which the investor lent them, the investor will have accumulated a profit. Thus simplified, an investor is anticipating downside markets. In our strategy, which will be explained in the following section, we clarify the use of the negative beta portfolio.

4 DATA AND METHODOLOGY

4.1 DATA

Taleb (2007) defines a black swan as a phenomenon that has three characteristics, namely 1) rarity 2) extreme impact 3) retrospective predictability. All three characteristics are essential to the black swan phenomenon. The first characteristic, rarity or unpredictability, can be explained through the fact that the event is an outlier, which lies in the tail of the graph shaping the normal distribution. An outlier lies further away from the mean than three times the standard deviation in the Bell curve.

This shows that the occurrence of such an event is exceptional and thus rare. The second characteristic is quite simple, the extreme impact that a black swan brings, can vary in different ways. For instance, it can have an impact on political, economic and social field. The last characteristic, specifically retrospective predictability, tells the possibility that the event can be explained after it has occurred. To make it seem less arbitrary than it actually was, people try to find explanations. This retrospective distortion or “rearview mirror-effect” leads to an illusion of understanding (Taleb, 2007).

Due to the fact that this definition cannot be used empirically, Estrada & Vargas (2012) therefore transformed the definition of a black swan to the observation of a monthly return in the world market higher than or equal to 5% in absolute value.

Table I. BLACK SWANS

This table shows all the black swans ordered chronologically. A black swan can be defined as a monthly return in the MSCI World index higher than or equal to 5% in absolute value. A period between January 1973 and January 2014 was considered, consisting of both developed and emerging countries as well as industries. All the returns are displayed in percentages.

Date	Return	Date	Return	Date	Return	Date	Return	Date	Return
Nov/73	-12.9	May/84	-7.4	Dec/91	7.3	Nov/01	5.9	Jul/10	8.1
Jul/74	-5.8	Aug/84	10.1	Mar/93	5.8	Jun/02	-6.0	Sep/10	9.4
Aug/74	-9.5	Jan/85	5.6	Nov/93	-5.6	Jul/02	-8.4	Dec/10	7.4
Sep/74	-9.2	May/85	5.2	Jan/94	6.6	Sep/02	-11.0	Aug/11	-7.0
Oct/74	9.7	Oct/85	5.4	Jul/95	5.0	Oct/02	7.4	Sep/11	-8.6
Jan/75	14.7	Nov/85	5.6	Nov/96	5.6	Nov/02	5.4	Oct/11	10.4
Feb/75	9.0	Feb/86	9.0	May/97	6.2	Apr/03	8.9	Jan/12	5.0
Jul/75	-5.4	Mar/86	9.8	Jun/97	5.0	May/03	5.8	May/12	-8.5
Oct/75	7.0	Aug/86	8.8	Aug/97	-6.7	Oct/03	6.0	Jun/12	5.1
Jan/76	9.0	Jan/87	11.8	Sep/97	5.4	Dec/03	6.3	Jan/13	5.1
Dec/76	7.6	Mar/87	6.2	Oct/97	-5.2	Nov/04	5.3	Jul/13	5.3
Jul/78	7.3	Apr/87	5.9	Feb/98	6.8	Jan/08	-7.6	Sep/13	5.0
Oct/79	-7.3	Aug/87	5.9	Aug/98	-13.3	Apr/08	5.3		
Jan/80	6.1	Oct/87	-17.0	Oct/98	9.1	Jun/08	-7.9		
Mar/80	-10.6	Feb/88	5.8	Nov/98	6.0	Sep/08	-11.9		
Apr/80	6.7	Aug/88	-5.5	Oct/99	5.2	Oct/08	-18.9		
May/80	5.1	Oct/88	6.7	Dec/99	8.1	Nov/08	-6.4		
Sep/81	-7.4	Jul/89	11.3	Jan/00	-5.7	Jan/09	-8.7		
Nov/81	7.6	Mar/90	-6.0	Mar/00	6.9	Feb/09	-10.2		
Feb/82	-6.0	May/90	10.5	Sep/00	-5.3	Mar/09	7.6		
Apr/82	5.0	Aug/90	-9.3	Nov/00	-6.1	Apr/09	11.3		
Aug/82	7.4	Sep/90	-10.5	Feb/01	-8.4	May/09	9.2		
Oct/82	7.0	Oct/90	9.4	Mar/01	-6.5	Jul/09	8.5		
Nov/82	5.4	Feb/91	9.3	Apr/01	7.4	Mar/10	6.2		
Apr/83	7.2	Jun/91	-6.2	Sep/01	-8.8	May/10	-9.5		

The world market, which is mentioned in the definition of Estrada & Vargas (2012), is the MSCI index of developed countries between January 1970 and December 1987. It also involves the MSCI index of both developed and emerging countries between January 1988 and January 2014 as well as the MSCI index of industries between January 1985 and January 2014. Emerging countries and industries are taken into account later than developed countries. Data from the world market is used to detect black swans and also functions as benchmark for performance evaluation. The MSCI World Short is an index completely mimicking the market portfolio, but takes short positions in the included securities. By shorting the market, the MSCI World Short can be used to construct our negative beta portfolio, which consists of both developed and emerging countries as well as industries between January 2001 and January 2014. All data on these return indices is gained from Datastream.

According to our calculations 105 black swans have occurred between 1970 and 2009. However due to the fact that when calculating the betas we have to take the data of minimum 36 months before the black swan, we focus only on the black swans since 1973. A time span of three years should at least be observable to measure the beta, while five years would be ideal. When we take this remark into account, we find a prevalence of 98 black swans between 1973 and 2009 and 112 black swans within the 1973-2014 period we can use. All black swans are relevant for developed countries. This does not hold for emerging countries because the index only runs between 1981 and 2014. Therefore only 64 black swans are relevant for those emerging countries. When we use the same reasoning for industries, which runs between 1988 and 2014, only 51 black swans are relevant. By comparing our detected black swans with the research of Estrada & Vargas (2012), two differences can be found. Our research finds a black swan in January 2009 with a negative return of 8.7%, while this black swan does not occur according to the paper of Estrada & Vargas (2012). The second difference runs the other way around, in September 2007 they find a black swan with a return of 5%, while our research only finds a 4.8% return for this period, thus not qualifying as a black swan.

Since previous research only examines returns until 2009, we extend the time span of occurring black swans. In the time period from 2009 to 2014, fourteen black swans have been detected. Ten of those black swans have had positive returns, averaging 6.7% and thus four of those have had negative returns, averaging -8.4%. It also should be mentioned that all the used indices are in dollars and account for capital gains and dividends as well as the fact that the MSCI World index is not only used to determine the calculated black swans but also as a passive investment to compare the strategies with. Exhibit 1 in the appendix shows an enumeration of all the participating countries (47) and industries (56) with their arithmetic mean, geometric mean and standard deviation.

4.2 MOTIVATION AND CONTRIBUTION

After explaining the used data, it is important to emphasize further what purpose this research paper serves. With this investigation we try to find answers to two research questions. As the literature section showed, there has been great disagreement in using beta as a risk measure. While beta was first commonly accepted, more and more reactions came to its widespread use. Especially motivated by this conflict, we state our first research question as follows: “Is beta a good risk measure?”. Without this first inquiry, it would not be possible to move on to the next research question. After evaluating beta as a risk measure it is then possible to build a practical strategy, based on the second research question: “Can different beta portfolios render profits to the investor in different market situations?”. The goal of this strategy is thus providing investors with returns in market situations where black swans are present. This strategy will be thoroughly explained in the methodology segment.

By constructing this research paper as we do, our contribution to the existing research is threefold. As mentioned in the previous segment of this research paper, we follow the research of Estrada & Vargas (2012), but contribute to their research by in the first place updating the time span. While their research ran until 2009, we extend this period by adding the next five years to the sample as well. Since there still are some post-crisis impacts affecting the market, these five years could prove very insightful as follow-up research. We also feel that dividing the used countries into two separate groups may provide useful insights. Therefore we will also test for differences between emerging and developed countries. Since Estrada & Vargas (2012) only handle these countries together, existing differences in nature between these two groups may provide some interesting results related to our goal of profiting in market situations.

The success of the strategy created by Estrada & Vargas (2012), has been immense. With their strategy, investors would be able to gain returns almost four times higher than when holding a passive portfolio, by following their method of beta portfolios. The results of this investment strategy will be elaborately explained in our Results section, together with the performance of our strategy. Although the method of Estrada & Vargas (2012) has been very successful, we still feel it could be beneficial to try out a slightly different strategy instead of copying it completely. This is also the second contribution of our research. Instead of four portfolios, our research adds a fifth portfolio to the spectrum. This fifth portfolio should consistently have one specific characteristic, a negative beta. While the importance of negative betas also has been thoroughly explained, we repeat it briefly here because of the essential nature for our fifth portfolio and second contribution. A negative beta can be found when a negative correlation exists, in this case both variables –securities or indices- move in opposite directions. (Bodie, Kane & Marcus, 2013) This inverse movement has great consequences for the overall risk of a portfolio. In situations where the market is affected negatively by macroeconomic influences, and thus where positive beta securities or indices generate negative returns, negative beta securities or indices do not follow this pattern. By using these negative beta portfolios, risk can be greatly constrained. This second contribution can lead to interesting discoveries.

Our third contribution is related to the results of the strategies. For performance evaluation, most research papers only use easy-to-interpret standard indicators such as arithmetic and geometric mean, standard deviation and risk-adjusted return. We try to find more profound indicators that are still understandable, but less basic than those more frequently used. These indicators will be explained thoroughly in the next segment, under performance.

4.3 METHODOLOGY

4.3.1 Black Swans

The first step in our research exists of calculating the black swans. "A black swan is defined as a monthly return in the world market higher than or equal to 5% in absolute value" (Estrada & Vargas, 2012, p.79) Due to the fact that our research is a follow-up to the paper of Estrada & Vargas, we use the same criteria to calculate black swans.

Like Estrada & Vargas (2012) already mentioned, it can be argued that using only 5% as the threshold for defining a black swan is rather small. Monthly returns of little more than 5% or -5% do not seem that extreme. Choosing higher thresholds will perhaps not be helpful in our line of research, but may render some interesting insights. For example when we would use an absolute value of 10%, we would only find 16 (9 negative and 7 positive) black swans between January 1973 and January 2014 instead of 112 black swans.

A list of all the black swans is mentioned in Table I. As observed there is a total of 112 black swans that have occurred in the period 1973-2014. 40 of these black swans are negative, averaging -8.5% and 72 positive, averaging 7.2%. Due to the difference in duration for emerging countries and industries, another amount of black swans appropriate. For emerging countries, only 64 (25 negative, averaging -8.3% and 39 positive, averaging 6.8%) black swans are relevant. For industries, the amount of black swans being relevant, decreases to 51 (21 negative, averaging -8.8% and 30 positive, averaging 7%).

4.3.2 Beta

To find an answer to our first research question, whether beta is a good measure for risk, we need to look for the impact that a black swan has on the diversified portfolio. In our literature segment on beta, we have already elaborately discussed the theoretical background on the validity of beta, but here we focus on a more empirical approach. These portfolios consist out of developed and emerging countries as well as different industries. Due to the fact that they are well diversified, we can exclude idiosyncratic risk (Sharpe, 1964). The way we are able to solve this first research question is straightforward: if beta is a good measure for risk, this would mean that high-beta portfolios fall more than low-beta portfolios in a decreasing market and vice versa.

