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DIPLOMA THESIS

Performance of alternative portfolios during Financial Crisis

2007 – 2009

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Prohlášení

Prohlašuji, že jsem diplomovou práci vypracoval samostatně a použil pouze uvedené prameny a literaturu.

Declaration

Hereby I declare that I compiled this diploma thesis independently, using only the listed literature and resources.

Prague, 16th May 2009

Adam Zaydlar

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Abstract

The main focus of the thesis was to analyze the performance of the alternative portfolio strategies with special attention to the period of Financial Crisis 2007 – 2009. In the thesis, we provide available literature based description of the Financial Crisis sources. For the analytical purposes, we have focused on dollar investor investing into the beta and contrarian trading strategy based portfolios analysis. We have analyzed portfolios consisting of US stocks with beta values equal to 1, 0.5 and negative betas (plus Contrarian portfolio). We provide description of 1\$ investment development through the period from 1998 to 2009 with comparison of all strategies in the period from 10/2007 to 03/2009 that is falling into the Financial Crisis period. All portfolios are compared based on the 1\$ investment price development, their volatilities and their Sharpe ratios.

Abstrakt

Hlavní náplní práce byla analýza výkonnosti alternativních portfolií se zvláštním zaměřením na období finanční krize 2007 – 2009. Práce nabízí popis zdrojů finanční krize na základě dostupné literatury. Hlavním tématem práce byla pozice dolarového investora investujícího do portfolií vytvořených a spravovaných na základě beta ukazatelů jednotlivých akcií a do portfolia spravovaného na základě Contrarian trading strategy. Analyzovali jsme portfolia sestávající z akcií amerického akciového trhu s beta ukazateli o hodnotě 1, 0.5 a zápornými (plus Contrarian portfolio). Dále popisujeme vývoj 1\$ investice během období 1998 – 2009, včetně porovnání vývoje všech strategií v období od října 2007 do března 2009, které spadá do období finanční krize. Všechna portfolia byla porovnána na základě vývoje ceny 1\$ investice, jejich volatilit a jejich Sharpe ratios.

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1 Introduction

This master thesis' aim is the analysis of the various portfolio construction and management approaches in the context of 2007 sub-prime mortgage crisis and 2008 financial crisis. Our goal is to analyze alternative portfolios.

The analysis will be applied on data from the period from 1998 to the beginning of the 2009 with attend to comparison of the portfolios during the Financial Crisis period. We will focus on construction of portfolios and description of their development before and after the Crisis emerged. The aim is to examine whether there was possibility for some of our chosen portfolios to be profitable or less loosing in comparison with the market during the Crisis. We will focus on strategies that were constructed in times of the growth of the market and stock prices. We will analyze whether those constructed portfolios were able to make profit during the Financial Crisis of 2007 – 2009 or whether they were able to reduce the loss the market suffered during the Crisis. Furthermore we will study which of the strategies were more likely to be vulnerable to the fluctuations and which were not, i.e. we are interested if there were some portfolios that were resistant to the fluctuations during the Crisis. As we will use exclusively stocks traded on US stock market (because of the data availability), we will focus on dollar investor returns, in our thesis.

Because the description of the environment is very important for understanding of the whole problematic of this thesis, in the second chapter, we will focus on description of the environmental background, on which we will build our research in subsequent parts of this thesis. Such descriptions will be based on the papers already published. We will mainly describe the sub-prime mortgage

crisis fundamentals and subsequently the analysis of the quantitative methods during the August 2007, based on literature published already.

In the third chapter of this thesis, we will describe methodology used in our analysis. We will mainly describe the dataset we have analyzed and approaches that were applied during the analysis. The aim of the Methodology is to provide reader some background to understand the approach of our analysis and reasons why particular methods were chosen and applied. We will furthermore describe the portfolios construction process and selection process of the stock. The beta based portfolios (i.e. such portfolios based on stocks' betas values that indicate the correlations of particular stocks' returns to the return of the market) and contrarian strategy portfolio will be described.

In the fourth section, we will focus on the description of the outcome of analysis. We will provide description of the market benchmark portfolio development, to which other portfolios were compared in particular periods. Beta based portfolios' and contrarian strategy's development will be described in more detail for the period 1998 – 2009 with focus on the period of Financial Crisis from 10/2007 – 03/2009 which is period for which the data were available during the compilation of our thesis. The price development of the 1\$ initial investment will be compared through the selected periods. At the end of the section, we provide comparison of all portfolios constructed and market portfolio in the period from 10/2007 to 03/2009. There will be compared returns as well as the volatilities of the portfolios, volatilities and Sharpe ratios of the portfolios analyzed.

The summary of the outcome of our analysis can be found in the fifth part of our thesis.

2 Environmental background

In this chapter of our thesis, we will focus on description of today's environment in which we will be analyzing the data. This description is very important for the subsequent analytical part of the thesis in order to understand the turbulent development we are facing nowadays. We will begin with housing price bubble burst in 2007 and subsequent Financial Crisis we are facing nowadays. Then we will continue with description of the sources of sub-prime mortgage crisis and subsequently we will shift to the description of the possible quantitative methods malfunction during the August 2007 as perceived by the literature nowadays. It is further important to underline the fact that in the time when this thesis was compiled (i.e. beginning second half of the 2008), there were scarce literature sources describing the today's Financial Crisis as it was still developing and emerging.

It is important for us to describe the origins of the crisis as perceived nowadays, 18 months after the Crisis emerged in the form of sub-prime mortgage crisis in the August 2007. Development set in August 2007 continued since then and escalated in September 2008. From this date we were experiencing the Crisis in our everyday life. The Crisis is perceived as failure of the financial markets – and that is where we can see that financial markets are very vulnerable to shocks that affect more important players, such as large hedge funds that manage portfolios consisting of large number of assets traded on these markets. As we will see in Chapter 2, in the descriptive part of the quantitative methods performance during the September 2007, based on the existing literature – many funds employed very similar strategies and had portfolios consisting of very similar or

identical assets. Together with increasing leverage employed, the fluctuation of the market caused considerable losses to the most of the funds. These funds were not able to avoid these losses, and strategies that generated profits in the last periods were unable generate profit any more – especially after September 2008 when all the markets began fluctuating. It is therefore important to understand the sources of the crisis to be able to investigate whether there was possible to find some strategy generating profit despite market fluctuations.

2.1 Sub-prime mortgage crisis – beginning of the Financial Crisis

In this section, we will focus on description of the events that led to the sub-prime mortgage crisis as the first degree of the financial crisis. In order to describe these events, we must also describe development preceding August 2007. From obvious reasons¹, we will focus on US environment.

2.1.1 Description of the sources

The mortgage crisis was caused by the house prices bubble. The prices of the houses in the US were rising through the 90's and continued rising also after 2000. This observed trend set the expectations of the house price movements just to increasing possibility. These expectations were adopted not just by consumers but also by the financial sector that expected just increasing prices over time. With respect to these expectations, the real estate investments were agreed to be the best long-term investment possibility (Case and Shiller (2003)). This investment

¹ The reason is especially amount of literature that focuses on the US, which is caused by the fact:
Of availability of data
Of size of US economy
That crisis emerged in the US in the first place and then spread worldwide.

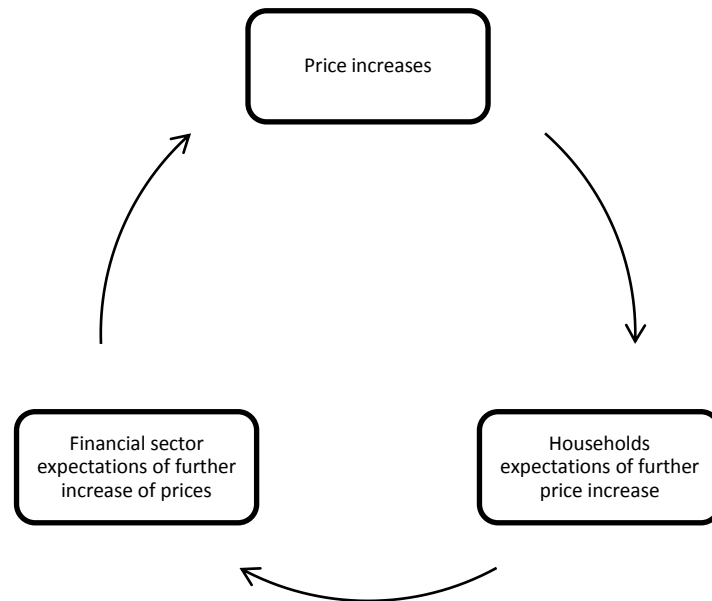
was also perceived as a very safe investment (Baily, Litan & Johnson (2008)). The problem of these expectations was that they lead to other price increases and thus created other expectations of price increase.

The second problem concerning increase of prices, according to Baily, , Litan & Johnson (2008), was that such increase of real-estate prices was not accompanied by corresponding increase of the household income – therefore the house prices rose too high above the income of households.

And the third problem was that nominal interest rates were declining during the corresponding period. This was also accompanied by the decline of real rates (not in such extent as nominal values). However according to Baily, Litan & Johnson (2008), the most relevant factor for the mortgage market is whether the borrower is able to make the monthly payments. Because these payments consist primarily of nominal rates, the nominal rates are the most relevant to the mortgage market. Because of the fall of nominal rates, demand for mortgages increased².

According to Baily, Litan & Johnson (2008), the assets price bubbles are characteristic by self-reinforcing cycles – i.e. price increases lead to more price increases. Furthermore, *“as the level of assets prices moves increasingly out of line with economic fundamentals, the bubble get thinner and thinner and finally bursts”* (Baily, Litan & Johnson (2008)). Then the cycle work in reverse as people get rid of these assets – i.e. prices decline.

² This was the worldwide phenomenon.



Picture 1: Diagram of price increase dynamics

The expansion of the US mortgage market resulted in increase of the amount of subprime or Alt-A and home equity lending (Baily, Litan & Johnson (2008)). As a subprime borrower, we will understand borrower with poor credit history that pays higher interest rate³. Alt-A is slightly better than subprime however not as good as prime borrowers. In 2003, there was 85% share of prime mortgages in whole amount; in 2006 it was amounting only to 52% (Baily, Litan & Johnson (2008)). This was caused by the significant change in lending patterns.

In the period 2001 – 2007 there was modest growth of household income in the US accompanied by decline of saving rate. Furthermore because of the increase of real-estate prices, the household consumption could be financed by home equity loans – i.e. borrowing against rising value of real-estate. Furthermore there was expansion of loan to more risky clients. Because of the increase of

³ Baily, Litan & Johnson (2008)

house prices and changes in lending standards, even low-income clients were provided mortgages with loan-to-value ratio up to 100%. This would normally require high interest rates however it was avoided by adjustable rate mortgages, which had low initial payments lasting up to three years. This was accompanied by possibility of early repayment at no costs. Therefore clients could rely on real-estate price increase in the two or three year horizon. After this period, client could refinance mortgage at more plausible terms⁴. According to Baily, Litan & Johnson (2008), also speculative demand increased together with overall housing demand. Share of adjustable rate mortgages on subprime mortgages increased from 51% to 81% from 1999 to 2006 and the share of adjustable rate mortgages in Alt-A increased from 6% to 70% in this period⁵. The boom in the mortgage market was caused by factors mentioned above, together with legal protection of clients – already mentioned repayment at no costs, in some states if client defaulted, the bank could just seize the house but could not recover losses on him – this led to more extensive moral hazard from the clients perspective. Clients were therefore encouraged to over-borrowing⁵. Further moral hazard undertook brokers and mortgage dealers that were paid based on the volume of loans sold. Therefore they were encouraged to sell mortgage even if they were riskier.

2.1.1.1 Key factors in inflating house price bubble

As stated by Baily, Litan & Johnson (2008), the key factor in inflating the housing bubble was the securitization of subprime mortgages. In this area

⁴ Meaning that after this period and increase of the price the value-to-loan ratio could decrease up to 80%.

⁵ Baily, Litan & Johnson (2008)

concerning securitization of mortgage loans emerged problems of asymmetric information between provider of the mortgage and investor who held the underlying risk. The securitization process ensured enough financial sources to the mortgages providers and therefore further expansion of the market. Availability of sources was among others guaranteed by Government Sponsored Enterprises created by US government as Freddie Mac and Fannie Mae⁶. These Government Sponsored Enterprises bought certain mortgage loans and these purchases were initially financed by issuing bonds. These processes were followed by mortgage-backed securities. Mortgage-backed securities issued by those Government Sponsored Enterprises were risk free in the terms of default risk. Investors faced just interest rate risk and were guaranteed against default risk and pre-payment losses.

In September 2008 government had to nationalize Freddie Mac and Fannie Mae and guarantee their liabilities in order to avoid their bankruptcy⁷. After bubble bursting, they could not cover the losses. These problems were caused by several reasons, as mentioned by Baily, Litan & Johnson (2008) – Freddie Mac and Fannie Mae were encouraged to provide loans to low-income borrowers by Congress in order to meet the goal of affordable living. As they were not limited in the amount of subprime mortgage-backed securities bought⁸, they were broadly affected by house price decline. Government Sponsored Enterprises are perceived as one of the main culprits in the Financial Crisis. However it was

⁶ Federal Home Loan Mortgage Corporation (FHLMC) and Federal National Mortgage Association (FNMA)

⁷ As at September 2008, those Government Sponsored Enterprises held or guaranteed \$5.4 trillion in mortgage debt (Baily, Litan & Johnson (2008)).

⁸ In contradiction to limitation to direct purchases of subprime mortgages

pointed out by Baily, Litan & Johnson (2008) that they lost their share⁹ on the securitization market on behalf of financial sector, which meant more risk and less regulation on the market. Another problem was that much of the sub-prime mortgages were concentrated in the leveraged financial sector.

Further securitization of the securities that combined existing MBS and other asset-backed securities (ABS) such as CDOs contributed to the deepening of the problem for it was possible to create senior AAA rated CDO consisting of low-grade junior tranches of MBS and ABS (Baily, Litan & Johnson (2008)). Such a process was allowed by using credit default swaps or credit insurance in order to obtain better rating, i.e. it was cheaper to insure such security and to pay lower coupon than to issue worse rated one. This caused non-transparency of these securities to the buyer.

The Credit Rating Agencies also contributed to the problem and complicated it as well – especially because their ratings were used as a proxy for the regulators. As described by Baily, Litan & Johnson (2008), agencies used Monte Carlo simulation based on the default data from period 1992 – 2000 to predict the probability of the default. However in this period the default rates were low and the prices of houses were rising. According to Baily, Litan & Johnson (2008) agencies also provided advisory services to CDOs issuers, which created conflict of interest.

Another subject that is marked as one of the culprits of the Crisis is Fed because it kept interest rates at low level for a long time. It is argued by (Baily,

⁹ From 78% in 2000 to 44% in 2006 (Baily, Litan & Johnson (2008)).

Litan & Johnson (2008)) that Fed should have recognized house pricing bubble and increase interest rates before bubble bursting¹⁰. On the one hand, according to (Baily, Litan & Johnson (2008)), part of the economic growth could be therefore sacrificed in order to reduce some of the consequences of the Crises, which exceeded potential costs from the economic growth reduction resulting from the interest rates increase. However, on the other hand, Baily, Litan & Johnson (2008) doubted efficiency of such an increase of the rates because there was substantial inflow of the funds into the US economy which allowed rates to stay at the low level.

Mistakes or inconsistency in regulation and supervision were other sources of the later problems as described by Baily, Litan & Johnson (2008). It was described that Fed as a regulator was aware of erosion of the lending standards however did not undertake appropriate steps to correct such development. Not all providers of mortgages were regulated by Fed but by local state regulation, however Baily, Litan & Johnson (2008) states that Fed could have warned and therefore influence state regulators in order to avoid the erosion of the lending standards.

Another problem was inconsistently applied risk management within banks and financial institutions. As stated by Baily, Litan & Johnson (2008), risk management rules were in place, however they were not applied, managers believed that risky assets were sold and not held (however without any supervision) and these assets were held because they were very profitable.

¹⁰ It was pointed out by Truman (2005) that if there are signs of a price bubbles, the monetary policy should be tightened.

2.1.2 Sub-prime mortgage crisis summary

Based on the literature evidence, we saw that Financial Crisis emerged from the sub-prime mortgage crisis in the US. There were several sources of the sub-prime mortgage crisis as bad adherence of the risk management rules, new off-balance sheet financial instruments such as mortgage backed securities that were badly regulated and understood. Furthermore there existed widespread belief in the house price increase and therefore the mortgage rules were benevolent (in connection with state policy of affordable living) and credit rating agencies assumed just increase in the house prices. Another problem of credit rating agencies was their ambivalent role – they provided advisory services to the clients, as well as rating of their issued assets-backed securities that were combined with mortgage-backed securities and rated far over the mortgage-backed securities rating, which was allowed by credit default swaps and credit insurance. Furthermore during the credit rating process there were used historical constant rates of default, which did not correspond with the reality on the market. The Fed could have increased interest rates (however the outcome was doubtful), could have warned state regulators and could have better enforce adherence with regulations. In conformity with statements above, there are opinions that there are not necessarily to be adopted more restrictive regulatory policies per se. We can therefore see that some of the sources of the Crisis (not all of them) could be avoided if particular agents would have been more consistent in the adherence of the rules that were set or if they were more involved in the process.

2.2 Quantitative methods performance during the Financial Crisis as perceived by literature

We have seen above the sources of the crisis. Now we will have closer look at development of the markets during August 2007. We will describe the analysis of quantitative methods during this period, as perceived by today's literature (we will mainly focus on the description of Lo (2008)).

