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Profitability of Momentum Strategies on the Eurozone Market

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Abstract

This paper investigates the profitability of the zero-cost strategies (Winner-Loser) on the Eurozone market for the time period 1999-2009. We find that the Winner portfolio outperforms the Loser portfolio by, on average, 0,8% per month when we combine formation and holding periods of 3, 6, 9 and 12 months. As the sum of these two periods gets closer to 24 months, the excess returns tend to dissipate. The momentum profits are consistent throughout the different sub-periods analyzed. The current financial crisis does not diminish these profits, as it affects the Losers more dramatically than the Winners. We observe the return continuation phenomenon across most of the countries and industries included in our study. Controlling for these two factors leads to a small decrease of our profits in the case of a country-neutral portfolio and to a more significant decrease for an industry-neutral portfolio, which indicates towards the industry factor as being responsible, to a small extent, for the existence of the momentum profits. Adjusting for systematic risk, size and value factors increases the excess returns and suggests that these factors cannot explain the abnormal profits.

Keywords: Momentum, Winner and Loser portfolios, zero-investment strategy, country, industry.

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1. Introduction

In this first chapter the reader is introduced to the background of the study and the problem discussion. We state the papers purpose, limitations, and target group, together with offering an outline of the rest of the paper.

1. Background

The Efficient Market Hypothesis states that today's price of a security should reflect all publicly available information or, at least, the past information (according to the weakest form). As this hypothesis constitutes the base point for the most of financial theory, there is a lot of research dedicated to checking its validity. A distinct aspect of this research is investor's reaction to new information, given that the most of the asset pricing models are built upon the assumption that investors' behaviour is rational and it leads to all the new information being incorporated into a security's price immediately. However, the finance research done in the second half of the 20th century, and particularly towards its end, is not based on this assumption; on contrary, authors' findings indicate against it.

Developed by Louis Bachelier in 1900 in his thesis *Theory of Speculation* (Lo and MacKinlay 1990), the random walk hypothesis implies the unpredictability of the stock prices. Tomorrow's stock price fluctuations will reflect only tomorrow's news and not today's price fluctuations, i.e. the stock price incorporates the new information immediately. Nowadays the common belief is that stock prices do not follow random walks, empirical studies showing that there are correlations among the lagged prices. Rejecting the random walk hypothesis leads to price changes being forecastable, thus allowing an investor to earn abnormal profits which are profits in excess of those earned as a compensation for risk.

2. Problem discussion

Starting with the mid 1980s a lot of research has been done in order to check the Efficient Market and the Random Walk hypotheses and thus to determine the possibility of forecasting future returns using publicly available information. Summing up, two categories of stock returns' tendencies have been identified. The first one is the short and long term return mean-reversion

and the second one is the medium term return continuation. Two groundbreaking papers could be thought as representing milestones in documenting these behaviours. The first one belongs to DeBondt and Thaler (1985) and demonstrates that a strategy which consists of buying prior loser stocks and selling prior winner stocks (which is called a *contrarian strategy*) earns significant abnormal returns on a long run. The second one was written by Jegadeesh and Titman in 1993 and shows that a *momentum strategy* that involves buying stocks that performed well in the past and selling stocks that performed badly results in abnormal profits on a medium run, particularly on a 3 to 12 month horizon. A momentum *(contrarian)* strategy implies buying *(selling)* past well performing stocks or selling *(buying)* past badly performing stocks expecting them to continue *(revert)* their past performance. It can also be a *self financing strategy* which would consist of simultaneously buying past well *(poor)* performing stocks with the proceeds from selling short past poor *(well)* performing stocks expecting a price continuation *(reversal)*.

As the standard asset pricing models encounter problems in explaining these anomalies the behavioural theories gained more and more popularity and attention. Behavioural theories relax the assumptions of investors' rationality and computational capacity (Hong and Stein, 1998) and focus instead on psychological determinants of their behaviour. Such determinants were suggested to be investors' overconfidence and self-attribution bias (Daniel et al, 1998), conservatism (Barberis et al, 1998) or underreaction to the public information (Hong and Stein, 1999). On a medium term stock prices underreact to news which is then gradually incorporated; this leads to the momentum effect. On a long term stock prices overreact to consistent patterns of news which then leads to a reversal to the fundamental value (Barberis et al, 1998).

3. Purpose

The main purpose of this paper is determining whether momentum strategies are profitable at the individual stocks level, industry level and country level within the perimeter of countries members of the Eurozone, together with analyzing the potential momentum sources. Findings demonstrating momentum strategies profitability on one or more of these levels would indicate towards the inefficiency of this market.

4. Limitations

This study includes the countries members of the Eurozone as of 31 December 2008, thus resulting 15 countries.[1] All major listed and liquid companies belonging to national stock exchanges of these countries are included in the study.

The time period analyzed extends from 01.01.1999 to 01.04.2009, as older periods have already been included in previous studies, though not for the same market. Furthermore, this time period allows us to capture both the "internet bubble" phenomenon from 1999-2000 and the world financial crisis which became visible in Europe in the fall of 2008.