Using the same technique as Estrada & Vargas (2012), we estimate the beta of each country, industry and the MSCI World Short when a black swan occurred. The beta is calculated using the following equation:

$$\beta = \frac{Cov\ (Ri, Rm)}{Var\ (Rm)} \tag{1}$$

The formula exists out of two parts. In the numerator the covariance is calculated between the return of the individual asset and that of the market. The covariance is the co-movement between the two assets. In the denominator the variance of the market returns is calculated. The variance is a measure of dispersion, where the square root is equal to the standard deviation. The estimation is based on the 60 months prior to the black swan but not including the month that the black swan happened. Like we already mentioned, if 60 months of data preceding the black swan is not available, we will always use a minimum of 36 months. We then divide all the calculated betas into four portfolios. To make the comparison with Estrada & Vargas (2012) complete, we construct these four portfolios individually for countries and industries. The following step is allocating the betas of countries and industries together in the different portfolios.

Table II. SUMMARY STATISTICS PORTFOLIOS

The average of the calculated betas of each portfolio and the strategies are represented in this table. The breakdown into Countries and Industries as well as both individually are displayed. The average betas are calculated for the Strategy High-Low and the Strategy High-Negative. For detailed information on the strategies we refer to the mean reversion segment.

	Countries & Industries	**Countries**	**Industries**
Portfolio 1	1.45	1.50	1.63
Portfolio 2	1.10	1.13	1.24
Portfolio 3	0.90	0.94	1.01
Portfolio 4	0.53	0.58	0.60
Portfolio 5	-1.04	-1.04	-1.04
Average β (Strategy H-L)	0.85	0.91	0.97
Average β (Strategy H-N)	0.55	0.58	0.35

In the abovementioned Table II, a summary is given of the average betas that were constructed in our research. To already give a slight preview, you can clearly see that the portfolios all have different beta-coefficients.

For instance, portfolio 1 has a higher beta than portfolio 2, which means that it is exposed to a higher risk. As you can see, the average betas for countries and industries are lower than those for countries or industries individually. This seems counter-intuitive. A closer look at the constructed betas however, explains this situation. For all individual time periods, the average beta for countries and industries lies between that of countries and industries individually, which is indeed the logical situation.

To explain this situation, we first need to mention one matter on the constructed portfolio betas through the observed time period. The characteristic that immediately can be qualified as important is the rising nature of betas. For country betas, it can be noted that until 2000, they remain quite stable, although they already rise a little. From 2000 until now, we can clearly see a strong rise in betas. Because industries only enter the sample around the year 2000, they experience the same effect. Although the rise in portfolio betas for industries is not as strong, because they have not experienced a period with relatively stable betas, the average for portfolio betas of industries is higher. On the other hand, because the rise in portfolio betas for industries is not as strong as for countries, the portfolio betas for countries and industries together is lower than the portfolio beta for countries.

Portfolio 5 on the other hand has a negative beta. So this shows that there is a negative relation between the market (MSCI World index) and the underlying assets in that portfolio. How the portfolio construction works will be explained in the following segment.

4.3.3 Mean Reversion

4.3.3.1 Profiting Of The Improbable

After discussing our interpretation of black swans and the use of beta for answering our first research question, we can turn to an important economic characteristic, essential for our second research question. This characteristic, mean reversion (Siegel, 2008), is essential in the paper of Estrada & Vargas (2012) where it is used as foundation for a strategy to optimize returns. In this strategy a link is constructed between the black swan and the calculated beta for the period after the black swan. The core principle of mean reversion is that observed positive black swans will be followed by negative returns and the other way around, in both cases tending to return to the long term mean (Siegel, 2008). In theory it should thus be possible to generate higher positive returns when expecting a positive black swan, and less negative returns or even positive returns when expecting a negative black swan. This is our second research question, and also where beta comes in. ‘Can different beta portfolios render profits to the investor, after observed black swans?’ Combining black swans with beta thus leads to different portfolios. By constructing these portfolios using beta as risk measure, the presence of mean reversion would leave room for a strategy to profit from these factors.

This research question also was posed by Estrada & Vargas (2012), but in other words. The reason our research question is posed a bit differently, is because of our contribution to the strategy constructed by Estrada & Vargas (2012). This contribution has been thoroughly discussed in the previous segment motivation and contribution.

4.3.3.2 Portfolio Construction

As mentioned before, beta is used to construct our different portfolios. These portfolios are part of the investment strategy, with which it should be possible to generate positive returns in case of both a negative and a positive black swan. With beta being discussed in the previous segment of our methodology, we can turn to the portfolio construction in this segment. It is very important to state that we use the same approach explained below, three times. The first time we estimate our portfolios with countries and industries together, and then we carry out our portfolio construction for countries and industries separately.

The calculated betas for all countries and industries within our sample will be divided into four or later on, five portfolios. The four portfolios follow the strategy high-low of Estrada & Vargas (2012), while the fifth portfolio is an experiment of our own. Every time a black swan is observed, the same approach is followed. Starting with the black swan of 1973, we categorize all eighteen betas of developed countries in these four portfolios. The first portfolio will comprise the four highest betas, the next portfolio will be created by the following five highest betas. The third portfolio is constructed by the ten through fourteenth highest betas and the last portfolio will be filled with the four lowest betas. This inequality in amount of betas is solved by allocating more to the neutral portfolios, to make sure that in this case the highest and lowest beta portfolio comprises of the same amount of betas.

From February 1991 on we have twenty-three betas of developed countries together with twelve betas of emerging countries in our sample, due to the delayed nature of some developed and emerging countries being added to the database. In this case the first portfolio includes the nine highest betas, the following portfolio includes the next nine betas, while the third only includes the next eight betas. In this case the last portfolio has the lowest nine betas. In the first years of data on emerging countries, twelve countries are still missing in the sample. From 1996, there are still five emerging countries missing, only from 1998 all emerging countries can be included. When these last five countries enter the sample, twelve countries are allocated into both the highest, second highest (first neutral) and lowest beta portfolio and eleven in the second neutral portfolio.

From 1998 on betas for industries are also available and one hundred and two betas are allocated into our four portfolios, in the same way when there were eighteen betas available. One industry, namely 'Internet Software & Services', only has data available from July 2002 on, thus after 2002 we have 103 betas to divide over our four portfolios and we choose the same allocation style as with thirty-five or forty-seven countries.

The countries included in developed countries or emerging countries are not necessarily currently developed or still emerging. This division was made in the paper of Estrada & Vargas (2012) and took into account the emerging countries at that moment. Because our research tries to follow the original as much as possible in this case, the same division is retained. In the appendix, Exhibit 1 shows which countries are included in the developed or emerging countries and which industries are part of our sample. In all cases we try to allocate the same number of betas to the different portfolios, since this is not often possible, we try to focus on equality in number of the highest and lowest beta portfolio. Whenever there is an even inequality, allocating more to the neutral portfolios provides a clearer distinction in beta and can only be advantageous for the outline of both strategies. Table II shows the different portfolios constructed based on their betas.

Furthermore, Table II also shows there is an existing fifth portfolio, which was only mentioned briefly. This portfolio does not exist in the research paper of Estrada & Vargas (2012), but is a completely new idea. The important characteristic of this portfolio is its negative beta. As mentioned in our literature section of this research paper, negative betas are an intriguing subject and can be very profitable for investment strategies. Data for this portfolio is only available from 2001 on, but although its inception date is still quite recent, it still contains an important addition to previous works. The Datastream "MSCI World Short index" provides these negative betas, by shorting the standard MSCI world index.

As mentioned above, the approach is completely the same whether countries and industries are handled separately or whether they are examined together. For countries alone, we can refer to our joint explanation above on countries and industries. For industries on the other hand, we should state that from its start in 1998, fifty-five industries have betas available, while one industry "Internet Software and Services" only has a beta available from 2002.

4.3.3.3 Strategy Implementation

After introducing the strategy we use in this research paper and explaining the construction of the portfolios that are essential to it, a further explanation of the strategy is justified. As mentioned before, the purpose of this strategy is to render profits to the investor in different situations in the market, characterized by the presence of possible black swans. Testing the strategy is done by comparing it, against the passive MSCI World index as benchmark. November 1973 is when the first black swan occurs and when it is possible to estimate beta with a window of 36 months. This first black swan is negative, so with the presence of mean reversion, we would expect the returns following November to be positive. In this case a symbolic hundred dollars is invested in the highest beta portfolio. As Table II showed, the highest beta portfolio should be able to amplify returns, through reacting stronger than the market. This portfolio will then be held until the next black swan occurs, until July 1974 in this case. From that moment on the same approach is used until the next black swan occurs and so on. By doing this for every single one of the 112 black swans, results can be compared to the benchmark. In case of a positive black swan, for example in October 1974, we expect declining returns and the lowest beta portfolio is thus the best choice. This strategy is what we call the Strategy High-Low. From 2001 on, the negative beta portfolio is an even better choice, because in that case even positive returns could be generated, instead of smaller negative returns. Because a time frame of 36 months is necessary, we could only start using this portfolio in 2005. From that moment on, it is possible to execute the Strategy High-Negative. Due to this short time span, we feel a combination of both strategies should be used to compare the end results of the impact of our new portfolio.

4.3.4 Performance

In our research we need to evaluate not only the collected data, but also our calculated strategy. To do so a number of performance indicators are used. As mentioned in the motivation and contribution segment, more indicators are used than in other research papers. Overall holding period return, minimum, maximum, arithmetic and geometric mean are used frequently, as is standard deviation and beta. However, we also include the Sharpe ratio and Treynor measure for evaluation as well. These two performance measures are less straightforward than those more frequently used, but we will explain what they signify and how they are constructed in a manner that is generally understandable. It should be mentioned that transaction costs are not included in our constructed examples.

4.3.4.1 Holding Period Return

The total return from an asset or a portfolio that is being held for a certain period is called the holding period return. It calculates the percentage that an asset or portfolio has grown over a particular period. The holding period is calculated using the following equation:

$$HPR_1 = \frac{P_1 - P_0 + D_1}{P_0} \qquad (2)$$

We can see that the formula consists out of two main parts, a capital gain ($\Delta P_1/P_0$) and a dividend yield (D_1/P_0). The holding period return is necessary to calculate the arithmetic and geometric mean.

A year ago, an investor bought one stock X at 50 USD. During that year, he received a dividend of 2 USD/stock. Today, one year later, the stock has reached its all-time high of 65 USD. By calculating the holding period return, the investor realizes that he has made a return of 34%. This return falls apart into a capital gain of 30% ($\frac{15\ USD}{50\ USD}$)and a dividend yield of 4% ($\frac{2\ USD}{50\ USD}$).