The beginning of the 2008 Financial Crisis can be found in sub-prime mortgage crisis that culminated in August 2007 and subsequently escalated into the Financial Crisis of 2008. Up to August 2007 there was period in which have happened many unexpected events in the United States¹¹:

“...blow-up of two Bear Stearns credit fund in June, the sale of Sowood Capital Management's portfolio to Citadel after losses exceeding 50% in July, and mounting problems at Countrywide Financial – the nation's largest home lender”
(Lo (2008), Chapter 10, pp. 255)

However these were just consequences of the investment into sub-prime mortgages or credit – related instruments, as described earlier in this thesis. But in August 2007 many US hedge funds experienced unpredictable losses that were caused by fluctuation of the market because these hedge funds mainly invested into equities traded on exchange. In fact, as mentioned by Lo (2008), the hardest

¹¹ We will mainly refer to US economic and companies as the literature used covers mainly these.

hit funds were employing long/short equity market neutral strategies that did not have significant beta exposure that should immunize most of the market fluctuations. The problems of these funds hit were that they used quantitative methods for portfolio management – on 7th August and 8th August these funds were exposed to losses afterwards there was some reverse on 9th August and 10th August that slightly corrected these losses. However some of the fund revised their strategies after 8th August to more risk averse and did not profit from the subsequent reverse. The funds experienced -5% to -30% losses in this four days period. Afterwards these fluctuations steadied.

These were four days that quantitative managed funds experienced and were able to recover. But in 2008 was this event followed by one more persistent and far more significant. Therefore we will now study what the existing literature thinks of sources of the short-term collapse of the financial markets and whether these consequences could be anticipated by quants¹² and hence avoided. Furthermore outcome of the rate of the quantitative methods failure will give us some information about quantitative methods and Financial Crisis that we are experiencing nowadays. For these purposes we will mainly use and quote Lo, Andrew W. (2008): *Hedge funds: An analytical perspective*, where in Chapter 10, can be found analysis of the quantitative methods based on the period from August 7th to 10th August 2007.

We will now focus on description of Chapter 10 from Lo, Andrew W. (2008): *Hedge funds: An analytical perspective*, as mentioned in the Introduction. Lo in his work tries to simulate a portfolio consisting of US equity titles. The author focused

¹² Managers and funds managed by quantitative methods.

on specific strategies – proposed by Lo and MacKinlay (1990), which were applied in order to examine the impacts of the events of August 6-10, 2007 on long/short equity portfolio. As a long/short equity portfolio are meant these strategies: statistical arbitrage, quantitative equity market neutral, long/short equity and 130/30 or active-extension strategies¹³.

2.2.1 Application of the contrarian trading strategy on dataset

In this section, we will focus on the description of application of the contrarian strategy, as described later in the methodology of this thesis, on the dataset in the period from 1995 – 2007 as published by Lo (2008). In order to study impacts of the market events in August 2007, contrarian trading strategy was applied to all stocks in the University of Chicagos's CRSP database and to stocks within 10 market-cap deciles¹⁴, from January 3, 1995, to August 31, 2007. Detailed theoretical description can be found, as was already mentioned, in the section describing methodology.

After application of the strategy on data from 1995 to 2007, Lo (2008) received following results (we will highlight some of them that were in the interest of the author) – in the first year, i.e. 1995, the strategy would earn 1.38% per day, which means 345% per 250-days year. The only problem was that such outcome could not be reached in 1995 due to several circumstances, such as non-zero

¹³ i.e. strategies, where long position dominates to the short position in ratio 130:30 in favour of long position.

¹⁴ Author used just US common stock with share price between \$5 and \$2,000. The deciles were formed furthermore just twice a year (first trading days in January and July) in order to reduce unnecessary turnover. For 2007 were constructed daily close-to-close returns for stock in CRSP universe as of December 29, 2006 (last trading day of 2006). This finally amounted to 3,724 stock titles in 2007.

transaction costs, price impacts, short sale constraints and other institutional limitations (Lo (2008)). Furthermore the daily turnover of merely 4,781 titles¹⁵ in 1995 was not technically possible. However, as author explained, this strategy was employed in order to be used as a measurement of impact of the market movements in August 2007 relative to its typical performance, so the author was not concerned whether the results were achievable in practice. The relation between profitability and market capitalization was confirmed – i.e. that smaller-cap stocks generally exhibit more inefficiencies and therefore profitability of this strategy was higher in smaller deciles than in larger-cap portfolios¹⁶. Furthermore the decline in average daily returns was identified¹⁷.

Further on unleveraged¹⁸ daily returns of the contrarian strategy were investigated over the 5-week period from July 30 to August 31, 2007. The days of August 7, 8 and 9 appeared to be outliers with losses of 1.16%, 2.83%, and 2.86%, respectively, with cumulative return of -6.85%, which is quite high in comparison with 2006 daily standard deviation of 0.52%. If we notice that many funds employed leverage, this loss was magnified several times. Another outlier emerged was profit of 5.62% on August 10, 2007 that corrected partially previous loss of the strategy. The return for entire week of August 6 was -0.43%, which was not very unusual, according to author. The decile returns showed that some of the intermediate deciles experienced cumulative 3-days returns of -8.09% in decile 3, -9.33% in decile 4, -8.95% in decile 5 and -8.81% in decile 8. However these

¹⁵ The amount of stock in 1995 that satisfied the conditions for being included in the portfolio

¹⁶ In 1995 3.57% in contrast to 0.04%

¹⁷ In 1995 daily return of 1.38%, 2000 daily return of 0.44% and in 2007 0.13%

¹⁸ Unleveraged portfolio return (RegT) R_{pt} and gross investment I_t of the portfolio (1) are given as (Lo (2008):

$$I_t = \frac{1}{2} \sum_{i=1}^N |\omega_{it}|, R_{pt} \equiv \frac{\sum_{i=1}^N \omega_{it} R_{it}}{I_t}$$

losses were to large extent compensated on August 10. As mentioned by author, interesting thing about these losses experienced by hedge funds was that there were no remarkable movements in the market that would explain these losses suffered on August 7 and 8. On August 9 there was loss of S&P 500 of 2.95%, which however did not explain losses of the funds. As explained:

“...explanation for these extraordinary return patterns is that they were the result of broad-based momentum due to a large-scale strategy liquidations, ..., and when the liquidation had run its course, the liquidation-driven momentum turned into a strong burst of mean reversion that caused Friday’s reversal.” Lo (1998), Chapter 10, pp. 271

2.2.1.1 Employing leverage

In the subsequent part, the development in 2007 was compared to the Long Term Capital Management debacle in August 1998. The performance of contrarian strategy in 2007 was compared to the performance of the same strategy in 1998. On August 1998, Russia defaulted on its GKO government bonds, which caused global flight to quality that widened credit spreads and subsequently generated extreme losses to funds. These losses were according to *Lo (2008)* caused by widening credit spreads that generated margin calls, which caused the unwinding of illiquid portfolios, generating further losses and additional margin calls, leading to a fund’s collapse.

Although this seems nearly identical to mortgage sub-prime crisis, the outcome of the analysis of data showed, that based on contrarian strategy, the development in August 1998 did not affect the daily profitability of contrarian

strategy in contrary to August 2007. Such a fact signals, according to author that in 2007 there was greater market integration than in 1998. One of the explanations of the difference between 1998 and 2007 was offered – *in 1998, there were fewer multi-strategy funds and proprietary trading desks engaged in both income arbitrage and long/short equity.* Lo (2008), Chapter 10, pp. 273. Second explanation was that there was not enough large capital employed to influence market significantly in August 1998. Third explanation offered concerned fewer leverage employed in 1998 in comparison to 2007. According to Lo (2008), to some extent all of these interpretations may be correct to some extent.

Lo (2008) further focused on concentration of the funds and equity managed. In 1994 average asset per fund was \$62 million, in contrary in 2007 there was \$229 million average asset managed per fund. These figures however do not include division according to particular strategies – according to Lo (2008), for example number of assets managed by 130/30 funds grew steadily and were expected to continue in such a growth. The problems of the swing of the 130/30 funds was that it impacted long/short equity hedge funds significantly. “Hard-to-borrow” securities were harder to borrow and new securities fell into this group. There was quite high probability that securities chosen by 130/30 funds and quantitative equity market neutral funds for shorting were the same.

So the increase in the number of funds, amount of assets managed and increase in the amount of strategies such as 130/30 implied greater competition and lower profitability, which was confirmed by contrarian strategy case. As explained by the author, in the case of the contrarian strategy was not employed leverage, which explains why there was still inflow of money in reality, when there

was downfall in the profitability – most of the hedge funds used leverage, which enabled them to reach desirable level of the profit.

To see the effect of the leverage, the comparison of the 1998 and other years was made – in order to reach 1998 expected return following leverage value θ^* had to be found:

$$E[L_{pt}] \equiv \frac{\theta}{2} E[R_{pt}] = E[R_{p,1998}], \quad (2.1)$$

$$\theta^* = \frac{2E[R_{p,1998}]}{E[R_{pt}]}, t = 1999, \dots, 2007. \quad (2.2)$$

The number 2 follows from the definition of leverage as the sum of gross the long and short positions (equal in the case of market neutral portfolios) divided by the investment capital. In comparison with 1998, when was leverage ratio 2:1, in 2006 it was almost 8:1.

Subsequently the outcome of the contrarian strategy was modified of the leverage – i.e. by multiplying outcome by $8/2=4$. This meant that funds that employed contrarian strategy and used leverage in August 2007 could be exposed to daily returns of -4.64%, -11.33% and -11.43% on August 7, 8 and 9 respectively. This means that such a fund using leveraged contrarian strategy could lose more than 25% within 3 days. Following days market corrected by leveraged return of 23.67%, however most of the funds cut their risk exposure before this correction.

¹⁹ Lo (2008), Chapter 10, pp. 278

2.2.1.2 The unwind hypothesis

The unwind hypotheses are all hypotheses were mentioned by the author (see later in the text) and lead to the August 2007 development. The fact of such a massive daily downfall of the returns was probably caused (according to Lo (2008)) by the liquidation of one or more sizable neutral equity portfolios, which is supported by the gains reported by exchange indices (S&P 500 and MSCI-ex-U.S.). Such a liquidation was most probably result of the July performance of the portfolio and August 7 – 9 might be, according to Lo (2008), the first days that managers could confront their extraordinary credit losses they suffered in July, which could, according to author, unwind also their more liquid investments such as equity portfolios. Such a development would caused losses of August 7 and 8 and would affect most of the quantitative equity portfolios, because the methods for constructing these portfolios were similar and dataset was identical. Furthermore intermediate-deciles suffered larger losses than the other – these deciles are most attractive to arbitrage funds. As mentioned before, problem was that portfolio managers on August 8, 2007 cut their risks, reduced exposures and lowered leverage, which caused that they were not compensated by the reverse on August 10, 2007. The reversal of 23.67% for leverage contrarian strategy is, according to author evidence that losses of previous 3 days were caused by the liquidation of the portfolios. There were several possibilities of reversal explanation offered – cumulative price impact of the 3 days losses would have created strong trade signals for long/short equity strategies that were exposed to most significant losses. Furthermore price impact of unwind and risk-reduction could revert to some degree. Another explanation was that decrease of the prices would attract

new investors recognized prices were out of equilibrium and could spend significant amount to buy/sell securities for deflated/inflated prices.

2.2.1.3 Illiquidity exposure of the funds

In order to test the possibility of increase in leverage of the funds in response to decrease of the liquidity in long/short equity, the author employed following test based on using monthly returns of each fund in the Lipper TASS database and measuring the funds exposure to illiquidity. Following was computed:

$$\hat{\rho}_{1i} = \frac{(T-2)^{-1} \sum_{t=2}^T (R_{it} - \hat{\mu}_i)(R_{it-1} - \hat{\mu}_i)}{(T-2)^{-1} \sum_{t=1}^T (R_{it} - \hat{\mu}_i)^2}, \hat{\mu}_i = T^{-1} \sum_{t=1}^T R_{it} \quad (2.3)$$

, which was correlation between fund i's return and its lagged return from previous month. According to Getmansky, Lo and Makarov (2004), funds with large $\hat{\rho}_{1i}$ are less liquid.

Afterwards the mean, median were computed by following way for each fund:

$$\hat{\rho}_{at} = \frac{1}{n} \sum_{i=1}^n \hat{\rho}_{1it} \quad (\text{equal weighted mean}) \quad (2.4)$$

$$\hat{\rho}_{bt} = \sum_{i=1}^n \frac{AUM_{it}}{\sum_j AUM_{jt}} \hat{\rho}_{1it} \quad (\text{assets weighted mean}) \quad (2.5)$$

$$\hat{\rho}_{ct} = \text{median}(\hat{\rho}_{11t}, \dots, \hat{\rho}_{1nt}) \quad (2.6)$$

On the outcome, it was found by Lo (2008) that $\hat{\rho}$ was increasing since 2000 and therefore there was increase in the illiquidity exposure of the Long/short equity and

Equity market neutral funds. This outcome was however still lower than the amount of illiquidity in fund such as emerging markets and convertible arbitrage (Getmansky, Lo and Makarov (2004), Chan et al. (2005),(2006)).

2.2.1.4 Testing of connectedness

To test the hypothesis of more interconnected financial markets, the author chose the network view approach based on the calculation of the changes in the absolute values of the correlations between hedge funds indexes (13 categories chosen) over time. The pair wise correlations were then compared in two periods: 1994 – 2000 and 2001 – 2007.

It was found that the correlation increased in the second period and therefore the hedge funds were more connected than before (significant especially in multi strategy category).

2.2.2 Quantitative methods performance during the Financial Crisis as perceived by literature – summary

We have seen many tests and hypotheses stated above, many conclusions of the partial analyses – however what can we say as a whole – can we conclude whether or not the events of the August 2007 were just random fluctuation, which affected unprepared hedge funds, or is it possible that quantitative approach failed as a whole?

As proposed by Lo (2008), the event of August 2007, subsequent to sub-mortgage crisis, were most likely not the impact of the quantitative methods failure but were consequences of many together appealing events. First of all, it seemed

that the events were launched by the liquidation of some of the hedge fund's portfolios as a result of liquidity problems caused by the previous investments into some non-equity portfolios that were influenced by the development on the market caused by the sub-prime mortgage crisis. This liquidation caused on August 7 and 8 decrease of prices and based on contrarian strategy, on August 9, 2007 hedge funds experienced high losses because of the high level of leverage employed and reconsidered their strategies and therefore could not be compensated by the reversal of the prices on August 10, 2007. Such development was also possible because of increased interconnection of the hedge funds as was examined by Lo (2008). Furthermore the funds experienced such considerable losses because of high leverage that multiplied losses of the portfolios merely eight-times. The increased value of leverage was caused, as shown, by the permanently decreasing returns of the stock in the period from 1994 – 2007. The decreased profitability was caused by the increase of the amount of hedge funds between 1998 and 2007.

According to Lo (2008), development in August 2007 was sort of coincidence of many events, on the other hand, Lo (2008) adds that we cannot say that the strategy is successful with just exception of 25-standard-deviation events. Based on Montier (2007), the risk in some markets became endogenous and therefore the players cannot estimate future returns based on historical volatility or better they cannot rely on the information that such estimates are accurate estimates of current risk exposure. Therefore Lo (2008) proposes quantitative methods to be adjusted – especially those market neutral strategies. The measures should be improved of illiquidity measures and should not rely just on volatility measures.

We have seen that, according to Lo (2008), we cannot ultimately say that quantitative approach failed. However what we can say is that at least part of it, relying on particular type of data, failed or malfunctioned. If the equity was hold until August 10, 2007, the funds could eliminate or decline their losses. This could be satisfied by the presumption that the true reasons of the downfall of prices were understood by portfolio managers. However as we can see the reason, why the funds could not recover from losses of August 7 – 9 was the mood on the market caused by the three day unexpected and high losses. Because these funds hold short positions and were selling, they experienced high losses, on contrary funds that hold long positions, ended month in a gentle profit. So the problem was, as seen by us, in the buying losers strategy, which ended in loss because of the mood on the market and before the reversal could come, the portfolio was adjusted. And the second reason was psychological, which caused the adjustment before reversal.

On the other hand, according to our opinion, we cannot say that quantitative methods failed per se in August 2007. It is very tricky to make conclusions just from the one week period malfunction. In the view of recent development in the 2008 and 2009 and market fluctuations we are experiencing nowadays, the outcome of the contrarian strategy could be different based on the longer period. What can be perceived as a problem of the week from August 7 to August 10, 2007 is that the funds decided to adjust positions after three days of losses that were on the other hand magnified by the leverage employed. If the portfolio managers held positions longer, they could have experience reversal of the market that came afterwards.

Furthermore, according to the partial conclusions, we could say that it would be sometimes more suitable to employ together with pure quantitative methods also qualitative methods. However because of the complicated approach concerning qualitative methods and the costs of acquiring necessary information and also the uncertainty of better outcome, we cannot say this would be much of help. Furthermore in the case of the long-term downfall of the whole market, there would probably help neither quantitative nor qualitative method.

3 Methodology

In this part of our thesis, we will describe the methodology that was used during the analysis. We will focus on the description of the dataset used. Furthermore we will describe the time interval in that we observed the data. We will also describe the approaches that were used for the analysis of the data and portfolio construction process description.

3.1 The Dataset

In the analysis we have focused on the analysis of the US stock market, because of the data availability and number of titles that are traded on the US market. The data were downloaded from <http://finance.yahoo.com>. The time period for which we observed the data is 01/1998 – 03/2009. More precisely the period begins on 2nd January 1998 and ends on 31st March 2009.

Into the dataset we have included all titles from NASDAQ 100, NASDAQ Financial 100 and Dow Jones Industrial Average, which sums up to 228 titles after removing duplicit titles²⁰. NASDAQ 100 comprises of stocks of largest non-financial companies on the NASDAQ market based on their market capitalization, NASDAQ Financial 100 comprises of stocks of largest financial companies on the NASDAQ market based on their market capitalization and DJIA comprises of stock prices of 30 largest and most widely held public companies in the US. Therefore

²⁰ In total, there would be 230 titles however 2 companies are traded both on DJIA and on of the NASDAQ indices. Particularly these are shares of Microsoft Corporation (MSFT) and Intel Corporation (INTC)

our data sample is consisting from stocks of largest companies traded - according to their capitalization and public spread.

As was already mentioned, our data sample begins in 01/1998, however this does not apply for all titles for some of them were not traded yet. This means at the beginning of the period, we had 166 companies in our sample and the others were added later because of the missing time series. Furthermore some of the titles had missing values in some dates. For these purposes in order of having consistent time series, we have adjusted values and have replaced missing values by average of the two nearest preceding and subsequent values, i.e.

$$P_t = \frac{P_{t-k} + P_{t+l}}{2} \quad (3.1)$$

, where P_{t-k} denotes the nearest preceding value and P_{t+l} the nearest subsequent value available. In the cases when there were more than 1 values missing, we have decided to replace missing values consistently by the average of the nearest preceding and subsequent prices such that all missing values were the same. This procedure allows us to avoid bias that could be caused in the case of more values missing, because in those cases, the prices would be constant and therefore there would be zero return during missing period, which corresponds to the situation when there is not possible to trade the title. By applying this procedure, we have therefore smoothed the development of the prices in the blank areas of the data series, i.e. including one day missing value meant one more price exactly in-between two nearest prices available. This procedure was more suitable than erasing incomplete days (i.e. those days when there was not complete data for all

titles²¹), which would cause sudden price jumps that would distort time series more than applied smoothing.

For further analysis of the stock and indices prices, we have used close-to-close prices. The initial idea was to apply analysis based on average daily prices consisting of open, close, high and low prices instead of using just close prices, which should ensure us some sort of more real prices because the prices are developing all the day and it is not usually possible to perform trades under close prices. However by application of such a procedure, we have come across problem of autocorrelation of stock returns, which was caused right by this procedure. The values of autocorrelations for particular stock returns can be found in the Appendix. It is obvious that in most cases the autocorrelation of the stock returns was positive and higher if applied average daily prices²². This would therefore distort results seriously. Especially in the case of application of contrarian trading strategy, we would have obtained opposite results – i.e. contrarian strategy would be loss making and opposite strategy based on opposite positions²³ to contrarian strategy would be profit making, based on the average data. This is caused by the fundamentals of the contrarian strategy it self – i.e. it is profit making in cases of not auto-correlated returns of stocks as stated by Lo (2008).

²¹ We must distinguish between not yet complete data (i.e. some titles were not traded yet) and missing observation for some day or period for stocks with previous price history. While missing data were problematic, there was no problem with not yet available data.

²² This statement is valid also for most of the absolute values of autocorrelations.

²³ i.e. such strategy that would recommend to buy long yesterdays winners and sell short yesterdays losers.

3.2 Returns

Now we will move from description of the dataset and its adjustments to description of the methods used in the calculation. Concerning returns, we have calculated daily returns based on the standard method based on formula $r_{it} = \frac{P_{it}}{P_{it-1}} - 1$. This formula was used for calculation of returns of stocks and market indices.

The returns of beta based portfolios were calculated as a weighted average of the returns of particular stocks in portfolio. In our case of equally-weighted portfolios, the weights were equal to $\frac{1}{N}$ and therefore the return of portfolio in time t is equal to average return of stocks in portfolio, i.e.:

$$R_{pt} = \frac{1}{N} \sum_{i=1}^N r_{it} \quad (3.2)$$

, where N is the number of stocks in portfolio and r_{it} denotes return of i th stock in time t .

The returns of contrarian strategy could not be computed by application of the formula above. We had to use the proposed by (Lo (2008)), because there is no net investment in this strategy:

$$R_{pt} = \frac{\sum_{i=1}^N \omega_{it} R_{it}}{I_t} \quad (3.3)$$

, where I_t is defined in the formula (3.8). The application of the formula (3.3) will be mentioned in the text.

In the returns of particular stocks, there were omitted returns from dividend payments from several reasons. First, the price of stock before dividend day is

already influenced by this payment and second, we mainly analyzed equally-weighted portfolios and just their returns, therefore it would be quite tricky to implement dividend payments into the returns. Furthermore if they were included, we would have to adjust the prices of the stocks before dividend day so that the dividends were not included in the returns twice. Another problem concerning dividends was that the data of the dividend payments were not available in the time series at <http://finance.yahoo.com>.

Furthermore we have analyzed our data with assumption of zero-transaction costs and non-existent price impacts, which was important simplification used for the analysis; therefore in real world of transaction costs and possible price impacts, we would obtain different results from those that are presented in the thesis.

3.3 Portfolio construction

In this section of methodology, we will describe portfolio approaches applied on the data. It is important to say that we have not focused on constructing such strategies that would be profitable or less losing than the market benchmark portfolio, during the Crisis; our aim was to compare various **selected** strategies and find out whether some of them would be profitable, less loss-making or less risky. It is also not possible to apply all strategies possible because there are numerous strategies that could be used and analyzed and all these strategies can differ in details based on portfolio manager preferences. There exists extensive literature describing various portfolio management approaches or portfolio analysis.

In our thesis, we mainly focused on the beta based portfolio and contrarian strategy. Both strategies are described in more detail later in the text. We have decided to apply strategies based on betas as it is one of the most basic financial instruments of portfolio analysis. The contrarian strategy was analysed as it is the market making strategy. The outcome of the analysis of Lo (2008) can be found above. In this section, we describe the strategy as proposed by Lo (2008).

3.3.1 Beta based strategies

In the empirical part of our thesis, we have analyzed beta based portfolios, i.e. portfolios created based on the beta coefficient of the stocks. We have first computed betas for all stocks in the data set. As a benchmark, we have used NASDAQ index returns. The betas were calculated on daily basis for the last 123 observations, i.e. 123 days in the past as this almost represents 6 month period. Including just 123 observations into the calculations of betas ensured us further volatility of betas and therefore volatility in the composition of portfolios. Furthermore in case of such low number of observations needed for the calculation of beta, the reaction to price changes was ensured. We have begun our calculation of betas as at 1.7.1998. Furthermore for the portfolio management purposes, the betas from previous day were used (i.e. β_{it-1}). This allowed us to calculate returns of stocks in time t to the portfolio returns because they were not needed for the calculation of betas. For the calculation of beta, we have used following well-known formula (Oh, Kim, Min, Lee (2006)):

$$\beta_{it} = \frac{\text{Cov}(r_i, I_m)}{\text{Var}(I_m)}, \quad (3.4)$$

Where r_i denotes return of i th stock for given period and I_m denotes the return of market benchmark portfolio, in our case NASDAQ index daily returns. Furthermore, the beta of constructed portfolios can be computed as follows:

$$\beta_{pt} = \sum_{i=1}^N \omega_{it} \beta_{it}, \quad (3.5)$$

, where β_{pt} denotes beta of selected portfolio in time t , ω_{it} denotes weight of i th stock in the portfolio in time t and β_{it} is beta of stock in the portfolio in time t (Chincarini, Kim (2006)). Because in cases of beta-based portfolios, we use equally-weighted method, for our purposes, the beta coefficient can be expressed as follows:

$$\beta_{pt} = \frac{1}{N} \sum_{i=1}^N \beta_{it}, \quad (3.6)$$

, where each individual weight ω_{it} of stock i in time t in the portfolio is equal to $\frac{1}{N}$. N denotes number of stocks currently in the portfolio in time t .

As was already mentioned, the stocks were selected into the portfolio based on their beta, more specifically on their beta range, because it would be difficult to select shares that have for example beta equal exactly to one. We have therefore selected spread of 0.1 from the selected value of beta desired.

3.3.2 Contrarian strategy

Now we will describe in more detail *Contrarian trading strategy* as proposed and applied by Lo (2008). The application of this model and its outcome, as described by Lo (2008), based on the data from the period of the financial crisis can be found above in the text, where it was discussed in connection of the

quantitative methods analysis during the Financial Crisis. Now let's describe this strategy in more detail:

Let's have a set of N securities and considered a long/short market neutral equity strategy that consists of an equal dollar amount of long and short positions and at each rebalancing interval long position consists of losers and short positions consists of winners²⁴. Now let's ω_{it} denote weight of stock i in time t then for some $k > 0$ we have:

$$\omega_{it} = -\frac{1}{N}(R_{it-k} - R_{mt-k}), \text{ where } R_{mt-k} \equiv \frac{1}{N} \sum_{i=1}^N R_{it-k} \quad (3.7)$$

For the purposes of the analysis set $k = 1$, i.e. 1 day, which means buying yesterday's loser and selling yesterday's winner. This means in fact speculation on drop of the price of winner and raise of the price of loser – “... such a strategy bets on mean reversion across all N stocks, profiting from reversals that occur within the rebalancing interval” (Lo (2008), Chapter 10, pp. 261). This strategy has also implications in providing liquidity to the market, stabilizing supply/demand imbalances and reducing market volatility. According to Lo and MacKinlay (1990) in the times of positively autocorrelated returns, contrarian trading strategy will record negative profit, which is also case of all market-making²⁵ strategies in case of trends in prices. This strategy can serve as an indicator of broad-based strategy liquidations of long and/or short positions. Another property of the weights is that

²⁴ i.e. underperforming stock and outperforming stock, respectively, in comparison to the market performance.

²⁵ contrarian trading strategy was initially used by market makers such as NYSE/AMEX and NASDAQ and were compensated for this role through bid/offer spread (Lo (2008))

they sum to 0, therefore contrarian trading strategy is arbitrage strategy and dollar neutral positions²⁶.

If we want to analyze returns of contrarian strategy based portfolio, classical approach cannot be applied as there is no net investment. However return of such a strategy can be computed as profit and loss of the strategy's position over the interval dividend by the initial investment. For the unleveraged portfolio the formula is according to Lo (2008) as follows:

$$I_t = \frac{1}{2} \sum_{i=1}^N |\omega_{it}|, R_{pt} = \frac{\sum_{i=1}^N \omega_{it} R_{it}}{I_t} \quad (3.8)$$

, where I_t denotes the gross dollar investment and R_{pt} portfolio return.

3.4 Portfolio performance and risk comparison

For the basic comparison of the riskiness of the portfolios we have used volatilities in particular years. For the calculation of volatility, we have used following formula:

$$\sigma = \sqrt{\text{var}(r_p)} \quad (3.9)$$

, which is square root of portfolio daily returns variance, i.e. standard deviation of daily returns of portfolio for the given period.

For the further comparison of the portfolios performance, we have applied Sharpe ratio (Sharpe (1994)), which can be also referred to as "reward-to-

²⁶ It does not imply that the strategy is also market neutral. For example portfolio consisting of long position of \$100 million with high beta exposure and short position of \$100 million with low beta exposure is dollar neutral but not market neutral and will have positive market-beta exposure (Lo (2008)).

variability” ratio. The ratio measures the compensation of the risk by the return of the asset (in our case of portfolio). The Sharpe ratio can be calculated as follows:

$$S = \frac{r_p - r_f}{\sigma} = \frac{r_p - r_f}{\sqrt{\text{var}(r_p - r_f)}} \quad (3.10)$$

, where r_p denotes return of the portfolio and r_f return of risk-free asset. Term $r_p - r_f$ denotes excess return of the portfolio over the risk-free asset.

For the purposes of comparison of our portfolios, we have used average daily returns of the portfolios and risk-free asset for the period of the Financial Crisis so that we obtained the Sharpe ratio for the whole period. The volatilities were calculated on the data for the whole period of the Financial Crisis²⁷ as well.

The Sharpe ratio will be used later in the text just in the sections of performance analysis of the Negative beta portfolios and in portfolios performance comparison during the Financial Crisis.

²⁷ i.e. for the period that falls in the Financial Crisis period (in our case 10/2007 – 03/2009).

4 Empirical results

In this section, we will describe and compare the results obtained by the analysis of the data. We have applied several strategies of the portfolio management. We have created portfolios based on the betas of stocks updated on daily basis and we have applied contrarian trading strategy, as described above. We have created and observed *Beta 1 portfolio* that was consisting of stocks with beta within 0.9 and 1.1, *Beta 0.5 portfolio* that was consisting of stocks with beta within 0.4 and 0.6, and *Negative beta portfolio* that was consisting of stocks with negative betas.

As an assumption of our thesis, an investor investing into the *Beta 1 portfolio* could expect the profit and risk similar to the market one. An investor investing into the *Beta 0.5 portfolios* could, on one hand, expect less profit during the periods of growth, on the other hand, he could expect to suffer lower losses during the periods of decline and Crisis. We will further compute negative beta portfolio that would be rather a benchmark. We expect the portfolio to be losing during the periods of growth and therefore there is expectation that no one would invest to such a portfolio. On the other hand, negative beta portfolio will be interesting during the Crisis period when it is supposed to grow while the market is falling. The *Negative beta portfolio* would become therefore interesting to an investor in the times of Crisis. An investor interested in investment into the *Contrarian portfolio* would expect daily reversals of the prices, which will be analyzed further.

In the description of the results, we will also compare daily returns of portfolios with daily returns of the market benchmark portfolio, i.e. of the returns of

the NASDAQ index. Furthermore, we have decided to create also portfolios based on the betas calculated based on the average price returns, as described above, in the methodology. However returns of such portfolios were calculated based on close-to-close price returns²⁸. These portfolios will be hereinafter referred to as *Beta X alternative portfolio*, where *X* denotes the value of beta selected.

For the purposes of the comparison with the benchmark market portfolio returns, we have decided to set the value of the Nasdaq index at the beginning of the observed periods to 1. This was also applied to all portfolios observed so that we could compare the 1\$ investment development through the period observed. The comparison of the results can be found later in the text.

4.1 The market portfolio

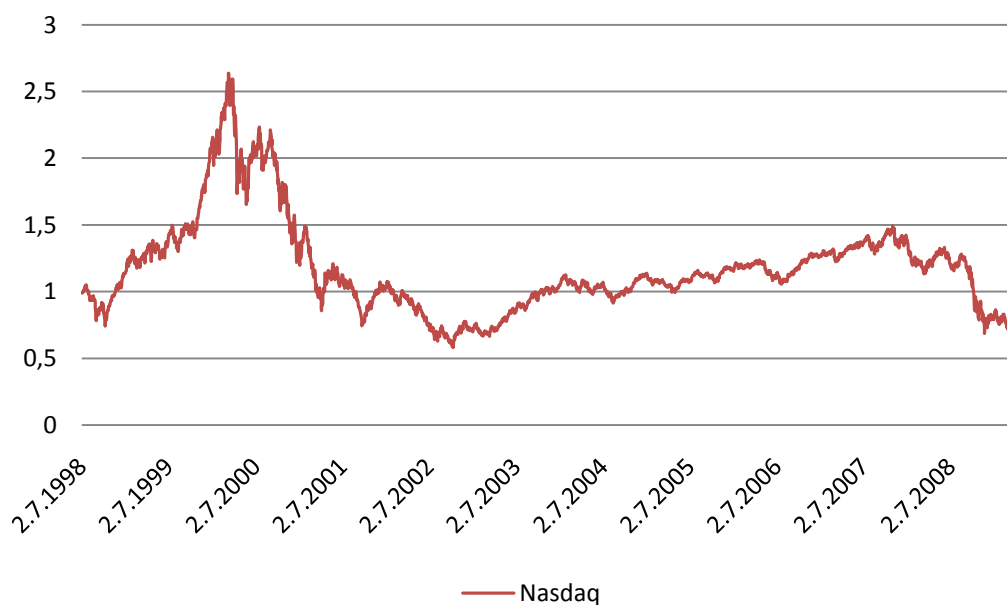
In this section, we will describe the development of the benchmark market portfolio based on NASDAQ index daily returns. From the Chart 4.1-1, we can see that if we omit short/term fluctuations of the prices, we have obtained two major periods of growth and two periods of decrease.

We can see that the first growth period was quite steep and also followed by steep fall – with its peak of 2.64\$ on 10th March 2000 (see Chart 4.1-1), which represented growth of 164% within year and a half. However, this steep growth was followed with fall of -77.96%, from the peak value, to the minimal price of 0.58\$ on 9th October 2002. Measured from the initial investment, the loss was -

²⁸ I.e. portfolios based on $\beta_{it}^{avg} = \frac{Cov(r_i^{avg}, I_m^{avg})}{Var(I_m^{avg})}$, and their returns calculated from close-to-close price returns, where upper index *avg* denotes that average daily prices (high, low, open and close) were used for the calculation.

42%. This period was then followed by longer but moderate growth period from 9th October 2002 to 31st October 2007 with peak of 1.49\$ and growth (measured from the 9th October) of 157%. These five years of growth were then replaced by the fall caused by the financial crisis we are experiencing nowadays.

Chart 4.1-1: Benchmark portfolio 1\$ investment price development



In the next sections of this thesis, we will compare performance of the selected portfolios to the performance of the benchmark market portfolio, which will be in the charts and tables hereinafter referred to as Nasdaq. The main interest, as was already mentioned, is whether our portfolios were able to outperform the market, i.e. were more profitable or less loss making in certain periods with focus on the period of Financial Crisis.