4.3.4.2 Arithmetic Mean

The second performance indicator, is the simplest version of calculating an average. The arithmetic mean is calculated by taking the sum of a collection of numbers and dividing them by the amount of numbers in the collection.

$$AM = \sum_{i=1}^{n} \frac{HPR}{n} \qquad (3)$$

An investor has bought stocks of two companies, namely X and Y. On his stocks from company X, he has gained a holding period return of 10%. However, due to a major earnings increase, company Y made sure that he received a holding period return of 60%. Not taking weight into account, the investor received an average return of 35% ($\frac{10\%+60\%}{2}$) *per company.*

The arithmetic mean is the perfect measure to calculate the performance over single periods. However it does not take the compounding effect into account. For instance, if an investor invests 100 USD into an asset and the next year its value increases to 200 USD but a year later it falls back to 100 USD, he would have earned a return of 25% ($\frac{100\%-50\%}{2}$) over the two-year period. Obviously this is not correct because the actual return should be 0%. The next performance indicator, geometric mean, is the perfect solution to this issue.

4.3.4.3 Geometric Mean

This kind of mean can be seen as the 'true' average rate of return due to the fact that it takes the compounding effect into account, as mentioned in the part about arithmetic mean. The formula assumes that the earnings from the investments are directly reinvested.

$$\mathrm{GM} = [(1+\mathrm{HPR}_1)(1+\mathrm{HPR}_2)(1+\mathrm{HPR}_3)\ldots(1+\mathrm{HPR}_n)]^{\frac{1}{n}} - 1 \quad (4)$$

To compare the geometric with the arithmetic mean, we will show how it works using the previous example where the investor puts 100 USD into an asset.

An investor puts 100 USD in an asset. One year later, the price of this asset increases to 200 USD, which means that the asset has gained a return of 100%. However, the next year it falls back to 100 USD, thus losing 50%. According to the arithmetic mean, the investor would have earned 25% Return on investment. However, using the geometric mean, which takes the compounding effect into account, he will have earned 0% ($\sqrt{(1+1)(1-0.5)} - 1$).

4.3.4.4 Standard Deviation

The standard deviation shows how much dispersion from the mean exists. This means that a low standard deviation indicates that the observed data points lie close to the average. Like we already mentioned, the standard deviation is the square root of the variance and can be calculated using the following equation:

$$SD_x = \sqrt{\frac{\sum_{i=1}^{n}(X_i-\bar{X})^2}{n-1}} \quad (5)$$

This performance indicator can also be seen as a measure of total risk, the higher the standard deviation, the higher the risk. Most of the time, an investor will have to make a choice between return and risk, due to the fact that there is a positive relation between the two. Thus, a higher return can be earned by taking a higher risk and vice versa.

4.3.4.5 Sharpe Ratio

The Sharpe ratio uses the total portfolio risk, both idiosyncratic and systemic risk. This reward-to-volatility ratio is also used as the slope in the Capital Allocation Line. (Markowitz, 1952) The higher the Sharpe ratio, the better the investment. Sharpe ratios greater than its benchmark premium (ex. the market) indicate a superior performance. Due to the importance of the Sharpe ratio in our research, we are obliged to discuss its appearance. This reward-to-volatility ratio is used as the slope in the Capital Allocation Line and is used for the decision making process between safe and risky asset. “Asset allocation is generally defined as the allocation of an investor’s portfolio among a number of “major” asset classes” (Sharpe, 1992, p.7). This normally positively sloped line describes the relationship between the expected return and the total portfolio risk that is measured by standard deviation. Thus the higher the Sharpe ratio, the higher the extra return per risk unit. Depending on the utility function which should increase when the expected return increases and/or when the square root of the standard deviation decreases, a weight is given to define the investor’s preferred capital allocation. The optimal complete portfolio is the tangency point where the indifference curve with the highest utility function crosses the capital allocation line.

$$SR_p = \frac{\bar{r}_p - \bar{r}_f}{\sigma_p} \tag{6}$$

An investor has earned an average portfolio return of 13.5% while the average risk-free rate during that investment period amounted to 2.75%. Taking into account a total portfolio risk of 18%, which is measured by the standard deviation, the Sharpe ratio is 0.597. If we should compare this to its benchmark with an average return of 10.25% and a standard deviation of 16.75%, the Sharpe ratio would be 0.448. Thus we can conclude that the investor performed superior compared to its benchmark.

4.3.4.6 Treynor Measure

Compared to the Sharpe ratio, the Treynor measure does not use total portfolio risk due to the fact that we can consider that our constructed portfolio is well diversified. This leads to the conclusion that we can exclude idiosyncratic risk (Sharpe, 1964). This means that only beta is an appropriate measure for risk. Therefore we need to find a performance indicator that only includes beta instead of both idiosyncratic and systemic risk. The Treynor measure takes all the previous mentioned aspects into account and can be calculated using the following equation.

$$TM_p = \frac{\overline{r_p} - \overline{r_f}}{\hat{\beta}_p} \tag{7}$$

Like the Sharpe ratio, it also should be stated that a Treynor measure greater than its benchmark premium (e.g. the market) indicates that the performance is superior.

The investment portfolio A has gained an average return of 15%, while having a rather volatile approach which leads to a beta-coefficient of 1.32. Investment portfolio B however gained only 10% but this is logical due to the fact that it only has a beta-coefficient of 0.62. Using a risk-free rate of 2.75%, the Treynor measure of investment portfolio A is 9.28, while B has a Treynor measure of 11.69. We can conclude that although investment portfolio B has a lower return, its Treynor measure shows that it outperformed investment portfolio A.

5 RESULTS

In this section we will discuss the results of our investigation. Like we already stated, we will use the abovementioned performance indicators to see how both strategies and the benchmark fared during the research period. We will divide both strategies so that we can compare them to the benchmark before eventually comparing them to each other. Besides this, we will also look at the difference in performance between emerging and developed countries as well as the difference when we use a higher absolute value to define a black swan. This last difference will be achieved by using a 10%-threshold of absolute value. Before we can start our performance analysis of the used strategy, we first have to construct an answer for our first research question.

5.1 IS BETA STILL USEFUL?

In our literature segment on beta, we elaborately explained how the academic community stands on using beta as a risk measure. Over the past decades, beta has received a high amount of criticism, but its validity still remains mostly intact. Before our investment strategy kicks off, we want to examine on an empirical ground whether it is justified to use beta to construct portfolios. We do this by trying to answer our first research question: 'Is beta a good risk measure?' For this research question we use the same approach as used by Estrada & Vargas (2012), where they also pose this question before using beta in an investment strategy. The way to answer this research question is quite straightforward. If we can conclude that high-beta portfolios, on average, fall more than low-beta portfolios in declining market or the other way around for rising markets, then beta is indeed still a useful portfolio management tool. The results for this research question can be found in the following tables. The below mentioned Table III gives a representation of the beta-return relation of the different portfolios for both countries and industries. The results of countries and industries separately can be found in the Appendix. This approach will be repeated for black swans with an absolute value of 10% and will be presented in Table IV.

Table III. BETA AND RETURN – Countries and Industries (Black Swan 5%)

This table shows the average calculated betas and returns of each portfolio as well as the world market. P1 can be considered as the high-beta portfolio while P4 is the low-beta portfolio. The additional portfolio, being P5, is the negative-beta portfolio.

	Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.38	1.03	0.85	0.49	-0.90	
Return	-8.46%	-11.50%	-8.63%	-7.12%	-4.05%	8.34%	-7.45%
	Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.47	1.12	0.92	0.54	-1.07	
Return	7.23%	10.80%	8.27%	6.81%	4.06%	-8.03%	6.74%

Table III shows the results for black swans of 5%, where average betas and returns are measured for 40 negative and 72 positive black swans. Although the earliest black swans only incorporate developed countries, and not even all of them, in the sample, we chose to use data from that period as well. That way, we use as much data as available. With a beta of 1, the market has provided an average decline of 8.46% during negative black swans and an average rise of 7.23% during positive black swans. By analyzing Exhibit 2 in the appendix, we can conclude that even though the results for countries and industries are different, the core inference is the same.

Firstly, it can be observed that there are small differences in the betas for negative and positive black swans, but the big picture is also the same. On average high-beta portfolios fall more than the market portfolio, and low-beta portfolios fall less than the market. The difference in decline for the first portfolio against the fourth portfolio is 7.45%, and the difference in rising markets for those portfolios is close to 6.74%, with a larger rise for industry returns (7.6%) alone. The high-beta portfolio reaches a return of -11.50% in this case, for a beta of 1.38. Whereas the low-beta portfolio reaches a return of -4.05% for a beta of 0.49. In rising markets, the high-beta portfolio of 1.47 provides a return of 10.80%. The low-beta portfolio of 0.54 provides a return close to 4%. The differences in declines and rises in country portfolios are much larger than found in the research of Estrada & Vargas (2012), where they find a difference between the highest-beta portfolio against the lowest-beta portfolio of 3.5% in declining market and 4.4% in rising markets. For industries, however, our results are more alike. Estrada & Vargas (2012) find a difference of 6.1% in declining and 5.4% in rising markets, where we respectively find a difference of 7.5% and 7.6%.

As already mentioned there also is a fifth portfolio in our research, which is not used in the research of Estrada & Vargas (2012). This portfolio indeed provides us with the reason why we incorporated it in our research, and finds a beta of around -1. As the next to last column of Table III shows, in declining markets, this portfolio reaches a return of 8.34% and in rising markets a negative return of 8.03%. It has to be mentioned again that the time span for the use of this fifth portfolio is very limited.

We can conclude that for black swans of 5%, beta is indeed a valid measure of risk. High-beta portfolios react stronger than the market and low-beta portfolios seem less sensitive to market fluctuations. We can now pose the same question for black swans with an absolute value of 10%. This is a large difference in measuring black swans, which leads to a much smaller amount of observed black swans, but we feel that in this case we can capture the entire black swan as a whole. With choosing 5% fluctuations for black swans, we see that in several instances, we observe multiple consecutive black swan months, and by doing so we break off one black swan into several. This could provide a negative outcome for our strategy. By choosing 10% fluctuations, we do not observe a similar situation of consecutive black swan months. Again it should be mentioned that the separation between countries and industries can be found in <u>Exhibit 2</u>.

Table IV. BETA AND RETURN – Countries and Industries (Black Swan 10%)

This table shows the average calculated betas and returns of each portfolio as well as the world market. P1 can be considered as the high-beta portfolio while P4 is the low-beta portfolio. The additional portfolio, being P5, is the negative-beta portfolio.

	Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.13	0.85	0.71	0.38	-0.70	
Return	-12.92%	-14.12%	-10.59%	-8.85%	-4.70%	9.43%	-9.41%
	Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.54	1.23	1.06	0.71	-1.13	
Return	11.45%	17.63%	13.95%	11.96%	8.05%	-12.16%	9.58%

Table IV shows the results for black swans with an absolute value of 10%, where average betas and returns are measured for 9 negative and 7 positive black swans. As mentioned, we reach a very small amount of black swans. We should also mention that these 16 black swans are not relevant for all countries and industries, only the last 7 take industries into account. With a beta of 1, the market provided an average decline of 12.92% during negative black swans and an average rise of 11.45% during positive black swans. Because of the small amount of black swans, we can see larger differences between negative and positive betas, but the core inference is again the same. The decline in beta from P1 to P4 remains. For industries we even get higher betas, because only 7 black swans are relevant.