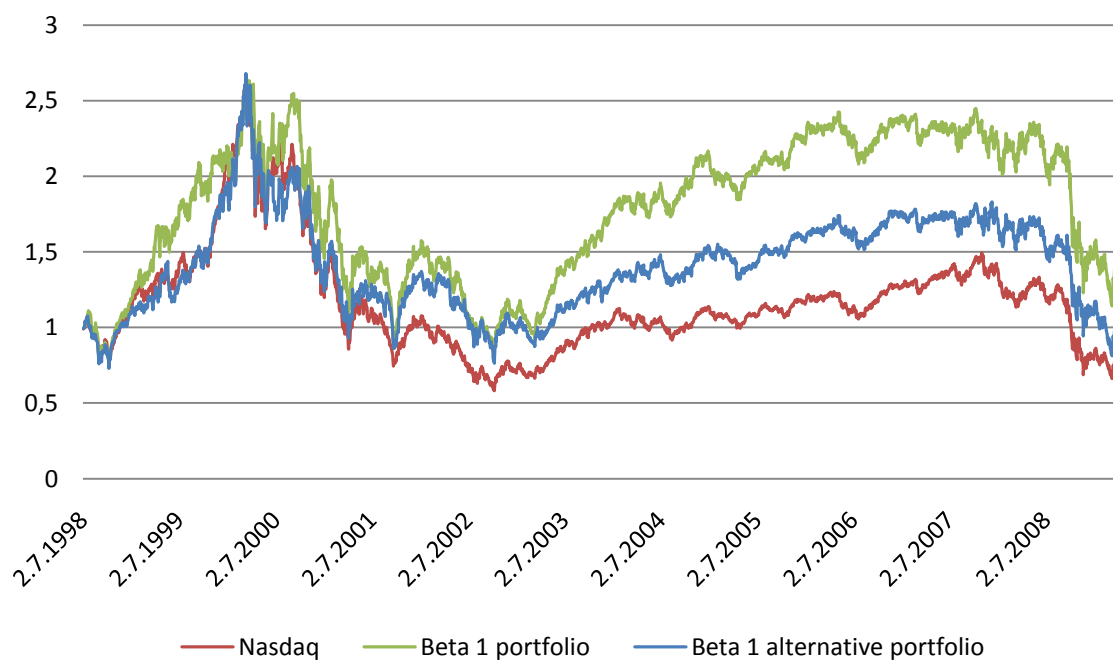
4.2 Beta 1 portfolio

This portfolio was based on the betas that were between 0.9 and 1.1 including both end-values. As beta is a measure of correlation of *i*th stock's return

to the return of the market, the value of portfolio consisting of stocks with beta within 0.9 to 1.1 means that the portfolio returns should more or less follow the returns of the benchmark market portfolio. The portfolio was equally-weighted without leverage employed. Now we will describe the outcome obtained by the analysis.

Analyzing the 1\$ investment in the *Beta 1 portfolio* at the beginning of the time period for which we have observed the data (2nd July 1998 – 31st March 2009), we can see that as at 31.3.2009 this investment would be worth 1.41\$, which means growth of 41% over almost 11 year period. However if we divide the period into smaller intervals, we can see that there were periods of growth and periods of decrease. Those periods were furthermore similar to the growth and decline periods of the market portfolio, as described above. However looking at the charts, we can see that there were some differences. We will now describe these periods in more detail.

Chart 4.2-1: Beta 1 portfolios 1\$ investment development 07/1998 - 03/2009



Despite similar development and following major break-even points, *Beta 1 portfolio* was able to outperform the market portfolio for the whole period, as can be seen on the Chart 4.2-1, above. The important findings is that after looking at the period of growth from 09/2002 – 09/2007, we can see that our portfolio consisting of betas within values of 0.9 and 1.1 was able to outperform the market (see Chart 4.2-2 bellow). And even during the 2007/2009 crisis, our portfolio was doing slightly better than the market portfolio, as can be seen from Chart 4.2-3 bellow.

Table 4.2-1: Average number of stocks in Beta 1 portfolios and number of stock in the sample

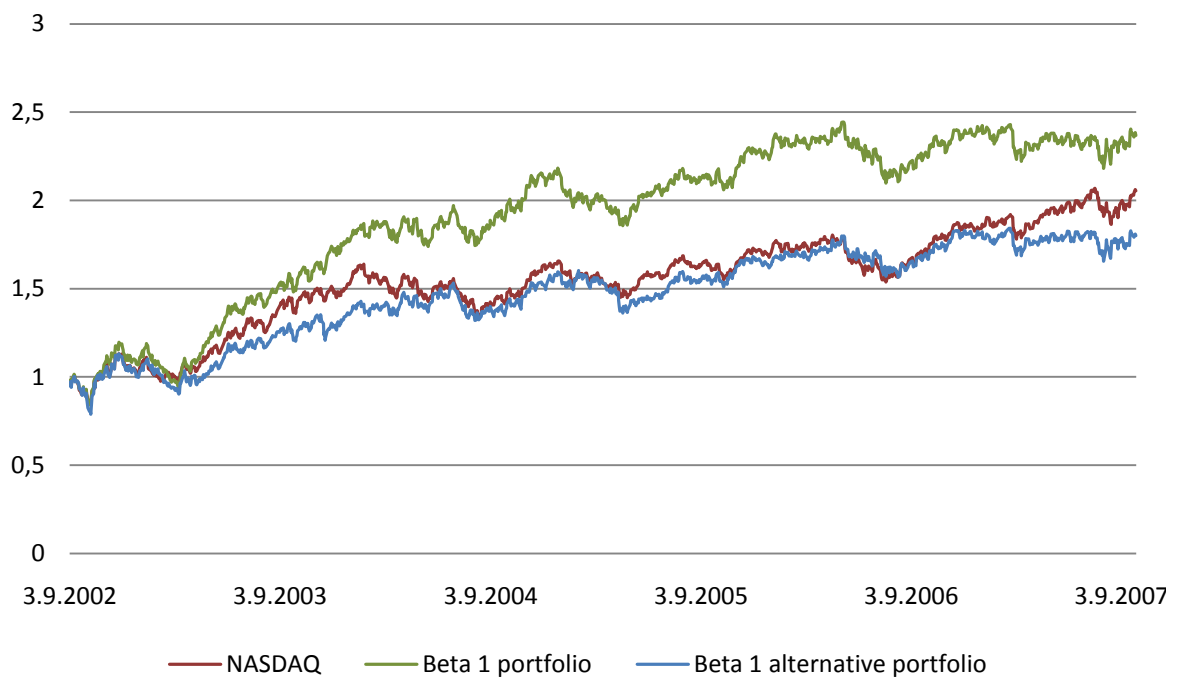
Year	Number of stocks in portfolio		
	Sample	<i>Beta 1 portfolio</i>	<i>Beta 1 portfolio adj</i>
1998	176	22	20
1999	188	11	12
2000	194	12	13
2001	200	11	11
2002	204	15	13
2003	212	25	18
2004	215	27	16
2005	223	39	34
2006	226	41	37
2007	228	50	51
2008	228	52	45
2009	228	67	65

Furthermore we have compared the performance of two similar strategies, both based on betas with values within 0.9 and 1.1 but constructed on differently measured returns. *Beta 1 portfolio* is denoted portfolio created based on close-to-close prices and *Beta 1 alternative portfolio* is denoted portfolio created based on average daily prices; daily returns of portfolios were measured based on close-to-

close price returns. The average number of stocks in portfolios in each year can be found in the Table 4.2-1, above.

As we can see from the charts, *Beta 1 portfolio* was doing better than *Beta 1 alternative portfolio*, which indicated that portfolios based on betas calculated from average daily price returns pick worse stocks than those based on betas calculated from close-to-close returns²⁹.

Chart 4.2-2: Beta 1 portfolios 1\$ investment development 09/2002 - 09/2007

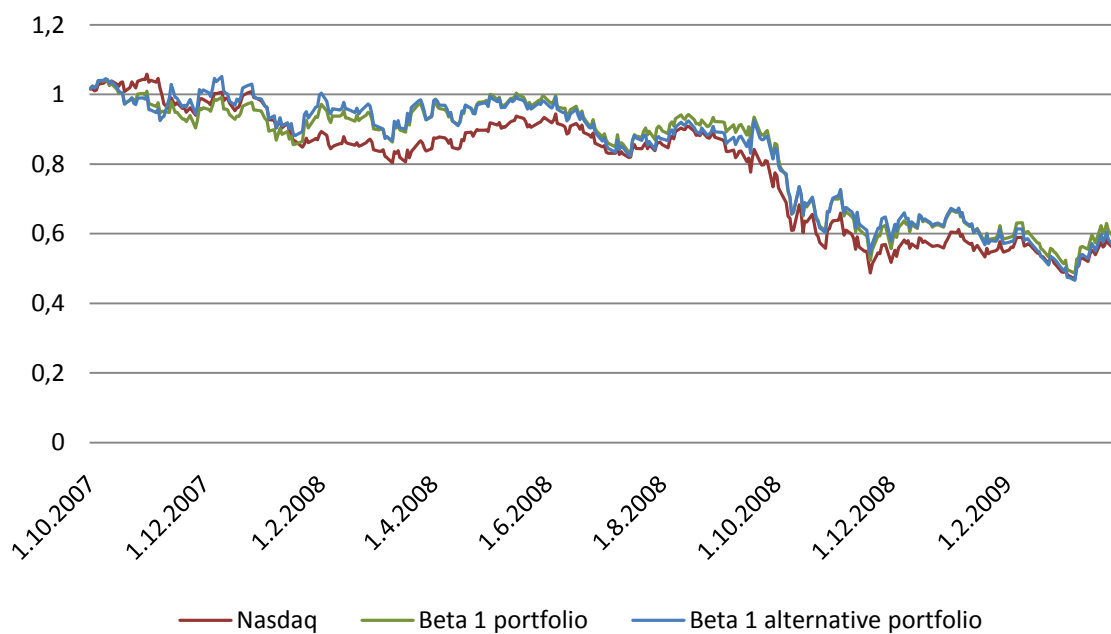


The difference was apparent during the period of growth, when the *Beta 1 portfolio* was doing better than *Beta 1 alternative portfolio*, which was however doing better than market, see Chart 4.2-2. In the period of the Financial Crisis, both portfolios had similar development and performance, as can be seen from the

²⁹ Important notion is that both portfolios returns were calculated based on returns calculated from close-to-close prices because of the autocorrelation problem caused by employment of returns calculated from daily average prices (see Methodology).

Chart 4.2-3³⁰ and did slightly better than the market. From the Charts 4.2-2 and 4.2-3, we can therefore see that the *Beta 1 portfolio* was able to outperform both the market and the *Beta 1 alternative portfolio* in the periods of growth and was more or less the same in the periods of decline of the market.

Chart 4.2-3: Beta 1 portfolios 1\$ investment development 10/2007 - 03/2009



We have also compared number of observations, when our portfolios outperformed market – *Beta 1 portfolio* outperformed market in 1394 cases out of 2703 which represents 51.57%, *Beta 1 alternative portfolio* outperformed the market in 1374 cases out of 2703 which amounts to 50.83%. In the growth period it was in 50.78% cases for *Beta 1 portfolio* and 49.92% for *Beta 1 alternative portfolio*. Furthermore *Beta 1 portfolio's* daily returns outperform *Beta 1 alternative portfolio's* daily returns in 1906 cases out of 2703, which represents 70.51%.

³⁰ In both periods were compared initial investments of 1\$ beginning at the beginning of each of the period.

We can see from these numbers that while comparing market daily returns to one of the portfolios, it is 50:50 with scales slightly on the side of portfolios. However in case of comparison of two portfolios, we can see that *Beta 1 portfolio* based on close-to-close prices was doing better than *Beta 1 alternative portfolio* in 70.51% of the cases, which corresponds to the situation on the charts.

Table 4.2-2: Daily returns and volatility comparison

Year	Average daily returns			Volatility		
	Nasdaq	<i>Beta 1 portfolio</i>	<i>Beta 1 portfolio adj</i>	Nasdaq	<i>Beta 1 portfolio</i>	<i>Beta 1 portfolio adj</i>
1998	0.13%	0.16%	0.10%	0.021	0.023	0.021
1999	0.26%	0.27%	0.24%	0.017	0.021	0.020
2000	-0.15%	-0.08%	-0.10%	0.031	0.032	0.034
2001	-0.06%	0.03%	0.07%	0.027	0.032	0.031
2002	-0.13%	-0.11%	-0.10%	0.022	0.024	0.023
2003	0.17%	0.21%	0.14%	0.014	0.015	0.016
2004	0.04%	0.09%	0.07%	0.011	0.012	0.012
2005	0.01%	0.02%	0.01%	0.008	0.009	0.010
2006	0.04%	0.03%	0.05%	0.009	0.010	0.010
2007	0.04%	-0.02%	0.00%	0.011	0.012	0.014
2008	-0.17%	-0.11%	-0.12%	0.026	0.028	0.028
2009	-0.01%	-0.08%	-0.16%	0.028	0.032	0.033

Average daily returns and volatility of daily returns, measured as standard deviation, of the portfolios in particular years can be found in the Table 4.2-2 above. We can further see from the Table 4.2-2 that the volatilities of the portfolios were slightly higher than those of the benchmark market portfolio.

4.3 Beta 0.5 portfolio

We will now describe the results of the Beta 0.5 portfolios analysis. Stocks with beta of 0.5 should be less affected by the fluctuations of the market – they should react less to the positive but also negative fluctuations. We have analysed the portfolios based on close-to-close price returns and on average price returns. We have used the close-to-close price returns for the calculation of the portfolios returns. Both portfolios were equally weighted and without any leverage employed.

Analyzing 1\$ investment from the beginning of the period of 2nd July 1998 – 31st March 2009, we can see that that overall both Beta 0.5 portfolios were above the market after 13th December 2000, as can be seen on Chart 4.3-1.

Chart 4.3-1: Beta 0.5 portfolios 1\$ investment development

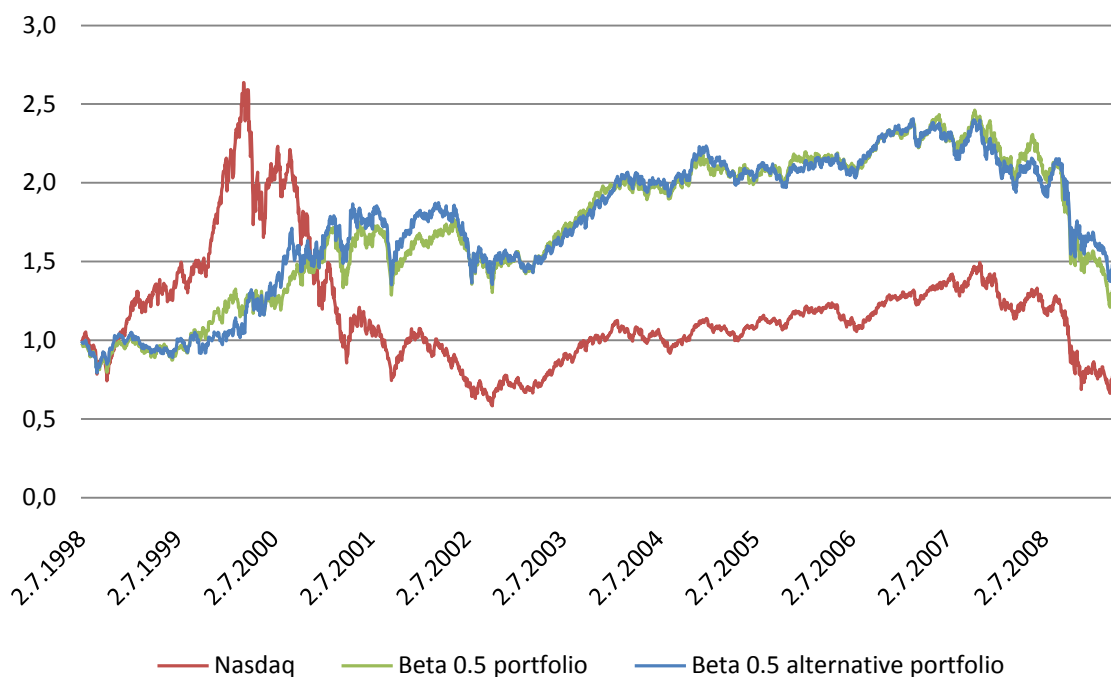
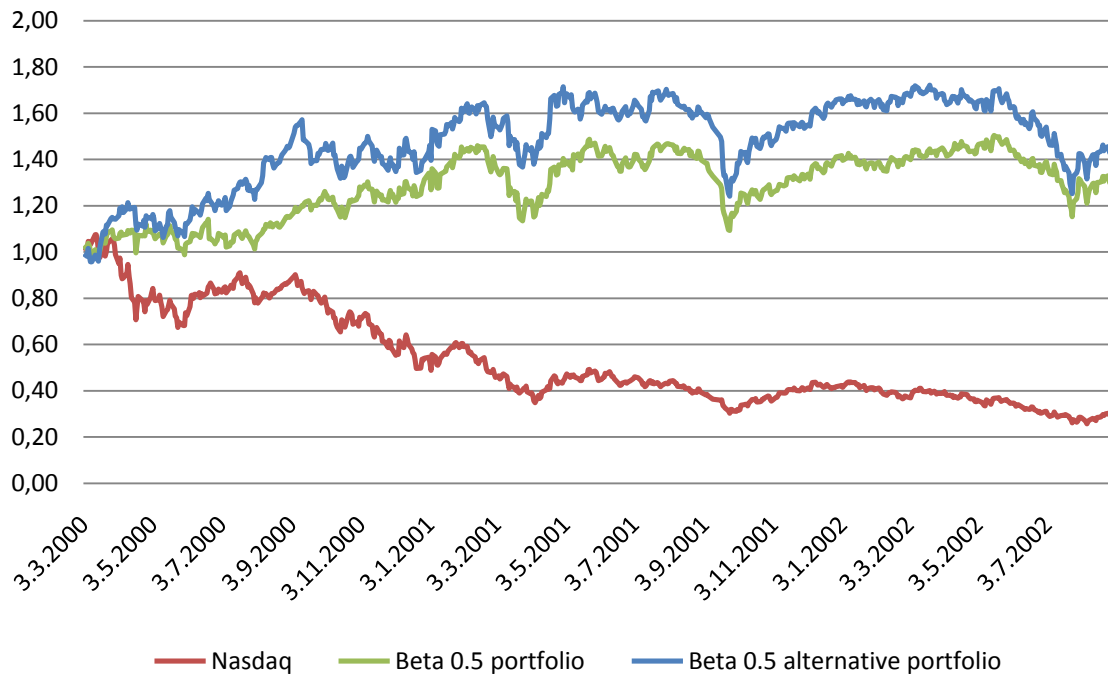


Chart 4.3-2: Beta 0.5 portfolios 1\$ investment development 03/2000 - 07/2002



However the fact that the price of the portfolios was above the market portfolio price was caused by the growth of portfolios during the period from 1st March 2000 to 30th August 2002, as can be seen from the Chart 4.3-2, above.

We can see that despite the decline of the market portfolio, both Beta 0.5 portfolios were growing and furthermore *Beta 0.5 alternative portfolio* was above the *Beta 0.5 portfolio*, i.e. the portfolio based on the average price returns was above the portfolio based on close-to-close returns. Looking at Chart 4.3-3, we can see that in the period from 09/2002 to 09/2007, both portfolios were below the market portfolio, i.e. were not able to identify growth opportunities at least as well as the market portfolio. And from Chart 4.3-4, we can see that the portfolios were falling slightly less than the market in the period of Financial Crisis that we have analyzed (again the *Beta 0.5 alternative portfolio* was doing better than the *Beta 0.5 portfolio* in the end).

Chart 4.3-3: Beta 0.5 portfolios 1\$ investment development 09/2002 – 09/2007

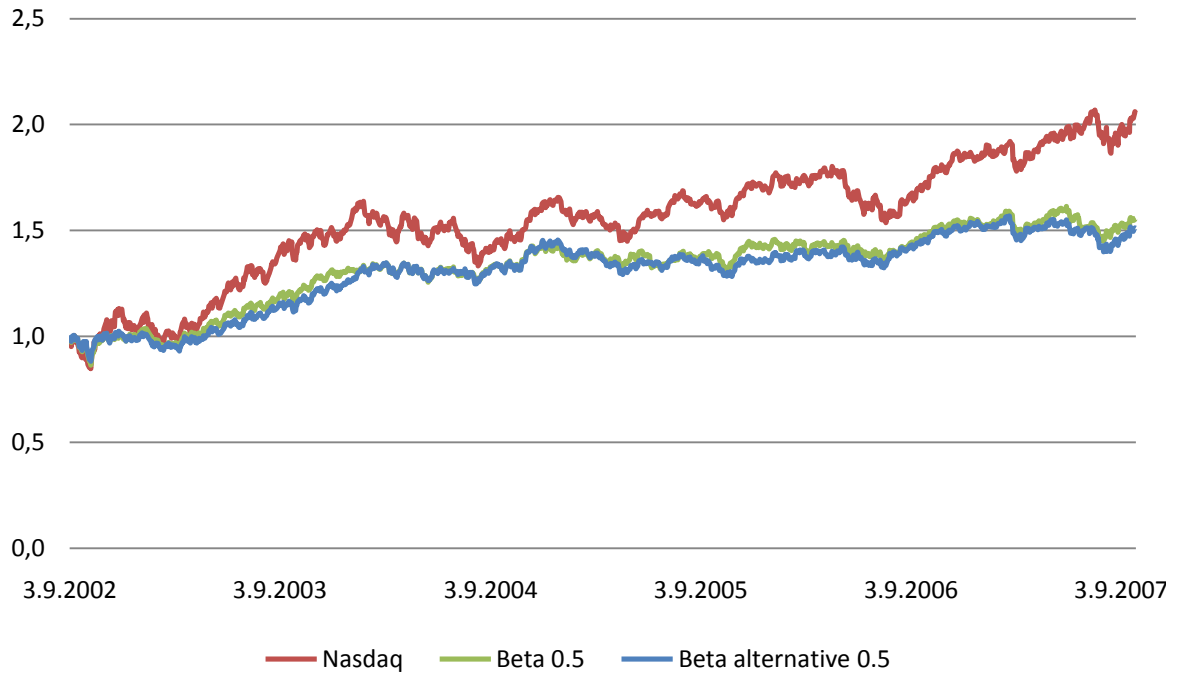
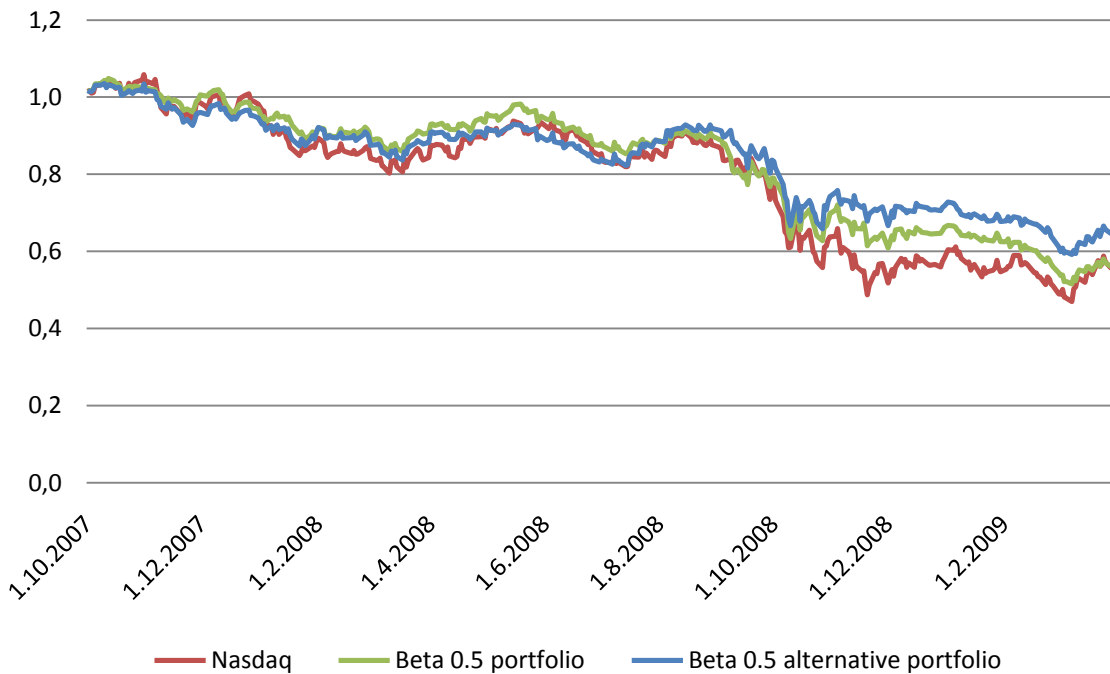


Chart 4.3-4: Beta 0.5 portfolios 1\$ investment development 10/2007 – 03/2009



From the Table 4.3-1 can be seen that Beta 0.5 portfolios rather underperformed market portfolio average daily returns (see below). From

comparison of the average daily returns of two Beta 0.5 portfolios we were analysing, can be seen that *Beta 0.5 alternative portfolio* did better than *Beta 0.5 portfolio* in 7 out of 11 years of observation. The volatilities and therefore risks of the two portfolios were almost the same through the period. In comparison to the market, from Table 4.3-1, we can see that both portfolios were less risky according to their volatilities in particular years. Furthermore, we can see that the number of titles in portfolios was decreasing and it was problem in the years of the recent financial crisis. As we can see, the average number of titles in 2009 was 10 and 9 in *Beta 0.5 portfolio* and *Beta 0.5 alternative portfolio*, respectively.

Table 4.3-1: Beta 0.5 portfolio comparison

Year	Average daily returns			Volatility			Average number of titles in portfolio		
	Nasdaq	<i>Beta 0.5 portfolio</i>	<i>Beta 0.5 portfolio adj</i>	Nasdaq	<i>Beta 0.5 portfolio</i>	<i>Beta 0.5 portfolio adj</i>	Sample	<i>Beta 0.5 portfolio</i>	<i>Beta 0.5 portfolio adj</i>
1998	0.13%	0.02%	0.03%	0.021	0.015	0.014	176	29	28
1999	0.26%	0.09%	0.01%	0.020	0.010	0.010	188	22	24
2000	-0.15%	0.11%	0.19%	0.031	0.019	0.021	194	16	14
2001	-0.06%	0.04%	0.07%	0.027	0.019	0.019	200	27	19
2002	-0.13%	-0.02%	-0.06%	0.022	0.015	0.015	204	38	35
2003	0.17%	0.11%	0.10%	0.014	0.009	0.010	212	44	46
2004	0.04%	0.04%	0.06%	0.011	0.007	0.008	215	44	55
2005	0.01%	0.00%	-0.03%	0.008	0.007	0.006	223	26	35
2006	0.04%	0.04%	0.05%	0.009	0.006	0.006	226	33	37
2007	0.04%	-0.01%	-0.02%	0.011	0.008	0.008	228	21	25
2008	-0.17%	-0.13%	-0.09%	0.026	0.019	0.020	228	15	18
2009	-0.01%	-0.24%	-0.15%	0.028	0.016	0.016	228	10	9

4.4 Negative beta portfolio

In this section, we will discuss the outcome of the Negative beta portfolios. Price of Negative beta portfolios should develop in opposite to the market portfolio,

therefore while market portfolio growing, the *Negative beta portfolio* should be falling.

Table 4.4-1: Average number of titles in portfolios

Period	Length of period	Negative beta	Negative beta alt
02. 03.1999 - 29. 07.2002	857	11	11
27. 01.2003 - 04. 02.2004	564	2	2
12. 05.2004 - 16. 05.2005	255	1	2
25. 10.2005 - 13. 07.2006	180	2	2
13. 11.2007 - 12. 05.2008	124	1	1

Negative beta portfolios are quite specific because in our sample, it was very problematic to choose enough number of titles into our portfolios –we have missing obtained values of returns of Negative beta portfolios in the time period and therefore we did not have joint series of the prices available. It was a problem in some periods to pick stocks with negative betas into the portfolios. Despite lack of titles with negative betas in some periods, we will describe the outcome in the longer periods, where were enough titles available³¹. In such cases that the time series were interrupted by few³² missing daily returns, we have replaced these returns by zero value so that we have received joint series. Furthermore it is important to notice low number of titles that could be placed into the portfolios in described periods. Average numbers of titles in portfolios in particular periods can be found in Table 4.4-1. We can see that except the first period from 2nd March 1999 to 29th July 2002, the average number of titles was 1 or two. Except period

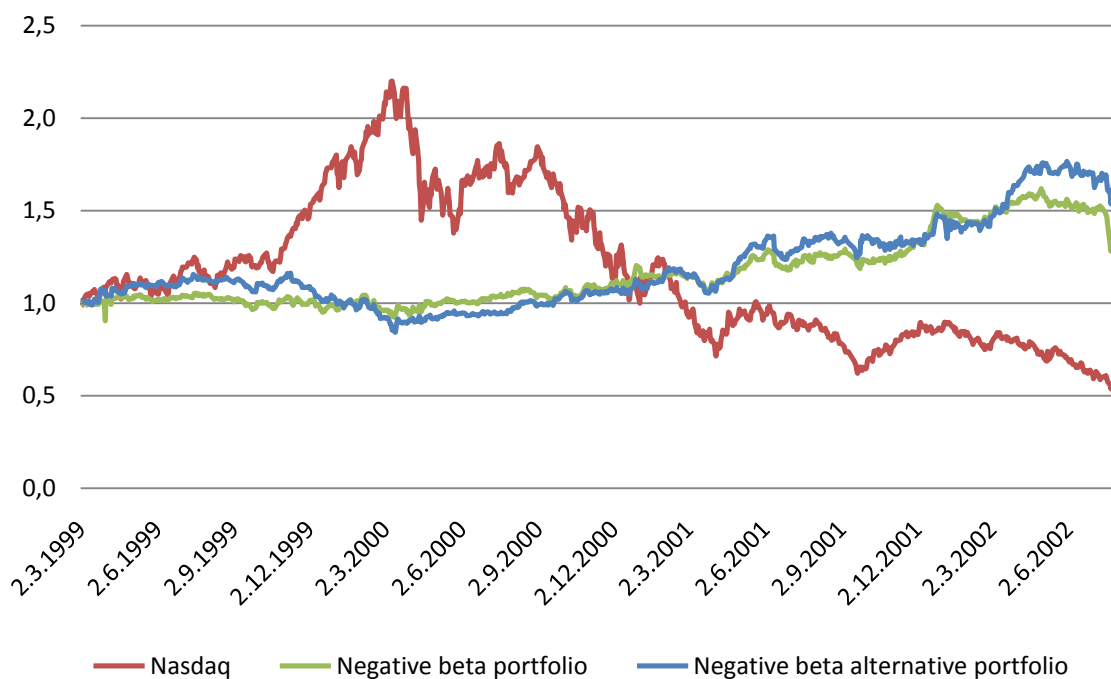
³¹ By enough titles we mean in this case at least one title so that it was possible to obtain portfolio return.

³² i.e. up to three

from 12th May 2004 to 16th May 2005 both portfolios contained the same average number of titles.

Looking at the Charts 4.4-1 to 4.4-5, we can see that mostly portfolios had very similar development through the periods. However in the period from 27th January 2003 to 4th February 2004, the *Negative beta portfolio* was in the second half able to outperform the market as well as the *Negative beta alternative portfolio*, which was under the market for the whole period (see Chart 4.4-2).

Chart 4.4-1: Negative beta portfolios 1\$ investment development 03/1999 - 07/2002



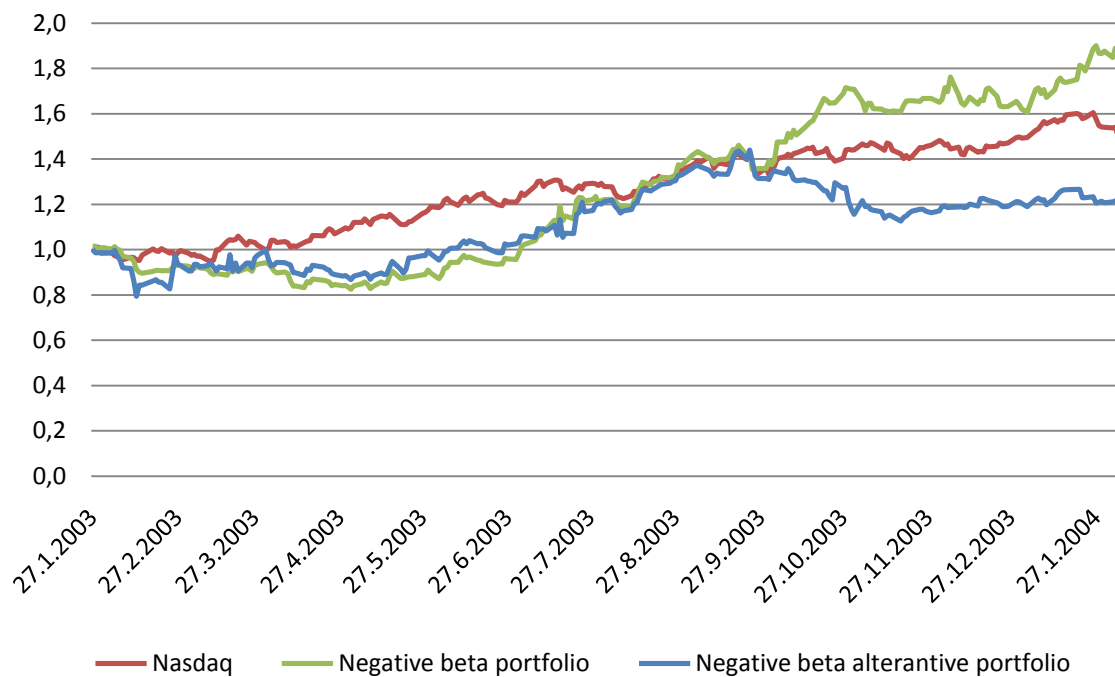
The volatilities of the daily returns of the portfolios and the Sharpe ratios, of the both the market portfolio and Negative beta portfolios can be found in the Table 4.4-2. The calculation of the Sharpe ration was based on the average daily excess return over the risk-free asset return, which we have set as 0% for the given period and on the volatilities of the portfolios in the given periods. From the table, we can see that except the second period from 27th January 2003 to 4th

February 2004³³, *Negative beta alternative portfolio* was better choice, according to Sharpe ratio than the *Negative beta portfolio*.