On average, high-beta portfolios still fall more than the market, the results are even stronger, because of the small amount of data. High betas are not flattened as much as with lots of data, and the result is thus somewhat amplified. The high-beta portfolio reaches a beta of 1.13 and falls with 14.12% during negative black swans. For positive black swan months, the high-beta portfolio reaches a beta of 1.54 and rises with 17.63%. The low-beta portfolio reaches a beta of 0.38 in negative black swan months and a beta of 0.71 in positive black swan months. The portfolio respectively falls with 4.7% or rises with 8.05%. This leads to differences in returns of around 9.5% between the high-beta and low-beta portfolio. Even though the limited data, we can still consider beta a proper risk measure. High-beta portfolios fall more on average during declining months and the other way around. The limited amount of data amplifies the results. The results for countries and industries together are discussed here, while the separate results for countries and industries can be found in Exhibit 3 of the appendix.

For our fifth portfolio, we again find a beta of around -1. In declining markets, this portfolio reaches a return of 9.43% and -12.16% for rising markets. These results are also stronger than for black swans with an absolute value of 5%, due the small time span and few black swans relevant for this period.

5.2 STRATEGY PERFORMANCE

Before we can discuss the results of the different strategies, we want to outline how this segment is built up. We will start with the method that uses a 5% absolute value to define a black swan. For this method, there are three different time spans. The first incorporates the full sample from 1973 until 2014. For this full sample we do not yet use the negative beta portfolio. For this time span, we can easily compare results with those of Estrada & Vargas (2012). We then examine the sample from 1973 until 2004 and lastly we examine the period of 2005 until 2014, in which the negative beta portfolio plays its role. After this first part of our results, we can move on to the method in which we define black swans as market fluctuations of over 10% absolute value. The same approach as for 5% black swans, i.e. different time spans is used here as well. We do this for the complete dataset, but also for countries and industries, and emerging and developed countries separately. This extra division may be able to provide us with some interesting additional insights in the functioning of the strategy.

5.2.1 Black Swans With Absolute Value of 5%

This first table shows the overall performance for the full sample. Our strategy[2] kicks off with 100 dollar, and runs from 1973 until 2014. As described in the methodology segment of our research, we choose high-beta portfolios after negative black swans and low-beta portfolios

[2] It should be noted that this is indeed an investable strategy, the portfolios are developed after the occurrence of a black swan and thus rely on available information at that time.

after positive black swans. This way we should be able to maximize returns and minimize losses. The low-beta portfolio is not the negative beta portfolio for this strategy. After running the strategy for more than forty years, we can see an enormous difference in performance indicators between the MSCI World and the strategy.

Table V. BETA AND PERFORMANCE

This table summarizes the performance of the MSCI World index and the full sample High-Low strategy. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

Performance Measures Strategy High-Low vs. World									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
World	4,606.09%	-40.33%	42.80%	11.76%	10.11%	18.23%	0.36084	6.580	1.00
High-Low	1,267.54%	-28.46%	33.66%	7.80%	10.15%	13.73%	0.19026	3.058	0.85

The MSCI World outperformed the strategy in the complete research period with an end total of 4,706 dollar (holding period return of 4,606%), while the strategy was only able to gain 1,367 dollar with the originally invested 100 dollar (indicating a HPR of 1,268%). Although being less exposed to fluctuations than the MSCI World (with a standard deviation of 18.23%) against the 13.73% that the strategy achieved and the lower beta, the Sharpe ratio and Treynor measure are not advantageous for the strategy. As we already mentioned, a higher the Sharpe ratio indicates a better the investment. The MSCI World rendered a superior performance compared to the strategy with a Sharpe ratio of 0.36 against the 0.19 of the strategy. However, we believe that the Treynor measure is a better performance indicator due to the fact that it only takes beta into account. Thus, it leaves the idiosyncratic or firm/security specific risk out of the picture. We believe that our portfolios are well diversified so that we can only take beta as a measure of risk and leave the idiosyncratic risk out of the picture. Again, when comparing the two portfolios with each other, we can clearly see that the Treynor measure of the MSCI World, (6.58) is far better than the one of the strategy (3.06). The World portfolio seemed to perform twice as well as the strategy.

We can conclude that the MSCI World performed far better than the strategy that was presented in the mean reversion segment. We believe that the reason for this underperformance lies in the high frequency of the black swans. A high frequency, namely 112 black swans within the forty year research period, tends to make the portfolio construction inefficient. The argumentation for this is rather simple. Normally when a negative black swan occurs, the mean reversion technique should suggest investing in high-beta portfolios because it assumes that positive returns will follow to bring it back to its long-term mean. However when we look at Table I, which provides an enumeration of all the black swans, we can clearly see that consecutive months of identical sign returns are present.

This means that for instance July 1974, providing a return of -5.8%, is part of a bigger black swan. This can be proven by the fact that August and September also have high negative returns.

It is only in October 1974 that the market recovers through the occurrence of a new positive black swan. In this case, when an investor chooses a high beta portfolio because of the occurrence of a negative black swan in July 1974 and thus assuming that positive returns will follow, the investor will have a higher exposure and finally lose more money than the market because of the high negative returns in August and September.

Table VI. BETA AND PERFORMANCE

This table summarizes the performance of the MSCI World index and the strategy for 1973-2004 & 2005-2014. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

Performance Measures Strategy High-Negative vs. World									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
World	4,606.09%	-40.33%	42.80%	11.76%	10.11%	18.23%	0.361	6.580	1.00
High-Negative	75.38%	-46.03%	30.30%	2.66%	9.47%	15.89%	-0.159	-4.548	0.56

The previous table shows the joint performance for the period of 1973-2004, in which the same high- and low-beta portfolios are used as in the previous table. But after 2004, the strategy uses a high-beta and a negative-beta portfolio. This should provide a maximization of returns, and a positive turn-around for losses. Normally an investor would choose to invest in a low-beta portfolio after the occurrence of a positive black swan. Again, because of the mean reversion phenomenon, one would expect negative returns. Although having a lower exposure than the market, an investor would still lose money in bear markets. Using this modification of the strategy, it is theoretically possible to gain money in periods with negative returns. The detailed performance of the two separate time spans (1973-2004 & 2005-2014) is shown in the two panels of Table VII below.

The outline is quite simple and is frequently used in the non-academic world and can be referred to as short-selling. If an investor is short-selling a particular market he believes that it will decrease in price. Indices that use short-selling provide us with a negative beta. This leads to the fact that if the market is down, your investment will go up. However, we should also mention that it was only possible to use this new strategy from the end of 2004 on. We were unable to find an earlier exchange trade fund (ETF) that shorted the MSCI World in earlier periods.

Table VII. PERFORMANCE INDICATORS

This table summarizes the performance indicators of both strategies, being the Strategy High-Low and the Strategy High-Negative. The Strategy High-Low runs from 1973 to 2004 and the Strategy High-Negative runs from 2005 to 2014. To make a fair comparison, the MSCI World for both periods was also calculated. This table refers to black swans with an absolute value of 5%. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

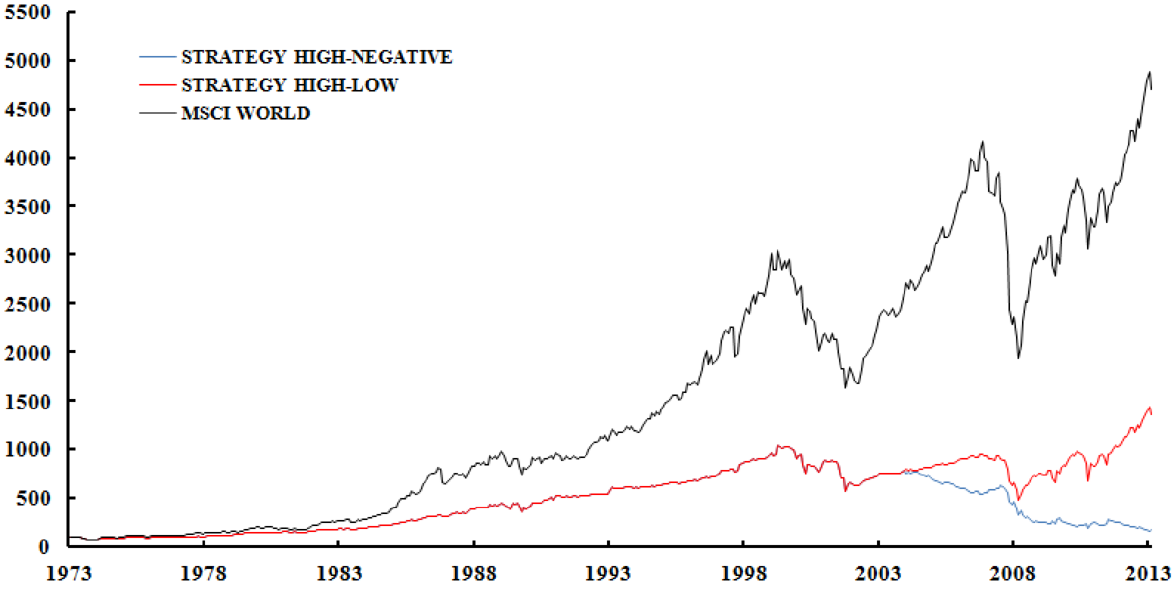
Performance Indicators: Strategy High-Low & High-Negative (Black Swan 5 %)									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
High-Low	694.21%	-26.76%	30.30%	7.64%	6.80%	12.34%	0.12	1.99	0.73
MSCI 1973-2004	2.618,02%	-24.48%	42.80%	12.54%	11.11%	17.55%	0.36	6.30	1.00
High-Negative	-76.86%	-46.03%	6.00%	-13.98%	-15.49%	15.92%	-0.97	-1,631.40	0.01
MSCI 2005-2014	63.39%	-40.33%	30.79%	9.10%	6.73%	21.35%	0.35	8.44	1.00

From 1973 until 2004, we see that investing 100 dollar at the start of the period, would have turned into 794 dollar in 2004. This implies a holding period return of 694% over thirty years. If we compare this to the market, we can clearly see an underperformance. Investing 100 dollar in the market in 1973 would have turned into 2,718 dollar by 2004. This already explains why the full sample performance (shown in Table V, and discussed above) is nowhere near the value of the passive investment in 2014. Although the lower risk (beta of 0.73) compensates for the worse performance, the difference still remains huge and does not warrant investing in the mean reversion strategy. Since the end total alone already gives away that our strategy does not compare against the performance of the passive investment, we feel a complete separate analysis against the MSCI is obsolete.

After 2004, this strategy uses the high-beta & negative-beta portfolio to cope with black swans. If we consider starting with how the strategy that uses high- and low-beta portfolio ended (value of 794), we lose almost four times its value and end up with only 175 dollar. If we would start investing in 2005, the 100 dollar would have turned into 22 dollar, ten years later. This implies a negative holding period return of 76.86%. It is interesting to see however, that the beta for this strategy is close to 0.

This last table clearly shows that the built-up profits, even though the gains are lower than the MSCI World benchmark, evaporate because of the strategy that uses the negative-beta portfolio after positive black swans. To give a visual image of the performance of the different portfolios, we constructed a graph that replicates the development of the monthly returns that were achieved with the different investment strategies.