Table 4.4-2: Negative beta portfolios volatilities and Sharpe ratios

Period	Volatilities			Sharpe ratio 0% rate		
	Nasdaq	Negative beta	Negative beta alt	Nasdaq	Negative beta	Negative beta alt
02. 03.1999 - 29. 07.2002	0.0253	0.0120	0.0119	-0.0124	0.0395	0.0592
27. 01.2003 - 04. 02.2004	0.0133	0.0181	0.0227	0.1247	0.1420	0.0454
12. 05.2004 - 16. 05.2005	0.0096	0.0212	0.0196	0.0179	0.1718	0.1982
25. 10.2005 - 13. 07.2006	0.0089	0.0239	0.0161	-0.0140	0.1338	0.1896
13. 11.2007 - 12. 05.2008	0.0156	0.0306	0.0306	-0.0118	-0.0973	-0.0973

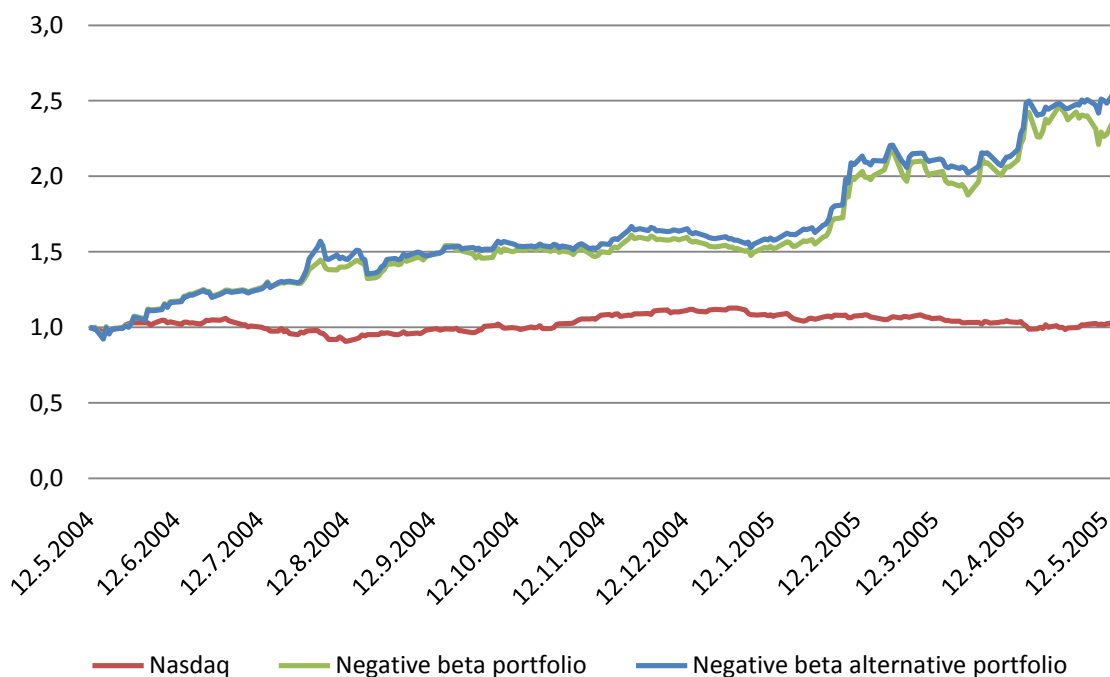
Chart 4.4-2: Negative beta portfolios 1\$ investment development 01/2003 - 02/2004



³³ The choice of the Negative beta portfolio over the Negative beta alternative portfolio also corresponds to the Chart 10 as was described above.

Furthermore, we can see that in all periods except the last period *Negative beta portfolio* was chosen over the market portfolio according to Sharpe ratio. The Choice of the market portfolio over both Negative beta portfolios can be also tracked in the Chart 4.4-5, where we can clearly see that the market benchmark portfolio was able to outperform both Negative beta portfolios. Another interesting thing about Chart 4.4-5 is that both *Negative beta portfolio* approaches identified the same titles into the portfolio so that both portfolios had the same return over this period.

Chart 4.4-3: Negative beta portfolios 1\$ investment development 05/2004 - 05/2005



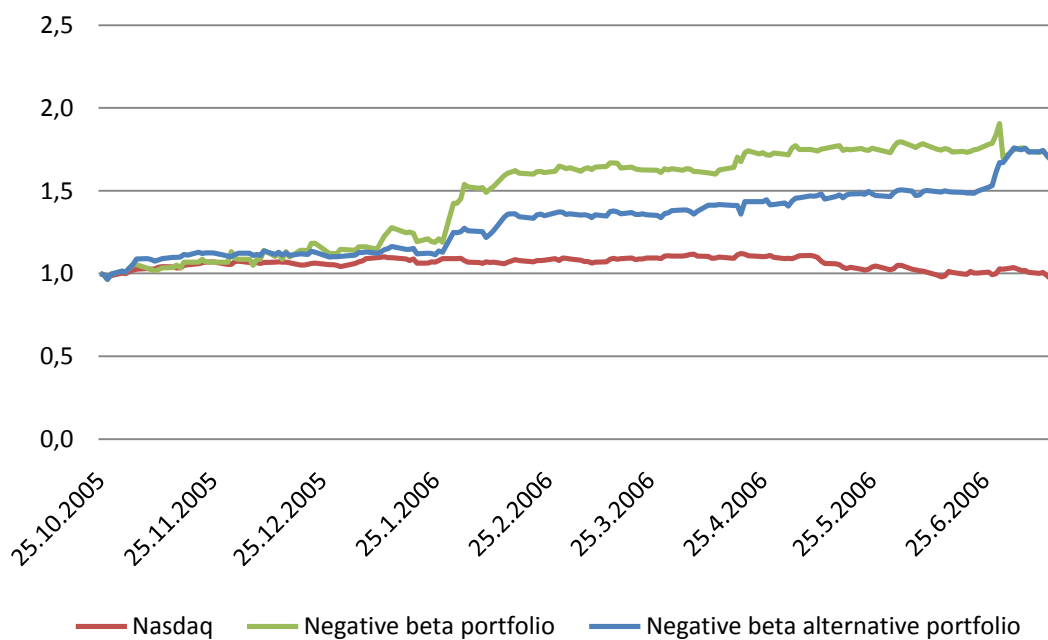
Looking further at Chart 4.4-5, we can see that through the whole period from 13th November 2007 to 12th May 2008 both the market portfolio and Negative beta portfolios were falling. This period already concerns the Financial Crisis period. From the Beta definition, we would expect that if the market was falling, the Negative beta portfolios would be growing at least a little. However we can see

that in contrary Negative beta portfolios were falling more steeply than the market. Another finding is that it is difficult to identify enough stocks with negative betas in the period of the financial crisis, which indicates that the stocks in our sample were mostly positively correlated to the market and followed the trend that was set by the market. The correlations of the portfolios returns to market can be found in the Table 4.4-3. Despite the definition of the beta, the portfolios returns were slightly positively correlated to the market. However as a support of our statement above, we can see that in the last period during the Financial Crisis the correlation was twice as high as in the previous periods.

Table 4.4-3: Negative beta portfolios correlations of returns to market

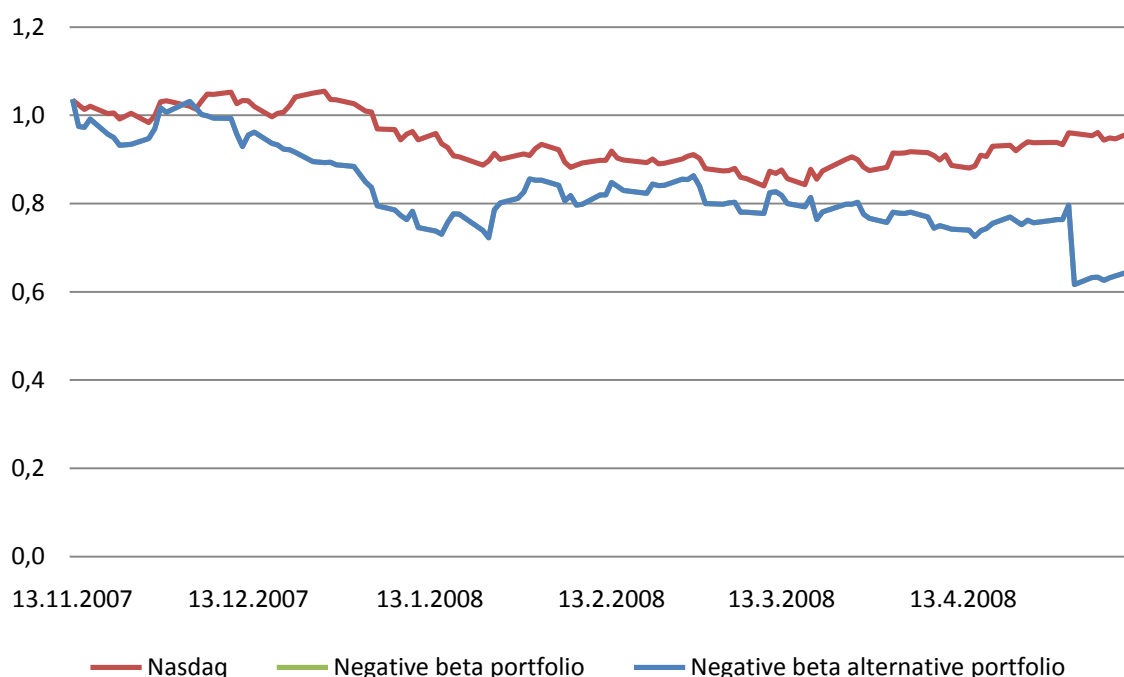
Period	Negative beta	Negative beta alt
02. 03.1999 - 29. 07.2002	0.138372	0.158119
27. 01.2003 - 04. 02.2004	0.271623	0.171309
12. 05.2004 - 16. 05.2005	0.140744	0.143667
25. 10.2005 - 13. 07.2006	0.170222	0.27723
13. 11.2007 - 12. 05.2008	0.455853	0.455853

Chart 4.4-4: Negative beta portfolios 1\$ investment development 10/2005 - 06/2006



As was already mentioned before, the application of *Negative beta portfolio* approach on our sample of 228 titles was quite problematic because this approach was not able to pick enough titles to the portfolios which caused first – missing values in the time series so that we did not obtained joint sequence of data and second when able to choose any, there were too few titles in the portfolios. Generally our portfolios consisting of stocks with negative beta were behaving according to assumption – were slightly falling or stagnating while market was growing and were growing while the market was falling or stagnating (with exception of the Financial Crisis period – see Chart 4.4-5). However in the period of the Financial Crisis from 13th November 2007 to 12th May 2008 the correlation of the returns grew and it was not further possible to find any stocks with negative beta in our sample. Still it is important to remember that the results we have obtained, based on our dataset, might be different on the larger sample and there might not be such problems of finding negative beta stocks.

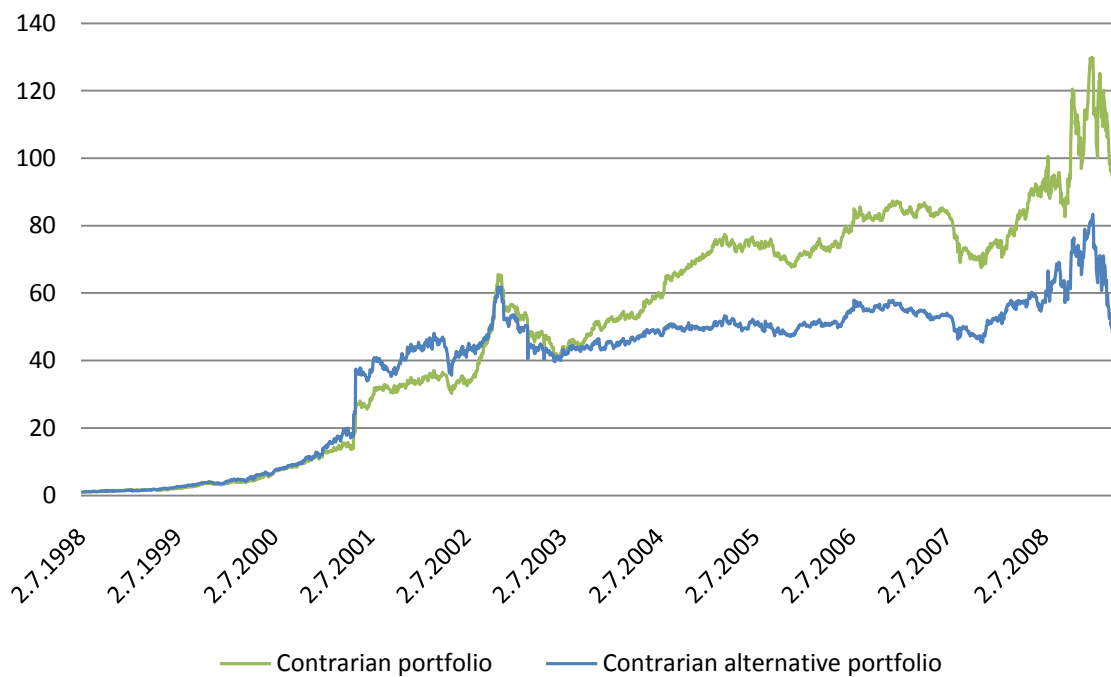
Chart 4.4-5: Negative beta portfolios 1\$ investment development 11/2007 - 04/2008



4.5 Contrarian strategy portfolio

In this section, we will describe the performance of the portfolio based on the contrarian trading strategy, as described above and proposed by Lo (2008). We have created non-leveraged portfolio based on weights given by the strategy. We will compare returns given by the strategy based on weights calculated from close-to-close prices, as well as returns of the strategy based on weights calculated from average price returns³⁴. The daily returns were measured based on formula (3.3).

Chart 4.5-1: Contrarian portfolios 1\$ investment development 07/1998 - 03/2009



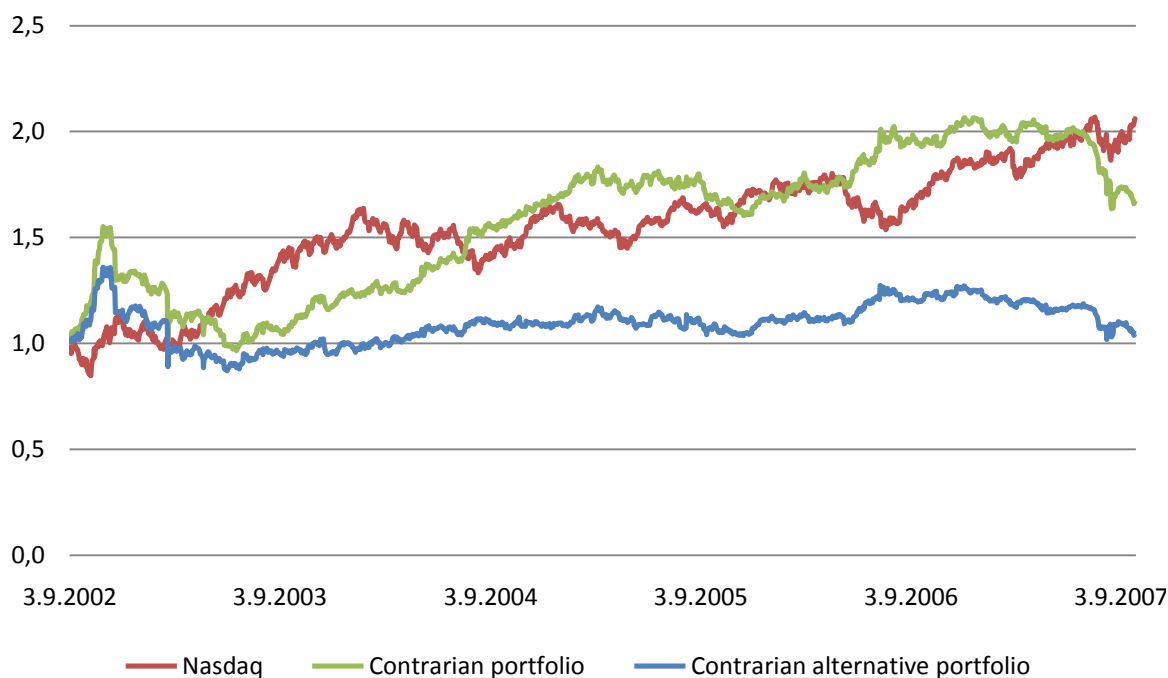
In the Chart 4.5-1, we can see the development of 1\$ investment through the period from 07/1998 – 03/2009. It is evident that contrarian strategies were very profitable through observed period, in the long-term. 1\$ investment made in

³⁴ In both cases the returns were computed from close-to-close price returns because, as was already mentioned in the text, computing average price returns causes autocorrelation problems.

1998 would be worth 114.49\$ in 2009 in case of *Contrarian portfolio* and 57.16\$ in case of *Contrarian alternative portfolio*, which represents growth of 11 349% and of 5 616%, respectively. We can see that *Contrarian portfolio* was able to outperform *Contrarian alternative portfolio* through observed period. However such steep and persistent growth was accompanied by fluctuations – for example decline between 2002 and 2003. From the Chart 4.5-1, we can see that the significant growth had foundations in the growth of both portfolios in-between 1998 and 2002, when *Contrarian portfolio* grew of 4123% and *Contrarian alternative portfolio* of 4451%.

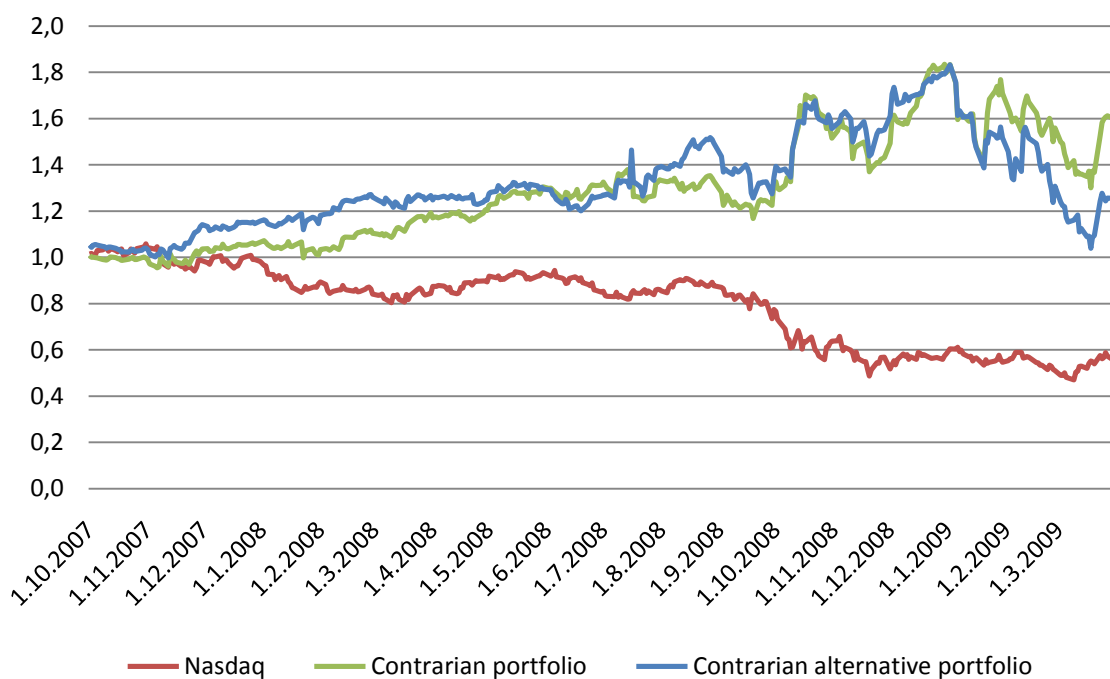
Furthermore the *Contrarian portfolio* was able to outperform market in 1407 cases out of 2703 which represents 52.05% on daily basis. In case of *Contrarian alternative portfolio* it was in 51.57% of all cases.

Chart 4.5-2: Comparison of 1\$ investment price through 09/2002 - 09/2007



Looking at Chart 4.5-2, we can see that through the period of the growth from 09/2002 to 09/2007, *Contrarian alternative portfolio* was below market and was merely above 1\$ price through this period. On the other hand *Contrarian portfolio* was more or less responding to the market and was able to match the price of the market portfolio; however we would rather say that both Contrarian portfolios were underperforming market within this period.

Chart 4.5-3: Contrarian portfolios vs. market 1\$ investment development 10/2007 - 03/2009



Looking at the period beginning 1st October 2007, we can see from Chart 4.5-3 that contrarian trading strategy was able to grow during the crisis contrary to the market in both cases – *Contrarian portfolio* and *Contrarian alternative portfolio* – as at 31st March 2009, the price of 1\$ investment for *Contrarian portfolio* and *Contrarian alternative portfolio* was 1.62\$ and 1.26\$, respectively. The price of the market benchmark portfolio was 0.57\$. This means 62% growth of *Contrarian*

portfolio, 26% growth of *Contrarian alternative portfolio* and decline 43% of the market over the year and a half.

Table 4.5-1: Contrarian average returns and volatilities

Year	Average daily returns			Volatility		
	Nasdaq	Contrarian	Contrarian alt	Nasdaq	Contrarian	Contrarian alt
1998	0.13%	0.41%	0.35%	0.021	0.018	0.018
1999	0.26%	0.33%	0.41%	0.017	0.020	0.020
2000	-0.15%	0.50%	0.48%	0.031	0.023	0.025
2001	-0.06%	0.49%	0.60%	0.027	0.040	0.045
2002	-0.13%	0.21%	0.08%	0.022	0.016	0.017
2003	0.17%	-0.01%	-0.04%	0.014	0.017	0.017
2004	0.04%	0.13%	0.04%	0.011	0.008	0.008
2005	0.01%	0.00%	0.01%	0.008	0.007	0.008
2006	0.04%	0.08%	0.05%	0.009	0.007	0.007
2007	0.04%	-0.05%	-0.03%	0.011	0.010	0.010
2008	-0.17%	0.23%	0.20%	0.026	0.021	0.021
2009	-0.01%	-0.11%	-0.51%	0.028	0.035	0.040

However application of this strategy might be suitable for longer periods because as we can see from the chart, there are periods of decline within period from 1st October 2007 to 31st March 2009. Therefore the price of the 1\$ investment was very volatile during this period in cases of both portfolios. From the Table 4.5-1, we can see that both portfolios were more volatile than the market, especially in 2009. From the end of the year 2008, we could observe decline in both Contrarian portfolios that was following the decline of the market portfolio. However we can also see that this decline of the Contrarian portfolios price was magnified in contrary to the market portfolio (however this statement was also valid for subsequent increase of the price, as can be seen in the Chart 4.5-3). In the 2009 Contrarian portfolios were both less profitable (suffered larger average daily losses) and more volatile. In 2009 was the *Contrarian portfolio* able to outperform

the market just in 45.90% of cases, based on daily returns. In case of *Contrarian alternative portfolio* it was just in 39.34% of cases.

From the Table 4.5-1 (see above), we can further see that our portfolio based on contrarian trading strategy earned significantly higher average daily returns than market portfolio in the period from 07/1998 to 12/2002. In 2003, 2005, 2007 and 2009 was the contrarian strategy daily returns below market (again in case of both portfolios). If we compare the average volatilities of daily returns, we can see that *Contrarian portfolio* was more volatile than the market just in the years 1999, 2001, 2003 and 2009. Therefore in other periods according to volatility, the *Contrarian portfolio* was less risky than the market one (this result is also valid for the *Contrarian alternative portfolio*).

4.6 Portfolios development comparison during Financial Crisis

In this section, we will compare all portfolios³⁵ that were described above. For the comparison, we will use the period of Financial Crisis so that we can say which of our portfolios was doing best during the crisis. For the comparison, we will use the 1\$ investment development during the period 10/2007 – 03/2009. Furthermore the ex-post Sharpe ratio and volatilities will be used to compare the portfolios.

For the Sharpe ratio calculation, we used formula (3.10) that was described above. As the input data, we used average daily returns of portfolios and risk-free asset (i.e. average daily excess returns). Moreover, we have calculated two

³⁵ With exception of Negative beta portfolios for we do not have joint series for the Crisis period.

Sharpe ratios – one as a comparison of excess return of portfolio over the daily 3M US treasury rate returns that is US secondary market rate. The daily returns of 3M US treasury were obtained as 1/250 of the daily rate published³⁶. Because the numbers obtained by the normalization of the 3M US treasury rate on the daily basis were very low³⁷, we also provide the second calculation of Sharpe ratio that was computed as an excess return of portfolios over the 0% daily rate as a risk-free asset daily return.

4.6.1 1\$ investment development during the Financial Crisis

Looking at the Chart 4.6-2, we can clearly see that both contrarian strategy based portfolios outperformed all beta based strategies as well as the market portfolio during the whole period. The *Contrarian portfolio* was able to generate returns of 61.8% for the whole period from 10/2007 – 03/2009. The *Contrarian alternative portfolio* generated returns in amount of 25.6% for the same period. Other strategies lost from the initial 1\$ investment as can be seen from Table 4.6-1.

Table 4.6-1: 1\$ investment price as at 31st March 2009

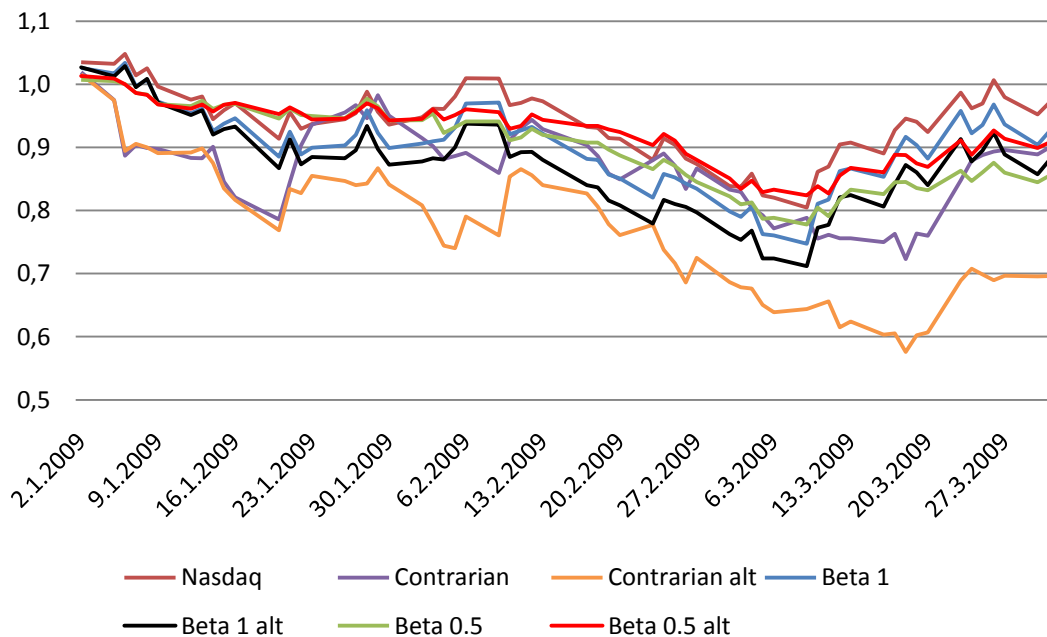
Period	Nasdaq	Contrarian	Contrarian alt	Beta 1	Beta 1 alt	Beta 0.5	Beta 0.5 alt
10/2007-03/2009	0.566	1.617	1.256	0.601	0.575	0.566	0.652
01/2009-03/2009	0.969	0.899	0.696	0.924	0.878	0.854	0.907

³⁶ 250 as a number of trading days in a year.

³⁷ For example rate of 2% calculated on daily basis equals to 0.008%.

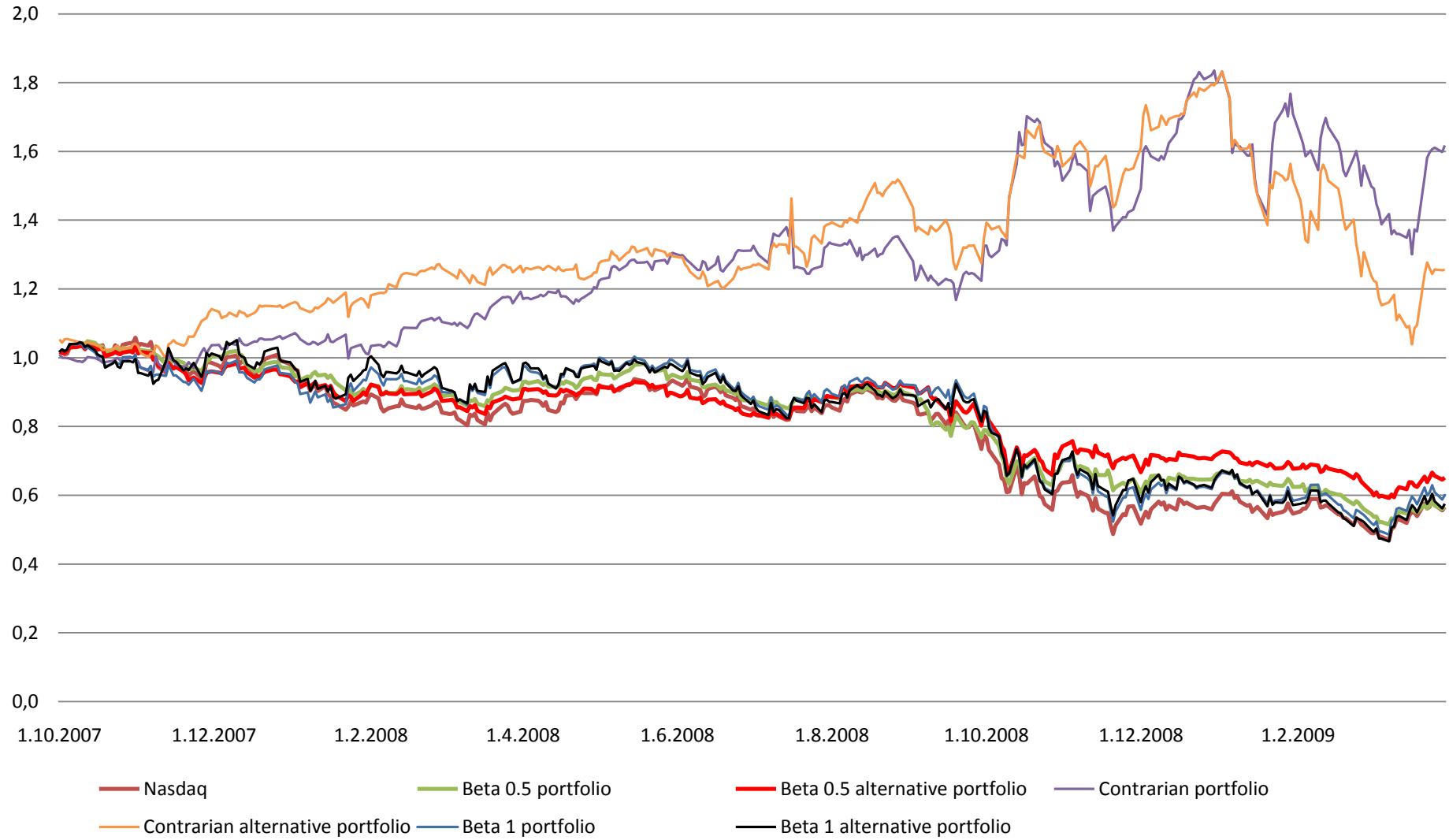
However it is clear that during the first three months of the year 2009, both Contrarian portfolios suffered losses that were larger than in case of all beta portfolios and market portfolio as well (see Chart 4.6-1 and Table 4.6-1).

Chart 4.6-1: Beta portfolios1\$ investment development 01/2009 - 03/2009



We can see that 1\$ investment made in the beginning of the 2009 suffered losses in case of all portfolios (see Table 4.6-1 for the investment prices at the end of the period). However, contrary to the whole period from 10/2007 to 03/2009, Contrarian portfolios did worse than market and even worse than *Beta 1 portfolio*. Moreover *Contrarian alternative portfolio* did the worst from all portfolios observed and suffered loss of 30.4% for the period of three months. In comparison, we can see that *Contrarian portfolio* lost “only” 10.1%, market portfolio 3.1% and *Beta 1 portfolio* 7.6%. This indicates that all our portfolios underperformed the market during the beginning of 2009, which can be seen in the Chart 4.6-1 as well as in the Table 8. We can further see that development of 1\$ investment to beta portfolios was very similar independent to the value of beta.

Chart 4.6-2: Portfolios 1\$ investment development 10/2007 – 03/2009



4.6.2 Measure of the risk and Sharpe ratio

From Table 4.6.2-1, we can see that during the first three months of the year 2009 both Contrarian portfolios had largest daily volatilities from all portfolios observed and moreover *Contrarian alternative portfolio* experienced highest daily average loss.

Table 4.6.2-1: Average daily returns and volatilities

Portfolio	01/2009-03/2009		10/2007-03/2009	
	Average daily returns	Volatility	Average daily returns	Volatility
Nasdaq	-0.013%	0.0275	-0.165%	0.0245
Contrarian	-0.113%	0.0352	0.153%	0.0235
Contrarian alt	-0.514%	0.0399	0.061%	0.0248
Beta 1	-0.080%	0.0318	-0.139%	0.0270
Beta 1 alt	-0.159%	0.0330	-0.151%	0.0280
Beta 0.5	-0.244%	0.0163	-0.170%	0.0172
Beta 0.5 alt	-0.146%	0.0163	-0.134%	0.0175

In order to be able to compare all portfolios performance with taking into account volatilities of the portfolios and not just returns of the strategies, we calculated Sharpe ratios of the portfolios as a measure of volatility adjusted excess returns of portfolios over risk-free asset. These ratios can be found in Table 4.6.2-2 and were calculated for the whole period as well as for the first three months of the 2009. As was already described in Methodology, the calculation of the Sharpe ratios were based on average daily excess returns and volatilities for particular periods. We have calculated the Sharpe ratios for the 3M US treasury rate daily values as risk-free asset returns and for 0% risk-free return. In the Table 4.6.2-2,

we also included preferences of the portfolios according to the Sharpe ratios as the higher the Sharpe ratio was, the better³⁸.

Table 4.6.2-2: Sharpe ratios

Portfolio	10/2007-03/2009			01/2009-03/2009		
	US treasury 3M	0% risk-free rate	Preference	US treasury 3M	0% risk-free rate	Preference
Nasdaq	-0.073	-0.068	5	-0.005	-0.005	1
Contrarian	0.061	0.066	1	-0.032	-0.032	3
Contrarian alt	0.020	0.025	2	-0.129	-0.129	6
Beta 1	-0.057	-0.052	3	-0.025	-0.025	2
Beta 1 alt	-0.059	-0.055	4	-0.048	-0.048	4
Beta 0.5	-0.107	-0.100	7	-0.150	-0.150	7
Beta 0.5 alt	-0.085	-0.078	6	-0.090	-0.090	5

We can see that if taking into account whole period of the Financial Crisis we observed, both Contrarian portfolios were chosen by the Sharpe ratio as strategies with the highest returns for given level of volatilities. Other strategies experienced negative Sharpe ratios. In contrary, in 2009 was *Contrarian portfolio* in the middle according to Sharpe ratios and *Contrarian alternative portfolio* was on the sixth place out of seven. We can further see that both Sharpe ratios – calculated based on the excess return over the daily 3M US treasury rate and calculation based on 0% daily risk-free rate – provided the same results and that difference caused by employing 0% risk-free rate to the Sharpe ratio was only marginal and did not change preferences that were assigned to portfolios. Therefore it was suitable to use 0% daily risk-free rate for the calculation of the Sharpe ratio.

³⁸ From the definition of the Sharpe ratio higher Sharpe ratio means higher return for the same amount of risk.

From these results, we can see that for longer investment purposes was the most suitable *Contrarian portfolio* in the observed period of the Financial Crisis, which is obvious from the price of the 1\$ investment as at 31st March 2009 and also from Sharpe ratio comparison above. On the other hand, contrarian portfolios suffered losses that were larger than the markets and in the case of *Contrarian alternative portfolio* even of other beta based portfolios with exception of *Beta 0.5 portfolio*. However it is important to notice that the period of the decline in 2009 was a three month period and question is what development would 1\$ investment to these portfolios have beyond this horizon – as we can see from Chart 4.6-1 and 4.6-2, there was some reversal at the end of the period and both contrarian portfolios were able to exploit this opportunity better than other portfolios. We can further say that generally, with exception of Beta 0.5 alternative portfolio, all portfolios based on close-to-close returns were superior to the portfolios calculated based on average daily returns.