FIGURE 7: Graphical Performance of the Investments



The rather weak performances do not come as a surprise having seen the different performance indicators. It is obvious that the benchmark, the MSCI World, outperformed both investment strategies. In the first ten years, the difference was negligible. However from 1983 on, the difference started to grow and eventually ended dramatically for both the constructed strategies. It is also important to note that we do not take transaction costs into account, which can have an impact on the results.

Since beta is the focus of this research, we feel that a focus on transaction costs would not increase the validity of beta as risk measure and would not benefit the analysis of our strategy. This approach of defining black swans of at least 5% absolute value is closest related to the method of Estrada & Vargas (2012), it could prove to be beneficial to compare the results of their research to ours. As mentioned, the same approach was chosen, but we contribute to the existing research in three ways. The separate discussion of emerging versus developed countries will follow in segment 5.4, but we can already discuss here what the impact of a longer time span and a negative-beta portfolio have had on the used strategy.

In the Data and Methodology section we have been able to show that the black swan months for both researches are much alike, with only a few differences. It is therefore even more interesting to see how our strategy has performed in comparison to Estrada & Vargas (2012).

Figure 7 can prove to be a helpful tool to compare performances. First off, we want to discuss a difference in the MSCI World benchmark. In the research of Estrada & Vargas (2012), they state that passively investing 100 dollar, would lead to 3,210 dollar by December 2009. We find that at that time, the passive investment would have gained 2,962 dollar to reach an end total of 3,062 dollar. Although this difference is quite small, it should be taken into account when assessing the strategies. By updating the time span of Estrada & Vargas (2012), we are able to see what the passive strategy would lead to if examined for another five years. On the 31st of January, the last month in our research, we find that the passive investment has gained 5,726 dollar to end with 5,826 dollar.

As discussed above, we reach an end total of 1,367 dollar with the original invested 100 dollar at the end of our research (January 2014). For December 2009, we only find an end total of 759 dollar. These results could not be more different from the results of Estrada & Vargas (2012). By using the same approach and finding almost the same return for the passive investment, they reach an end total of almost 20 times our result. The 100 dollar they initially invested had turned in to 12,834 dollar by December 2009. For the time span until the year 2000, the strategy of Estrada & Vargas (2012) reaches around 2,500 dollar. But after this time span, the value seems to increase 10 times over in the following seven years. Finding such a gigantic difference in performance, for the same strategy, we feel it should benefit our results to turn to the parameter (beta) that could bring forth such dissimilarity.

To be able to increase returns so fast and so strongly, the strategy should depend on massive betas to be able to amplify results, which cannot be found to that extent in our research. It is therefore less probable to have such a massive increase in returns in the period of 2000-2007. Another concern is the lack of clarity given by Estrada & Vargas (2012) for the sudden performance increase of the strategy used.

Our first contribution to this field of research, the time span update, has provided some interesting results. The same cannot be said for adding the negative-beta portfolio to the strategy. Compared to the strategy that incorporates low-beta portfolios, the strategy that uses negative-beta portfolios, has underperformed greatly. We attribute this performance to the short time span in which this portfolio can be used, and feel that with larger time spans, it can indeed be an interesting addition to the original strategy. Another reason for the bad performance of both discussed strategies, is the large amount of black swans taken into account. Since a black swan is defined as a very rare phenomenon, it can be argued that over 110 in the last forty years, does not correspond with reality. In the next segment, we will therefore choose an absolute value of 10% to define a black swan. We feel this will be able to provide us with a more realistic strategy, which is also more efficient in its set-up.

5.2.2 Black Swans With Absolute Value of 10%

If we increase the absolute value to define a black swan from 5% to 7.5%, we will still find 48 black swans to have occurred during our research period. However, using the 10%-threshold, we only find 16 black swans. Compared to Taleb's definition of a black swan, this number of rare events seems even more likely. For this reason, we decided to extend our research by duplicating the process from the 5% absolute value but instead using the 10% absolute value. Thus, we define a Black Swan as the monthly return in the MSCI World index higher than or equal to 10% in absolute value. To be able to compare the different results, we decided to use a similar lay-out, by first looking at the time span of 1973 until 2014 with the high- and low-beta portfolio, followed by the joint time periods of 1973-2004 and 2005-2014, in the last case using the negative-beta portfolio.

Table VIII. BETA AND PERFORMANCE

This table summarizes the performance of the MSCI World index and the full sample High-Low strategy. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

Performance Measures Strategy High-Low vs. World									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
World	4,606.09%	-40.33%	42.80%	11.76%	10.11%	18.23%	0.36084	6.580	1.00
High-Low	6,726.67%	-53,67%	73.75%	13.29%	11.18%	20.55%	0.39429	8.562	0.95

This table covers the performance when an absolute value of 10% is used to define a black swan. We again start the race with 100 dollar and let it run for little over forty years. We can clearly see an enormous difference between the previous results if black swans are defined with an absolute value of 5% against these results of the 10-threshold. The biggest difference with our previous results, is the fact that here, the market is outperformed. Ending with 6,832 dollar (HPR of 6,732%) instead of 4,706 dollar (HPR of 4,606%) implies a much higher performance. Return of a strategy is one thing, but the fact that we are able to achieve this with a lower systematic risk, really indicates an interesting strategy.

The overall portfolio risk on the other hand, which is measured by standard deviation, amounts to 20.55% against the 18.23% of the MSCI World index. However we attribute more weight to beta as risk measure, because our strategy works with diversified portfolios, for which total risk is not of the highest importance. When we look at the Sharpe ratio of 0.39429, it still outperforms the benchmark, which has a Sharpe ratio of 0.36084. This can be extended to the Treynor measure, which is respectively 8.56 for the strategy and 6.58 for the market.

Table IX. BETA AND PERFORMANCE

This table summarizes the performance of the MSCI World index and the Strategy High-Negative. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

Performance Measures High-Negative vs. World									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
World	4,606.09%	-40.33%	42.80%	11.76%	10.11%	18.23%	0.361	6.580	1.00
High-Negative	1,271.27%	-53.67%	73.75%	9.03%	6.57%	22.26%	0.173	5.615	0.68

The previous table shows the joint performance for the period of 1973-2004, in which the same high- and low-beta portfolios are used as in the previous table. But after 2004, the strategy uses a high-beta and a negative-beta portfolio. It is rather difficult to discuss the results because they are a small part of the total sample. We should have a larger sample in order to see if our new strategy effectively works, because in the period of 2005-2014 only five black swans occur, which is too few to test it. With only two positive black swans, in this case, the negative-beta portfolio is only used twice for the strategy. The detailed performance of the two separate time spans (1973-2004 & 2005-2014) is shown in the two panels of the table below.

We can conclude that although the end result is better, the modification of the absolute value did not have a significant positive impact on the results of the strategy high-negative. However, we predicted that this modification would not influence the additional strategy due to the fact that the only way to explicitly test our strategy is finding an ETF that shorts the MSCI World index for a longer period than from 2004.

Table X. PERFORMANCE INDICATORS

This table summarizes the performance indicators of both strategies, being the Strategy High-Low and the Strategy High-Negative. The Strategy High-Low runs from 1973 to 2004 and the Strategy High-Negative runs from 2005 to 2014. To make a fair comparison, the MSCI World for both periods was also calculated. This table refers to black swans with an absolute value of 10%. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

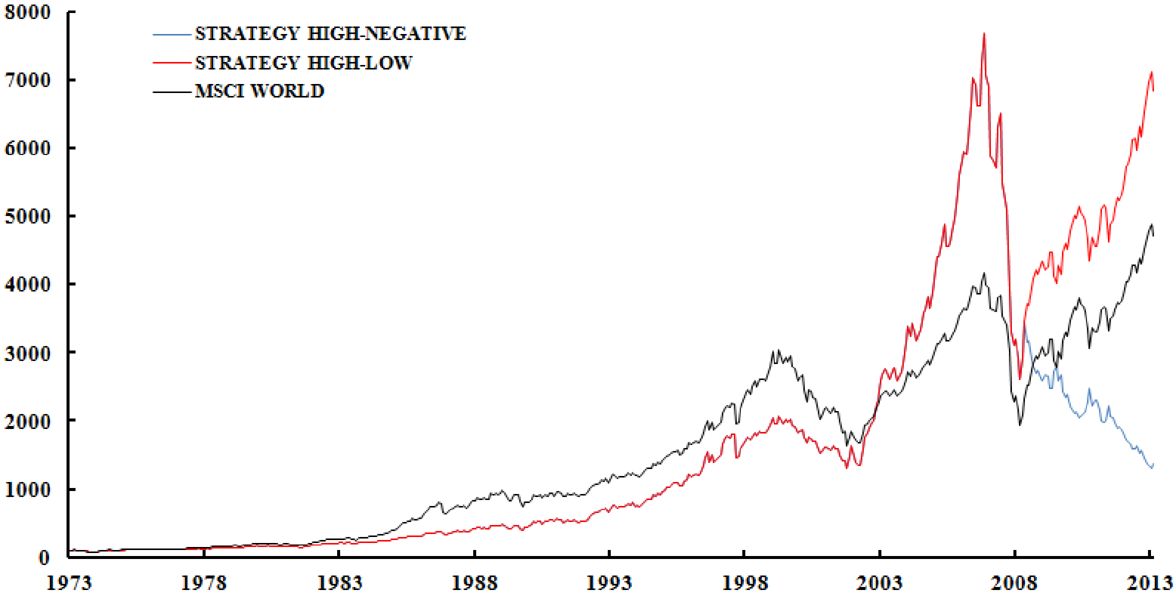
Performance Indicators: Strategy High-Low & High-Negative (Black Swan 10%)									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
High-Low	3,281.23%	-22.81%	73.75%	13.28%	11.93%	18.08%	0.39	8.02	0.88
MSCI 1973-2004	2,618.02%	-24.48%	42.80%	12.54%	11.11%	17.55%	0.36	6.30	1.00
High-Negative	-66.18%	-53.67%	43.49%	-5.60%	-10.02%	29.64%	-0.24	-3.01	0.23
MSCI 2005-2014	63.39%	-40.33%	30.79%	9.10%	6.73%	21.35%	0.35	8.44	1.00

To interpret the real performances of both strategies, being the strategy high-low and the strategy high-negative, we calculated the results when only using that particular strategy. Thus for the strategy high-low, the period between 1973 and 2004 was taken into account.

On the other hand, the strategy high-negative was calculated from 2005 until 2014. Table X gives a summary of the performance indicators that were calculated to assess both of the strategies. Each time, the MSCI World index was also taken into account for the same periods to make the comparison more clear. For instance, we can see that the strategy high-low outperformed the benchmark with a holding period return of 3,281%, leading to an end total of 3381 dollar, while the benchmark only gained 2,618 dollar (holding period return of 2,618%). Remarkable is the fact that this return was achieved with a lower beta-coefficient of only 0.88. Being exposed to a lower minimum and profiting from a higher maximum, the strategy high-low is clearly superior. Both the Sharpe ratio (0.39) and the Treynor measure (8.02) confirm this result.

Sadly enough, these results cannot be extended to the results of the strategy high-negative. Having a negative holding period return, it clearly underperformed the MSCI World index. This weak performance can be explained through the small research period as well as the fact that a series of negative black swans have occurred in those years. Thus following the mean reversion theory, we invested in high-beta portfolios that made sure that it fell even harder than the market. The upside of working with the strategy high-negative is that an investor can clearly lower his/her risk, which can be seen by the beta-coefficient. We still believe that the strategy high-negative could actually work when used on a longer research period and using an absolute value of 10% to define a black swan.

FIGURE 8: Graphical Performance of the Investments



Having a visual image of those previously mentioned results says more than a thousand words. We can clearly see that the strategy outperformed the MSCI World index.

During the years 2003-2007, the superior performance was enormous. While the benchmark reached around 4,200 dollar, the strategy already made 6,977 dollar. This can be explained through the fact that during those booming years, investing in high-beta portfolios paid off. For instance, the benchmark had an annual return of 33.76% in 2003 while the strategy earned 73.75%. Due to the occurrence of a negative black swan in September 2002 (-11%) and following the mean reversion strategy, the choice was made to invest in the high-beta portfolio. However, the financial crisis made sure that the performance reduced significantly. A negative black swan of -11.9% has occurred on September 2008. This again led to the investment in the high-beta portfolio, anticipating on positive returns to recover from this severe decline. Nevertheless, a series of negative returns followed which crushed our already build-up investment value. If the mean reversion theory would be completely correct, our investment in the high-beta portfolio would eventually lead to an even better performance. Unfortunately this was not the case and the performance of the strategy fell with more than 50%. Also remarkable is that the strategy only started to outperform the MSCI World from 2003 on.

If we analyze figure 8 further, we can divide the performance into five specific time periods. Starting in 1973 until 1998, both the passive investment strategy and the mean reversion strategy used by us, run the same upward course. In 2000 a summit is reached of 3,047 dollar for the MSCI World and of 2,053 dollar for the strategy. After that, both the passive and active strategy experience strong declines, to end with respectively 1,675 dollar and 1,332 dollar in 2003. After 2003, the strategy clearly starts working.

The past negative returns lead to high-beta portfolios during the recovery of the market, and thus at the end of 2007 the strategy is able to show a result of over 7,629 dollar, opposed to around 4,200 dollar for the passive investment. The following period is characterized by the financial crisis, where in 2008, both strategies again experience immense declines. The MSCI World index loses more than half its value (from around 4,200 dollar to 1,933 dollar), and the mean reversion strategy loses almost three times its value (from 7,629 dollar to 2,592 dollar) due to the allocation in the high-beta portfolio. And this point we can ask ourselves the question whether this strategy is thus appropriate to cope with black swans, because at the time of declines the active strategy seems to experience fluctuations stronger than the market. The next period can help us answer this question. If we see how well the strategy recovers, compared to the world market, we can imagine that there is more than one way to limit losses. A fast and stronger recovery as the market, leads to an interesting strategy.

We still believe in the practical use of our new strategy combined with the strategy that was based on the mean reversion theory. However, we believe that an adaption could be necessary. Like we already mentioned in the literature section, there is lack of research in the average duration of a black swan. Here we always invested in the most extreme portfolio, which was either the high-beta, low-beta or negative-beta portfolio. However, we also calculated the more neutral beta portfolios but never made use of them. If there would be certain research on the average duration of a black swan, we would be able to decide on average how long to invest in a certain portfolio before changing it to a more neutral portfolio. This way, we protect our investment against sudden corrections, and maximize the use of our strategy to cope with corrections and recoveries. This strategy will be discussed further in the Future Research section.

5.3 COUNTRIES VS. INDUSTRIES

Seeing as previous results seem to support beta as a measure of risk and portfolio selection tool, examining a possible difference between countries and industries along the line of the testing in Estrada & Vargas (2012) may seem interesting. We decided to test the data on industries alone, as a first robustness test, and also because we feel some specific situation may even provide even better results. By running the entire tests for a whole other set of data, interesting insights can be provided. We should firstl note that we have only 56 industries compared to 57 in the research of Estrada & Vargas (2012), in their research they use the industry ‘Road and Rail’ twice. For industries there are 51 relevant 5% black swans, divided into 21 with negative and 30 with positive returns. When we again use the 10%-threshold, we find 5 negative and 2 positive black swans. As mentioned in the discussion of our first research question, we find similar results for countries and industries, compared to countries and industries separately. High-beta portfolios for industries also fall stronger in declining markets, compared to low-beta portfolios, so beta remains a valid risk measure even for industries alone. Exhibit 2 gives information on the different portfolios.

For industries, we only use the strategy with the high-beta and low-beta portfolio. Our other strategy, with the negative beta portfolio, is not used to analyze the performance of industries. The ETF we use to create a negative beta portfolio, shorts the entire MSCI World, so it would not serve its purpose if we compare it to only the industry part of the MSCI World.

Applying our mean reversion strategy to industries, we start off with 100 dollar in 1998. If we define black swans as market fluctuations of higher than 5% absolute value, it would lead to an end total of only 234 dollar in 2014. Over fifteen years, this only leads to a holding period return of 134%. The beta for this strategy is also a bit lower than the market (0.97). Risk adjusted return for this strategy can be compared to that of the market. This return can be compared to the research of Estrada & Vargas (2012), while they find that the strategy devised by them, and again used by us, reaches a value of over 25% more than the market by

December 2009, we find that the value gained by the MSCI and the 5% strategy can be considered more or less the same, with almost the same risk. Starting with 100 dollar in 1998, the MSCI would provide an end total of 222 dollar.

Defining a black swan as a market fluctuation of 10% value or more on the other hand, gives a better result. Over the same fifteen years, the 100 invested dollars would have turned into 431 dollar, implying a holding period return of 331%. With this higher performance follows a somewhat higher risk, the beta for industries is 1.04. Double the value with a bit higher risk still seems interesting.

The results for industries alone, strengthen the validity of beta as a risk measure and reinforce the power of our strategy. It can again be found that high-beta portfolios fall more in downward markets and that our 10% black swan strategy again performs better than the market.

5.4 EMERGING VS. DEVELOPED COUNTRIES

In addition to our research, we are interested to see if there is in fact a difference between emerging and developed countries and in particular dealing with their systemic risk. Like we already mentioned, systemic risk is measured by the beta-coefficient. Emerging countries are considered more volatile than the developed countries. In the Appendix, Exhibit I gives a description on the emerging and developed countries. One way to look at volatility is looking at the average calculated betas. In the following table, a representation is given of those calculated betas, both for the 5% and 10% absolute value.

Table XI. BETA-COEFFICIENTS OF PORTFOLIOS

This table gives a summary of the average beta-coefficients that were calculated for each portfolio as well as the breakdown into developed and emerging countries. The calculation covers both definitions of a black swan.

Beta-coefficients of Emerging and Developed Countries				
	Portfolio 1	**Portfolio 2**	**Portfolio 3**	**Portfolio 4**
Black Swan 5%				
Developed Countries	1.45	1.14	0.97	0.72
Emerging Countries	1.81	1.37	1.02	0.44
Black Swan 10%				
Developed Countries	1.33	1.05	0.91	0.65
Emerging Countries	1.71	1.36	1.09	0.57

In Table XI, a representation is given of the different beta-coefficients of both developed and emerging countries. We have again made a distinction between black swans with an absolute value of 5% and those of 10%. With black swans of 5%, we can clearly see that the beta-coefficients of the emerging countries are higher than those of developed countries. For instance, portfolio 1 of developed countries has a beta of 1.45 while the beta of portfolio 1 of emerging countries amounts to 1.81. This does not hold when we look at portfolio 4 due to the fact that the beta-coefficient is significantly higher for developed countries than emerging countries (Developed: 0.72 vs. Emerging: 0.44).

When we compare these results to the ones when an absolute value of 10% is used, Table XI shows that the argumentation can be extended. With a beta of 1.71, the emerging countries clearly exceed the developed ones with a beta of 1.33. Again, portfolio 4 has the opposite results where emerging countries have lower beta than those of the developed countries.

After checking the constructed betas for the different portfolios, we also want to test whether beta remains a valid risk measure when analyzing developed and emerging markets separately. We do so for both definitions of black swans as market fluctuations of 5% or 10%. After finding a result in favour of beta, we would be able to again run our investment theories, as a second robustness test.

By analyzing the different panels in Exhibit 4, we can indeed see that beta is again a proper risk measure. High-beta portfolios fall, on average, more than the market, and more than low-beta portfolios. This statement is true for both developed and emerging countries, and for both the 5% or 10% strategy. By comparing developed and emerging countries, we can see in table XI that betas for emerging countries are much higher, and here we see that returns are more volatile as well. Panel 2, which shows results for the 10% black swan strategy, clearly indicates a large difference for emerging countries. The large difference between the high-beta and low-beta portfolio also suggests increased volatility. However, we cannot attribute too much credence on these results, because only two positive black swans are relevant for emerging markets.

Table XII. PERFORMANCE INDICATORS DEVELOPED VS. EMERGING

This table summarizes the performance indicators for developed and emerging countries. These performance indicators were calculated taking into account an absolute value of 5% to define a black swan. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

Black Swans 5% - Developed and Emerging Countries									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
Developed	3,488.44%	-29.53%	50.75%	10.71%	9.36%	16.79%	0.33	5.68	0.97
Emerging	117.74%	-32.99%	35.60%	4.66%	3.44%	15.56%	0.21	3.43	0.95

For developed and emerging countries, we again only test our High-Low strategy, because the negative-beta portfolio shorts the entire MSCI World. By only focusing on a part of this, achieving a negative beta might not be possible. The difference in performance between developed and emerging countries can be explained through the fact that emerging countries only started in 1991, thus 100 dollar was invested in 1991 while the same 100 dollar was already invested in 1973 with developed countries. Thus with a clearly lower investment period, it underperformed the developed countries. This can be seen in Table XII, which is presented above and where developed countries achieved a holding period return of 3,488% while the emerging countries only gained 118%. It is also remarkable that emerging countries reached a higher minimum, lower maximum, lower arithmetic mean, lower geometric mean, lower standard deviation, lower Sharpe ratio, lower Treynor measure and a lower beta compared to developed countries. Of course, the comparison between developed and emerging is not fair when it comes to the holding period return. To solve this problem, we put 100 dollar starting on the same date of the emerging countries. However with a holding period return of 528%, the developed countries still outperform the emerging countries (118%).

Table XIII. PERFORMANCE INDICATORS DEVELOPED VS. EMERGING

This table summarizes the performance indicators for developed and emerging countries. These performance indicators were calculated taking into account an absolute value of 10% to define a black swan. The following performance indicators were used, in chronological order: Holding period return, minimum, maximum, arithmetic mean, geometric mean, standard deviation, Sharpe ratio, Treynor measure and beta.