5 Conclusion

In our thesis, we have tried to analyze the performance of the various portfolios that were created and managed based on different strategies. As it is obvious from the literature, there are yet scarce sources that focus on the Financial Crisis problematic. As the Crisis advances, there is expected increase in the amount of literature that focuses on the recent Financial Crisis. As we described in the Literature survey section, the Financial Crisis roots can be found in the US mortgage market.

We could clearly see the sources of the US sub-prime mortgage crisis that led to the Financial Crisis we are experiencing nowadays. There were clearly sources in both sectors – the private and governmental one as well. However it is clear that it is not necessary to adopt new institutional framework per se. Mainly there were problems with adherence with existing regulatory and risk management methods. Therefore better adherence should be enforced on the side of the private and governmental sector, which should do the job.

We could further see, based on literature survey, the analysis of the quantitative methods during the August 2007. According to Lo (2008), there were some problematic issues concerning quantitative methods during August 2007 (based on contrarian strategy analysis) and should be adopted better risk measures and should not depend just on volatility measures but should be also improved of illiquidity measures. As we perceive the problem, there are not needed new measures to be adopted per se. We could see that the contrarian strategy was able to profit from the reversal during the August 2007. However

there were psychological aspects that caused that the positions were sold before reversal and therefore the funds suffered substantial losses that were magnified by the high leverage employed. Another problem was that based on one-week evidence, in our opinion, we cannot conclude very strong results.

In our thesis, in the analytical part, we have focused on the analysis of the development of contrarian trading strategy based portfolio and portfolios based on the stocks' betas during the period from 1998 to 2009 with special attention to the period of the Financial Crisis from 10/2007 to 03/2009.

As was mentioned in the methodology, we have come across the problem of autocorrelation while analyzing portfolios' returns based on the average daily prices of stocks. We have found out that with application of the analysis on the average daily prices, there increases positive autocorrelation of the stocks' returns, which would be very problematic while analyzing the contrarian strategy that would result in opposite outcome (i.e. hold long positions for yesterdays' winners and short positions for yesterdays' losers). However we have provided the comparison of the same strategies based on close-to-close price returns and average price returns with calculation of the portfolios returns from close-to-close price returns in all cases.

We have focused on the unleveraged equally-weighted beta based portfolios and unleveraged contrarian portfolio. *Beta 1 portfolio's* construction assumption was that investor investing to such a portfolio could expect more or less the same performance and risk as in the case of the market portfolio. However while analyzing *Beta 1 portfolios* and comparing them to the market portfolio development, we have found out that *Beta 1 portfolios* were able to

outperform the market throughout the period beginning 1998 and ending 2009. It is also important to notice that generally *Beta 1 portfolio* was able to outperform both the market portfolio as well as the *Beta 1 alternative portfolio* in the periods of growth, which we could observe in the period of 2002 – 2007. In the periods of decline, both beta 1 portfolios did quite similar to the market.

Beta 0.5 portfolios were expected to moderate the consequences of the market price declines and on the other hand to have lower returns than the market in the periods of growth. We have found out that Beta 0.5 portfolios were able to outperform the market portfolio in the whole period of 1998 – 2009. However, we have also found that both portfolios did worse than the market in the growth period of 1998 – 1999, when there was steep growth of the market and portfolios grew just modestly, which corresponded to our assumption. We have therefore found that Beta 0.5 portfolios underperformed the market portfolio performance during the periods of the growth but on the other hand, both Beta 0.5 portfolios were able to outperform the market in the periods of the fall, especially in the period from 03/2000 to 07/2002, when despite the decrease of the market price both portfolios were able to grow. However during the subsequent period both portfolios were under the market performance and in the period of the Crisis from 10/2007 to 03/2009 both Beta 0.5 portfolios' price decreased but less than the market ones'.

The Negative beta portfolios were quite problematic to apply on our dataset because of the number of titles analyzed. The negative betas were very scarce in both cases – *Negative beta portfolio* and *Negative beta alternative portfolio*. We have therefore obtained just few consistent data series we were able to compare to the market. An assumption of the negative beta portfolios was that they should

have opposite development than the market portfolio. I.e. we have used negative beta portfolios as a benchmark and to an investor investing to such a portfolio would be interested just in case of the decline of the market or in the periods of crisis. Indeed, in the periods of growth, both negative beta portfolios were stagnating or decreasing. In the periods of decrease or stagnation of the market, the negative beta portfolios were really able to grow. However during the period of 11/2007 – 04/2008 that was falling into the Crisis when we have obtained enough observations to be able to construct the negative beta portfolios, we have found that negative beta portfolios underperformed the market, which was caused by two factors – sudden increase in positive correlation between portfolio and market returns and portfolio contained just 1 title had during this period. We cannot therefore deduce any strong results from such scarce sources but because of increasing correlation of returns during the Crisis, it seems that negative beta portfolio could not be profitable or less losing than the market.

Generally, we could say that the beta portfolios calculated based on close-to-close returns had better performance in all periods than beta alternative portfolios based on the calculation based on the average daily price returns (with exception of Beta 0.5 alternative portfolio that did better than the Beta 0.5 portfolio in all periods).

The analysis of the contrarian trading strategy based portfolios showed that both contrarian portfolios were able to outperform the market significantly during whole observed period with foundations of the significant outperformance in the period from 07/1998 to 07/2002 when Contrarian portfolio earned 4120% and Contrarian alternative portfolio earned 4451%. In the subsequent period from 2002

to 2007, we could observe similar development as in case of the market portfolio. However in the period of the Crisis from 10/2007 to 03/2009, both contrarian portfolios outperformed the market portfolio and were able to grow despite the fall of the market. We could however see that Contrarian portfolios were volatile and were vulnerable to the fluctuations and therefore it was rather suitable to hold the contrarian portfolios with longer investment objective.

The analysis of the 1\$ investment during the Financial Crisis period from 10/2007 to 03/2009 provided such results that led us to the conclusion of the superiority of contrarian trading strategies to the selected beta portfolios. We could observe that throughout the whole period, both contrarian strategies were able to outperform the market portfolio as well as all beta based portfolios. This was also indicated by the Sharpe ratios calculated – both contrarian portfolios were recommended over the rest of the portfolios. As we could see, the Contrarian portfolio based on close-to-close returns did the best among all the portfolios, which was also confirmed by the Sharpe ratio analysis. However in the period of the beginning of 2009, both Contrarian portfolios underperformed market and Contrarian alternative portfolio underperformed all investment strategies. From the Sharpe ratios calculated for this period, the market portfolio and the Beta 1 portfolio were recommended over the Contrarian portfolio. Both contrarian portfolios could suffer more extensive losses if it were not for the reversal at the end of the March 2009 that at least partially compensated for the losses suffered from the beginning of the year. We cannot predict the development after this period, however the reversal could continue and the Contrarian portfolio would perform better than the other as it could better identify the reversal opportunity. We

could see that the development during the beginning of 2009 confirmed the recommendation to holding contrarian portfolios for longer periods.

It is clear that the Financial Crisis is not far behind us and we are still experiencing the fluctuations of the markets. The results presented in this thesis are therefore incomplete based on the fact that the Crisis continues and the conclusions that were presented in this thesis are therefore just partial based on the data and time series available. There could be of course used also other portfolio approaches, however it is not possible to analyze all the approaches possible and provide such an extensive analysis. We have found that there were some portfolios being able to outperform the market. During the Crisis period, there was a possibility to obtain possible positive returns while investing into the contrarian portfolios, which were however volatile and were losing during the beginning of the 2009. We would therefore recommend holding contrarian portfolios for longer periods. It is further important to remember that we assumed zero transaction costs and no price impacts of the strategies.

References

- [1] **Baily M. N., Litan R. E., and Johnson M.S. (2008):** *The Origins of the Financial Crisis; Fixing finance series – Paper 3*
- [2] **Case, Karl E. and Robert J. Shiller. (2003):** *Is There A Bubble in the Housing Market?;* Brookings Papers on Economic Activity 2; pp. 299-342
- [3] **Chan L., Getmansky M., Haas S. and Lo A. (2006):** *Do hedge funds increase systematic risk?;* Federal Reserve Bank of Atlanta Economic Review; pp. 49 – 80
- [4] **Chan L., Getmansky M., Haas S. and Lo A. (2005):** *Systematic risk and hedge funds;* MIT Sloan School of Management; WP 4535-05
- [5] **Chincarini L. B., Daehwan K. (2006):** *Quantitative equity portfolio management;* McGraw-Hill; ISBN 978-0-07-145940-2
- [6] **Dowd, Kewin (1999):** *Adjusting for risk: An improved Sharpe ratio;* International Review of Economics and Finance; vol. 9 (2000), pp. 209 – 202
- [7] **Eon, Cheol S. (1994):** *The Benchmark Beta, CAPM and pricing anomalies;* Oxford Economic Papers, vol. 46 (1994); pp. 303 – 343
- [8] **Getmansky M., Lo A. and Makarov I. (2004):** *An econometric analysis of serial correlation and illiquidity in hedge-fund returns;* Journal of Financial Economics vol. 74, pp. 529 – 609
- [9] **Grinold R. C., Kahn R. N (2000):** *Active portfolio management;* McGraw-Hill; ISBN 978-0-07-024882-3
- [10] **Lo, Andrew W. (2008):** *Hedge funds: An analytic perspective;* Princeton University press

- [11] **Lo, Andrew W. and McKinley C. (1990):** *When are contrarian profits due to stock market overreaction*; Review of financial studies 3; pp. 175-206
- [12] **Montier J. (2007):** *The Myth of Exogenous Risk and the Recent Quant Problems*; <http://behaviouralinvesting.blogspot.com/2007/09/myth-of-exogenous-risk-and-recent-quant.html>
- [13] **Sharpe, William F. (1994):** *The Sharpe Ratio*; Journal of Portfolio Management
- [14] **Oh, Kyong J., Kim, T. Y., Min, Sung-Hwan, Lee Hyoung Y. (2006):** *Portfolio algorithm based on portfolio beta using genetic algorithm*; Expert system with Applications 30, pp. 527 - 534
- [15] **Truman, Edwin M. (2004):** *Postponing Global Adjustment: An Analysis of the Pending Adjustment of Global Imbalances*; Peter G. Peterson institute for international economics, WP 05-7
- [16] **Yahoo! finance;** <http://finance.yahoo.com>

Appendix

Autocorrelations of the stocks

Title	Average	Close-to-close	Title	Average	Close-to-close	Title	Average	Close-to-close
AAPL	0.153	-0.047	PCAR	0.219	-0.075	NAVG	0.137	-0.103
ADBE	0.149	-0.077	PDCO	0.152	-0.061	NBTB	0.118	-0.191
ADP	0.154	-0.071	PPDI	0.235	0.000	NDAQ	0.348	0.065
ADSK	0.214	0.000	QCOM	0.095	-0.036	NITE	0.255	0.074
AKAM	0.312	0.064	RIMM	0.219	0.003	NPBC	0.189	-0.139
ALTR	0.167	-0.074	ROST	0.200	-0.055	NTRS	0.168	-0.096
AMAT	0.175	-0.077	RYAAY	0.180	0.004	NWLI	0.159	-0.053
AMGN	0.139	-0.037	SBUX	0.136	-0.045	NWSB	0.145	-0.201
AMZN	0.160	-0.008	SHLD	0.339	0.022	OXPS	0.223	-0.042
APOL	0.216	-0.042	SIAL	0.181	-0.096	PACW	0.274	-0.135
ATVI	0.165	-0.034	SPLS	0.215	-0.028	PBCT	0.120	-0.079
BBBY	0.200	-0.027	SRCL	0.219	0.003	PBKS	0.210	0.001
BIDU	0.210	0.010	STLD	0.220	-0.038	PBNY	0.034	-0.102
BIIB	0.157	-0.005	STX	0.274	0.014	PCBC	0.209	-0.085
BRCM	0.213	0.002	SYMC	0.211	-0.039	PICO	0.010	-0.018
CA	0.198	-0.031	TEVA	0.137	0.022	PNFP	0.069	-0.156
CELG	0.199	0.002	URBN	0.269	0.034	PRAA	0.287	-0.034
CEPH	0.263	0.021	VRSN	0.257	0.022	PRSP	0.182	-0.063
CMCSA	0.185	-0.092	VRTX	0.237	0.008	PVTB	0.195	-0.039
COST	0.191	-0.030	WCRX	0.083	-0.098	SAFT	0.173	-0.150
CSCO	0.118	-0.065	WYNN	0.367	0.039	SBIB	0.159	-0.141
CTAS	0.218	-0.094	XLNX	0.182	-0.059	SBNY	0.337	-0.034
CTHS	0.205	0.018	XRAY	0.150	-0.068	SEIC	0.170	-0.027
CTXS	0.220	0.031	YAHOO	0.168	0.007	SCHW	0.168	-0.062
DELL	0.134	-0.013	ACAS	0.396	0.104	SIGI	0.193	-0.127
DISH	0.149	-0.046	ACGL	0.148	-0.107	SIVB	0.280	0.025
DTV	0.177	-0.074	AGII	-0.003	-0.003	STBA	0.118	-0.190
EBAY	0.186	-0.028	AMTD	0.187	0.017	STFC	0.195	-0.120
ERTS	0.204	-0.045	ANAT	0.163	-0.221	STSA	0.243	-0.047
ESRX	-0.116	-0.165	ASBC	0.229	-0.039	SUSQ	0.241	-0.122
EXPD	0.174	-0.072	BANF	0.088	-0.132	TRMK	0.157	-0.135
EXPE	0.234	-0.004	BKMU	0.075	-0.103	TROW	0.196	-0.026
FAST	0.241	0.023	BOKF	0.142	-0.096	TRST	0.098	-0.194
FISV	0.188	-0.097	BPOP	0.203	-0.128	TSFG	0.272	0.001
FLEX	0.204	0.015	BRKL	0.147	-0.112	TWGP	0.251	0.017
FLIR	0.193	-0.040	BUSE	0.101	-0.205	UBSI	0.215	-0.119
FSLR	0.192	-0.050	CACC	0.183	-0.132	UCBH	0.193	-0.046
FWLT	-0.071	-0.071	CATY	0.178	-0.053	UCBI	0.219	-0.067
GENZ	-0.158	-0.231	CBSH	0.214	-0.103	UFCS	0.203	-0.059
GILD	0.198	-0.004	CCRT	0.326	-0.015	UMBF	0.124	-0.167
GOOG	0.240	0.000	CFRN	0.332	-0.049	UMPQ	0.166	-0.163
GRMN	0.241	0.021	CINF	0.121	-0.106	WABC	0.172	-0.084
HANS	0.206	-0.055	CME	0.324	-0.023	WFSL	0.259	-0.087
HOLX	0.210	-0.011	CRBC	0.272	-0.082	WRLD	0.266	-0.098
HSIC	0.273	-0.006	CVBF	0.200	-0.103	WSBC	0.224	-0.204
CHPK	0.201	-0.042	DCOM	0.269	-0.037	WTFC	0.241	-0.067
CHRW	0.178	-0.060	DLLR	0.315	-0.005	WTNY	0.183	-0.101
IACI	0.192	-0.050	EMITF	0.071	-0.092	ZION	0.298	-0.018
ILMN	0.299	0.052	ERIE	0.126	-0.212	AA	0.222	0.010
INFY	0.199	0.046	ETFC	0.236	0.015	AXP	0.164	-0.036

INTC	0.152	-0.027	EWBC	0.289	-0.024	BA	0.297	-0.006
INTU	0.180	-0.080	FCFS	0.150	-0.117	BAC	0.209	0.000
ISGR	0.209	-0.001	FCNCA	0.154	-0.132	C	0.231	0.043
JAVA	0.056	-0.006	FFIN	0.094	-0.222	CAT	0.204	-0.015
JBHT	0.235	-0.029	FITB	0.225	0.035	CVX	0.147	-0.077
JNPR	0.196	0.006	FMBI	0.295	-0.092	DD	0.277	-0.025
JOYG	0.255	0.012	FMER	0.293	-0.156	DIS	0.145	-0.049
KLAC	0.236	-0.025	FNFG	0.177	-0.087	GE	0.165	-0.032
LBTYA	0.286	0.017	FTBK	0.244	-0.106	GM	0.233	0.058
LIFE	0.259	0.035	FULT	0.235	-0.109	HD	0.190	0.015
LINTA	0.184	-0.023	GBCI	0.247	-0.103	HPQ	0.170	-0.036
LLTC	0.202	-0.040	GFIG	0.211	0.003	IBM	0.130	-0.056
LOGI	0.101	-0.034	HBAN	0.234	-0.115	JNJ	0.149	0.009
LRCX	0.261	-0.007	HBHC	0.117	-0.137	JPM	0.184	-0.029
MCHP	0.161	-0.060	HCBK	0.069	-0.059	KFT	0.228	-0.051
MICC	0.223	0.031	HGIC	0.268	-0.142	KO	0.324	0.006
MRVL	0.270	0.051	CHCO	0.117	-0.219	MCD	0.179	-0.009
MSFT	0.109	-0.034	CHFC	0.183	-0.166	MMM	0.165	-0.021
MXIM	0.215	-0.082	IBKC	0.201	-0.098	MRK	0.187	-0.009
NIHD	0.254	0.083	IBOC	0.045	-0.191	PFE	0.092	-0.027
NTAP	0.175	-0.029	IPCC	0.210	-0.060	PG	0.153	-0.035
NVDA	0.219	0.023	IPCR	0.300	-0.027	T	0.180	-0.035
NWSA	-0.122	-0.122	ISBC	0.264	-0.139	UTX	0.169	-0.025
ORCL	0.141	-0.046	KRNY	0.174	-0.202	VZ	0.175	-0.064
ORLY	0.210	-0.024	MBFI	0.227	-0.080	WMT	0.199	-0.002
PAYX	0.183	-0.111	MXGL	0.169	-0.073	XOM	0.148	-0.091