Black Swans 10% - Developed and Emerging Countries									
	HPR	**MIN**	**MAX**	**AM**	**GM**	**SD**	**SR**	**TM**	**β**
Developed	8,571.75%	-51.66%	68.37%	13.97%	11.80%	21.04%	0.42	11.05	0.79
Emerging	436.70%	-60.90%	90.21%	16.65%	11.07%	33.65%	0.45	22.75	0.67

When we use an absolute value of 10% to define a black swan, we can see that there are some differences compared to the previous table. Again, it should be mentioned that emerging countries started in 1998 while developed countries already started in 1973 by investing 100 dollar. With a holding period return of 8,572%, the developed countries made a gain of 8472 dollar, to end with almost double the value of the market (MSCI World performance is shown in Table VIII). On the other hand, the emerging countries only had a holding period return of 437% with the 100 dollar that was invested in 1998. However when we invest the same 100 dollar in 1998 with developed countries, we would have achieved a holding period return of 492%. We can see that emerging countries have a higher minimum, higher maximum, higher arithmetic mean, lower geometric mean, higher standard deviation, higher Sharpe ratio, higher Treynor measure and a lower beta. It should be stated that the holding period return of 8,572% clearly outperforms the strategy high-low with a holding period return of 6,727% due to the fact that emerging countries has a negative effect on the results.

6 CONCLUSION

Based on the research of Estrada & Vargas (2012), we constructed our research questions the same way they did. We first posed the question whether beta is a valid risk measure. Our literature section already discussed the argumentation of the proponents and adversaries on the use of beta. Following this theoretical investigation, we tried to answer it empirically. We found that beta remains a good risk measure, for our first dataset (countries and industries) and for all separate focuses (countries, industries, emerging countries and developed countries). We can conclude this because our high-beta portfolios, on average, fall more than the market portfolio or the low-beta portfolios. The created fifth portfolio, which we chose because of its supposed negative correlation with the benchmark, indeed satisfies its purpose. This negative beta portfolio reaches betas of around -1, thus renders positive returns in declining markets and suffers negative returns in bull markets.

Since we believe that the 5%-threshold for defining a black swan seems counter-intuitive, leading to an enormous enumeration of black swans, the definition was also adapted to 10% market fluctuations. We do so because otherwise this does not correspond to the first characteristic of rarity in Taleb's (2007) definition of the black swan phenomenon. For this reason we included both definitions, the 5%-threshold to compare our research to the previous work, and the 10%-threshold to satisfy the black swan requirements.

Conducting our investment strategies for both 5%- as 10%-black swans has proved some interesting insights in this line of work, and should be able to empirically answer our second research question, whether different beta portfolios can render profits to an investor in diverse market situations. The results for the two separate definitions are of contrasting nature. For black swans of 5%, we find that both the strategy that uses the high-beta and low-beta portfolio as well as the one that uses the high-beta and negative beta portfolio, strongly underperform the MSCI World index. Although the risk of these strategies is notably lower than the market, the risk-adjusted performance indicators clearly show that actively investing according to the mean reversion technique is not warranted. One reason for this underperformance can be found in the fact that when choosing the 5%-threshold, we experience consecutive black swan months, which may imply that they are elements of one large black swan. We felt that through using a 10%-threshold, we were able to capture these completely, and thus not suffer from amplified losses.

Looking at the results for the 10%-threshold, we can verify our hypothesis that through capturing the entire black swan, our investment strategies do provide sufficient profits in various market situations. For the full sample, countries and industries together, we found that our strategy that uses high- and low-beta portfolios is superior to the market in two ways.

Firstly it achieved a higher return than the market, and secondly it was able to do so with lower systematic risk. This implies that when comparing risk-adjusted performance indicators, our strategy comes out on top.

For the strategy that relies on the negative-beta portfolio, we found different results. Here we finish with a much lower end total compared to the passive investment. Although we are able to build up profits with the combination of the high-beta and low-beta portfolio until 2004, from 2005 onward the strategy uses the negative-beta instead of the low-beta portfolio, and through that suffers extreme losses.

To see whether a specific focus may lead to even better results, industries were examined firstly, followed by developed and emerging countries. This division can also be considered as a robustness test, because a different dataset is used. For industries, developed and emerging countries separately, beta remains a proper risk measure. Only using the high-beta and low-beta portfolios for running our strategy, we found that over the fifteen years when data on industries is available, the performance of our strategy again overshadows the market's performance. Running the same test for developed and emerging markets, we found that due to higher betas and volatile returns, emerging markets clearly perform worse than developed countries. This can be attributed to the shorter dataset for emerging countries as well. We can conclude that investing in developed countries instead of countries and industries together would have led to an even higher value of the investment. Actively investing still seems to be able to outperform a passive investment strategy, when based on a legitimately founded theory.

7 FUTURE RESEARCH

Having executed this research into coping with black swans, we found some lack in the present literature. To construct a fundamentally correct strategy, literature concerning the average duration as well as the average recovery of a black swan would be useful. We are aware of the difficulties related to these two characteristics but feel it would provide a useful addition to the current research nonetheless. Using the mean reversion technique, we either use the high-beta or the low-beta portfolios but not the ones in between. However knowing the average duration and recovery time, we would be able to use the more neutral portfolios after the recovery or correction is complete and thus be less exposed to severe market fluctuations.

Looking at our results, we noticed that the amount of data for industries (1998), emerging countries (1991) and the MSCI World Short index (2001) is limited. Because of this, our strategies do not reach their full potential. A follow-up research updating the time span when more data is available, may provide better results. Another advantage of the time period update would be that when a new black swan occurs, the researcher could investigate the underlying cause of the occurring black swan. This way, a distinction could be made between market fluctuations which have a structural problem as background or market fluctuations in itself.

8 APPENDIX

EXHIBIT 1: DATA MSCI World Index (Countries)

Country	AM	GM	SD	Start	Country	AM	GM	SD	Start
Developed					*Emerging*				
Australia	1.0	0.8	7.0	Jan/70	Argentina	2.2	1.1	15.5	Jan/88
Austria	0.9	0.7	6.8	Jan/70	Brazil	2.4	1.3	14.5	Jan/88
Belgium	1.1	0.9	6.0	Jan/70	Chile	1.5	1.2	7.1	Jan/88
Canada	1.0	0.8	5.7	Jan/70	China	0.5	0.0	10.2	Jan/93
Denmark	1.2	1.1	5.7	Jan/70	Colombia	1.6	1.2	9.0	Jan/93
Finland	1.1	0.7	9.2	Jan/88	Czech Rep.	0.5	0.0	9.0	Jan/95
France	1.0	0.8	6.6	Jan/70	Egypt	1.7	1.2	9.9	Jan/95
Germany	1.0	0.8	6.4	Jan/70	Hungary	1.4	0.8	11.0	Jan/95
Greece	0.9	0.3	10.9	Jan/88	India	1.1	0.7	8.9	Jan/93
Hong Kong	1.7	1.2	10.1	Jan/70	Indonesia	1.8	0.9	14.1	Jan/88
Ireland	0.6	0.4	6.5	Jan/88	Israel	0.7	0.5	6.9	Jan/93
Italy	0.7	0.5	7.5	Jan/70	Jordan	0.4	0.3	5.4	Jan/88
Japan	0.9	0.8	6.2	Jan/70	South Korea	1.1	0.6	10.8	Jan/88
Netherlands	1.1	1.0	5.6	Jan/70	Malaysia	1.0	0.7	8.1	Jan/88
New Zealand	0.8	0.5	6.7	Jan/88	Mexico	1.9	1.5	8.9	Jan/88
Norway	1.2	0.9	7.9	Jan/70	Morocco	0.9	0.8	5.8	Jan/95
Portugal	0.5	0.3	6.7	Jan/88	Peru	1.6	1.2	9.3	Jan/93
Singapore	1.2	0.9	8.3	Jan/70	Philippines	1.1	0.7	9.0	Jan/88
Spain	1.0	0.8	6.9	Jan/70	Poland	1.9	1.1	13.8	Jan/93
Sweden	1.3	1.1	7.0	Jan/70	Russia	2.5	1.0	17.2	Jan/95
Switzerland	1.1	0.9	5.3	Jan/70	South Africa	1.2	0.9	7.8	Jan/93
UK	1.0	0.8	6.4	Jan/70	Taiwan	1.0	0.5	10.3	Jan/88
USA	0.9	0.8	4.5	Jan/70	Thailand	1.2	0.6	10.8	Jan/88
World					Turkey	2.0	0.8	16.2	Jan/88
MSCI World	0.9	0.8	4.3	Jan/70					

EXHIBIT 1: DATA MSCI World Index (Industries)

Industry	AM	GM	SD	Start
Aerospace and Defense	1.1	1.0	5.7	Jan/95
Air Freight and Logistics	0.8	0.7	5.5	Jan/95
Airlines	0.5	0.3	6.4	Jan/95
Auto Components	0.7	0.5	5.9	Jan/95
Automobiles	0.7	0.5	6.2	Jan/95
Beverages	0.9	0.8	4.4	Jan/95
Biotechnology	1.7	1.4	8.6	Jan/95
Building Products	0.5	0.3	6.2	Jan/95
Chemicals	0.9	0.7	5.4	Jan/95
Commercial Banks	0.6	0.4	6.2	Jan/95
Commercial Services and Supplies	0.4	0.3	4.5	Jan/95

Communications Equipment	0.8	0.4	9.1	Jan/95
Computers and Peripherals	1.2	0.9	7.8	Jan/95
Construction and Engineering	0.6	0.4	6.3	Jan/95
Construction Materials	0.7	0.5	6.6	Jan/95
Containers and Packaging	0.4	0.3	6.0	Jan/95
Distributors	0.2	-0.2	8.6	Jan/95
Diversified Financial Services	0.7	0.4	7.6	Jan/95
Diversified Telecommunication Sces.	0.6	0.4	5.3	Jan/95
Electric Utilities	0.6	0.6	3.6	Jan/95
Electronic Equipment and Instruments	0.4	0.2	7.4	Jan/95
Electronic Equipment Manufacturers	0.8	0.6	6.5	Jan/95
Energy Equipment and Services	1.2	0.8	9.0	Jan/95
Food Products	0.8	0.8	3.7	Jan/95
Food/Staples Retailers	0.6	0.6	3.7	Jan/95
Gas Utilities	0.8	0.8	4.1	Jan/95
Health Care Equipment and Support	0.9	0.8	4.4	Jan/95
Health Care Providers and Services	0.8	0.7	5.7	Jan/95
Hotels, Restaurants and Leisure	0.9	0.8	5.0	Jan/95
Household Durables	0.2	0.0	6.6	Jan/95
Household Products	1.0	0.9	4.6	Jan/95
Industrial Conglomerates	0.8	0.6	6.3	Jan/95
Information Technology Services	0.4	0.1	7.0	Jan/95
Insurance	0.7	0.5	6.0	Jan/95
Internet and Catalogue Retail	1.4	1.0	9.1	Jan/95
Internet Software and Services	2.1	1.2	14.4	Jan/97
Leisure Equipment and Products	0.5	0.3	4.9	Jan/95
Machinery	0.8	0.6	6.3	Jan/95
Marine	0.6	0.4	7.2	Jan/95
Media	0.8	0.6	5.7	Jan/95
Metals and Mining	0.7	0.4	7.7	Jan/95
Multi-Utilities	0.5	0.4	5.7	Jan/95
Multiline Retailers	0.9	0.7	5.7	Jan/95
Office Electronics	0.5	0.2	6.6	Jan/95
Oil, Gas and Consumable Fuels	1.0	0.9	5.4	Jan/95
Paper and Forestry Products	0.5	0.3	7.0	Jan/95
Personal Products	1.1	0.9	5.7	Jan/95
Pharmaceuticals	0.9	0.9	4.1	Jan/95
Road and Rail	0.7	0.6	4.2	Jan/95
Specialty Retail	0.9	0.8	5.8	Jan/95
Textiles, Apparel and Luxury Goods	1.0	0.8	6.4	Jan/95
Tobacco	1.5	1.3	6.4	Jan/95
Trading Companies and Distributors	0.6	0.4	6.7	Jan/95
Transportation Infrastructure	1.0	0.8	5.6	Jan/95
Water Utilities	1.3	1.1	4.9	Jan/95
Wireless Telecommunication Services	1.1	0.9	6.5	Jan/95

EXHIBIT 2: BETA AND RETURN

Black Swan 5% - Countries

	Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.18	0.87	0.73	0.43	-0.70	
Return	-8.46%	-12.03%	-8.92%	-7.38%	-4.51%	8.34%	-7.50%
	Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.52	1.15	0.96	0.77	-1.13	
Return	7.23%	11.14%	8.49%	7.09%	4.45%	-8.03%	6.70%

Black Swan 5% - Industries

	Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.41	1.08	0.88	0.54	-0.90	
Return	-8.46%	-12.13%	-9.25%	-7.56%	-4.59%	8.34%	-7.50%
	Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.71	1.31	1.06	0.63	-1.07	
Return	7.23%	12.23%	9.39%	7.63%	4.59%	-8.03%	7.60%

EXHIBIT 3: BETA AND RETURN

Black Swan 10% - Countries

	Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.18	0.87	0.73	0.43	-0.70	
Return	-12.92%	-14.70%	-10.89%	-9.06%	-5.24%	9.43%	-9.50%
	Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.59	1.28	1.12	0.77	-1.13	
Return	11.45%	18.12%	14.47%	12.62%	8.68%	-12.16%	9.40%

Black Swan 10% - Industries

	Negative Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.10	0.83	0.68	0.42	-0.70	
Return	-12.92%	-13.81%	-10.42%	-8.57%	-5.37%	9.43%	-8.40%
	Positive Black Swans						
	World	**P1**	**P2**	**P3**	**P4**	**P5**	**P1-P4**
Beta	1.00	1.92	1.55	1.27	0.88	-1.13	
Return	11.45%	20.60%	16.61%	13.68%	9.49%	-12.16%	11.10%

EXHIBIT 4: BETA AND RETURN

Black swan 5% - Developed Countries

	Negative Black Swans					
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.37	1.06	0.90	0.66	
Return	-8.46%	-11.53%	-8.89%	-7.58%	-5.56%	-6.03%

	Positive Black Swans					
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.47	1.15	0.98	0.73	
Return	7.23%	10.85%	8.52%	7.27%	5.38%	5.47%

Black swan 5% - Emerging countries

	Negative Black Swans					
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.67	1.26	0.93	0.41	
Return	-8.46%	-14.08%	-10.63%	-7.99%	-3.60%	-10.48%

	Positive Black Swans					
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.83	1.40	1.05	0.46	
Return	7.23%	12.95%	9.97%	7.52%	3.25%	9.70%

Black swan 10% - Developed Countries

	Negative Black Swans					
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.14	0.88	0.74	0.52	
Return	-8.46%	-14.26%	-11.04%	-9.26%	-6.34%	-7.92%

	Positive Black Swans					
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.58	1.28	1.13	0.82	
Return	7.23%	18.05%	14.40%	12.76%	9.22%	8.83%

Black swan 10% - Emerging Countries

			Negative Black Swans			
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	1.45	1.09	0.84	0.41	
Return	-8.46%	-18.15%	-13.60%	-10.45%	-5.11%	-13.04%
			Positive Black Swans			
	World	**P1**	**P2**	**P3**	**P4**	**P1-P4**
Beta	1.00	2.37	2.04	1.73	0.99	
Return	7.23%	25.52%	22.04%	18.66%	10.70%	14.82%

9 REFERENCES

Banz, R., 1981, “The Relationship between Return and Market Value of Common Stocks” *Journal of Financial Economics* 9: 3-18.

Basu, S., 1977, “Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis” *The Journal of Finance* 32 (No.3): 663-682.

Bhandari, L., 1988, “Debt/Equity Ratio and Expected Common Stock Returns: Empirical Evidence” *The Journal of Finance* 43 (No.2): 507–528.

Bikchandani, S., et al., 1992, “A Theory of Fads, Fashion, Custom and Cultural Change as Information Cascades” *Journal of Political Economy* 100 (No.5): 992-1026.

Bikhchandani, S., and S. Sharma, 2001, “Herd Behavior in Financial Markets” *IMF Staff Papers* 47 (No.3): 279-310.

Black, F., 1972, “Capital Market Equilibrium with Restricted Borrowing” *Journal of Business* 45: 444-455.

Black, F., 1993, “Beta and Return” *The Journal of Portfolio Management* 20 (No.1): 8-18.

Bodie, Z., Kane, A. and A. Marcus, 2013, *Essentials of Investing*, McGraw Hill.

Bogle, J., 2008, “Black Monday and Black Swans” *Financial Analysts Journal* 64 (No.2): 30-40.

Carlson, M., 2006, “A Brief History of the 1987 Stock Market Crash” *Finance and Economics Discussion Series*: 1-24.

Chan, K., Chen, N. and D. Hsieh, 1985, “An Exploratory Investigation of the Firm Size Effect” *Journal of Financial Economics* 14: 451-471.

Chan, L. and J., Lakonishok, 1993, “Are Reports of Beta’s Death Premature?” *The Journal of Portfolio Management* 19 (No.4): 51-62.

Chen, N., Roll, R. and S. Ross, 1986, “Economic Forces and the Stock Market” *The Journal of Business* 59 (No.3): 383-403.

Cloninger, D., et al., 2004, “Returns on Negative Beta Securities: Implications for the Empirical SML.” *Applied Financial Economics* 14: 397- 402.

CTFC and SEC, 2010, “Findings Regarding the Market Events of May 6, 2010” *Joint Advisory Committee on Emerging Regulatory Issues*: 1-104.

Davidson, P., 2012, “Keynes and Knight on Uncertainty – Ontology vs. Epistemology” *Real World Economics Review Blog*, Consulted on May 13 2014 at http://larspsyll.wordpress.com/2012/07/29/keynes-and-knight-on-uncertainty-ontology-vs-epistemology/

Estrada, J. and M. Vargas, 2012, “Black Swans, Beta, Risk, and Return” *Journal of Applied Finance* 22 (No.2): 77-89.

Fama, E. and K. French, 1992, “The Cross-Section of Expected Stock Returns” *The Journal of Finance* 47: 427-465.

Fama, E. and K. French, 1993, “Common Risk Factors in the Returns on Stocks and Bonds” *Journal of Financial Economics* 33: 3-56.

Fama, E. and K. French, 2012, “Size, Value and Momentum in Stock Returns” *Journal of Financial Economics* 105 (No.3): 457-472.

Fama, E. and J. Macbeth, 1973, “Risk Return and Equilibrium: Empirical Tests” *Journal of Political Economy* 81: 607-636.

Focardi, S., and F. Fabozzi, 2009, “Black Swans and White Eagles: On Mathematics and Finance” *Mathematical Methods of Operations Research* 69 (No.3): 379-394.

Gomes, J., Kagan, L. and L. Zhang, 2003, “Equilibrium Cross Section of Returns” *Journal of Political Economy* 111 (No.4): 693-732.

Grinold, R., 1993, “Is Beta Dead Again?” *Financial Analysts Journal* 49: 28-34.

Grundy, K. and B. Malkiel, 1995, “Reports of Beta’s Death Have Been Greatly Exaggerated” *The Journal of Portfolio Management* 22 (No. 3): 36-44.

Holton, G., 2004, “Defining Risk” *Financial Analysts Journal* 60 (No.6): 19-25.

Kahneman, D., and A. Tversky, 1979, “Prospect Theory: An Analysis of Decision under Risk” *Econometrica* 47 (No.2): 263-292.

Keynes, J., 1936, *The General Theory of Employment, Interest and Money*, Palgrave Macmillan.

Kothari, S., Shanken, J. and R. Sloan, 1995, “Another Look at the Cross-Section of Expected Stock Returns” *Journal of Finance* 1 (No.1): 185-224.

Lakonishok, J. and A. Shapiro, 1986, “Systematic Risk, Total Risk and Size as Determinants of Stock Market Returns” *Journal of Banking and Finance* 10: 115-132.

Lewis, M., 2014, *Flash Boys,* Barnes and Noble.

Linn, W., et al., 2009, “What Causes Herding: Information Cascade or Search Cost?” *MPRA Paper* (No.21204): 1-32.

Lintner, J., 1965, “The Valuation of Risky Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets” *Review of Economics and Statistics* 47: 13-37.

Marsh, T. and P. Pfleiderer, 2012, “Black Swans and the Financial Crisis” *Review of Pacific Basin Financial Markets and Policies* 15 (No.2): 1250008-1 – 1250008-12.

Mossin, J., 1966, “Equilibrium in a Capital Asset Market” *Econometrica* 34: 768-783.

Paxson, C., 1990, “Borrowing Constraints and Portfolio Choice” *The Quarterly Journal of Economics* 105 (No.2): 535-543

Pettengill, G., Sundaram, S. and I. Mathur, 1995, “The Conditional Relation between Beta and Returns” *Journal of Financial and Quantitative Analysis* 30: 101-116.

Romer, C., 1991, “What Ended The Great Depression?” *Nber Working Papers Series*: 1-53.

Roll, R., 1977, “A Critique of the Asset Pricing Theory’s Tests” *Journal of Financial Economics* 4: 129-176.

Roll, R., 1988, “The International Crash of October 1987” *Financial Analysts Journal*: 19-35.

Sharpe, W., 1964, “Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk” *Journal of Finance* 19: 425-442.

Sharpe, W., 1992, "Asset Allocation: Management Style and Performance Measurement” *Journal of Portfolio Management*: 7-19.

Siegel, J., 2008, “Stocks for the Long Run. *The Definitive Guide to Financial Market Returns & Long Term Investments Strategies*, Columbus, OH, McGraw Hill.

Stattman, D., 1980, “Book Value and Stock Returns” *The Chicago MBA: A Journal of Selected Papers* 4: 25-45.

Taleb, N., 2005, *The Black Swan: Why Don’t We Learn That We Don’t Learn?* Random House.

Taleb, N., 2007*, The Black Swan: The Impact of the Highly Improbable,* Random House.

Terzi, A., 2010, “Keynes’s Uncertainty is not about White or Black Swans” *Journal of Post Keynesian Economics* 32 (No.4): 559-565.

Treynor, J., 1961, "Market Value, Time, and Risk" *Unpublished Manuscript dated 8/8/61*: 95-209.

Weber, M., and C. Camerer, 1998, “The Disposition Effect in Securities Trading: An Experimental Analysis” *Journal of Economic Behavior & Organization* 33: 167-184.

Wolfski, R., 2009, “The Influence of Negative Beta Assets on the Empirical SML in the Polish Capital Market” *Folio Oeconomica Stetinensia* 8 (No.1): 140-153.