The novelty brought by our study consists of applying previously used methods in momentum effect research to a completely new market – the Eurozone - and for a time period that includes the current global financial crisis. According to our knowledge, no such study has been previously performed.

Our main source of time series data is Datastream. Monthly data was used as it is recommended by most of the previous studies; moreover, it will allow us to compare our results to the previous findings. In order to avoid the "survivorship bias" we include the companies which have been delisted throughout the time period analyzed.

5. Target group

The target group this paper is aimed at consists in general of people interested in and having some general knowledge of finance. These could be students, professors, researchers, as well as investors and potential investors interested in the peculiarities of the stock market.

[1] Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovenia and Spain.

6. Outline

The remainder of this paper is organized as follows:

Chapter 2: Relevant theoretical issues and research that has been done in this area are presented. We present the most important articles that have contributed to the understanding of the issue treated in this paper.

Chapter 3: We present the data and the methodology that we have used, describing in detail each step, thus making replication possible. We describe both the method that was used in the momentum effect study and the method used for the analysis of its sources.

Chapter 4: We present the results we have come up to. We analyze our results through diverse tests for determining economic and statistical significance and interpret them according to the existing theories. We analyze the potential sources of momentum profitability.

Chapter 5: A summary of our findings is presented in this chapter, together with suggestions for further research.

2. Theoretical framework

In this chapter the relevant theoretical issues and research that has been done in this area are presented. We summarize the most important articles that have contributed to the understanding of the issues treated in this paper.

2.1 Efficient Market Hypothesis

According to Fama (1970), an efficient market means a market in which security prices fully incorporate all the available information. As new information becomes available, prices fluctuate depending only on it. The new information is reflected instantaneously in the security prices and this makes them unpredictable. Depending on the degree of novelty of the information the price is based upon, Fama distinguishes three possible forms of market efficiency:

- **The weak form of market efficiency** states that current security prices reflect all the past information. Since the prices already reflect all the past information, there should be no possibility to predict future performance using the same past returns, as there is no relation between these and the future returns. Equilibrium is not required by this hypothesis; required is only the impossibility of the market participants to systematically profit from market inefficiencies. As the prices are believed to follow a random walk they are not correlated throughout a time period, thus there are no patterns that could be exploited. A pattern allowing for abnormal profits would be mitigated away by the fact that all the investors would try to earn these profits, in consequence exhausting them.

- **The semi-strong form of market efficiency** claims that current security prices reflect all the historical information and publicly available information. Assuming that investors are rational none of them should be able to earn abnormal profits as they identify the same factors determining the security prices formation in the public information. As prices incorporate the new information very quickly no investor could earn abnormal profits by trading on this information.

- **The strong form of market efficiency** ads to the previous the fact that private information is also reflected in the security prices. Given that the insider information is already incorporated

in the price an investor should acquire new private information and act rather quickly in order to obtain abnormal returns. As this is expected to be very costly and improbable and adding the fact that it is also illegal in the most of the markets, the possibility of earning excess returns would be reduced to zero.

The strong form of market efficiency is thought to be extreme by most researchers and acts more like a benchmark when observing the deviations from market efficiency (Fama, 1970). However, the common belief is that the markets exhibit at least the weak form of efficiency. Finding that momentum strategies are profitable as a result of our research would come in contradiction with this hypothesis.

2.2 Random Walk

According to the random walk hypothesis, security prices do not follow any patterns or trends throughout time. Instead, their behaviour can be described as a 'random walk', i.e. there are no correlations among them. This leads to the fact that it is impossible to predict the future performance of a security from its past performance.

The beginnings of the random walk hypothesis can be attributed to Louis Bachelier's thesis written in 1900 *Theory of Speculation* (Lo and MacKinlay 1990) and since then it constituted an important subject of research and debates among financial researchers. Its popularity increased as new research confirmed its validity. An especially strong impact had the papers written by Kendall (1953), Fama (1965) and Malkiel (1973). However, towards the end of the 20th century the confidence in the random walk hypothesis was seriously shaken by a new wave of research. Among others, Lo and MacKinlay (1990) mention "it is by now well-known that the unforecastability of asset returns is neither a necessary nor a sufficient condition of economic equilibrium. And, in view of recent empirical evidence, it is also apparent that historical stock market prices do not follow random walks". There are three versions of the random walk hypothesis (Asgharian, 2008):

- **Random Walk 1** ***(RW1)*** is the strongest version and it implies that the price changes are independent and identically distributed *(IID)*.

- **Random Walk 2** ***(RW2)*** relaxes the second assumption, stating that price changes are still independent, but not identically distributed *(INID)*.

- **Random Walk 3** ***(RW3)*** is the weakest form of random walk hypothesis and it relaxes both assumptions and implies that returns can be dependent, but they have to be uncorrelated and they can be not identically distributed *(DNID)*.

2.3 Previous research

2.3.1 Momentum

Momentum strategy meaning to buy stocks that performed well in the past and to sell stocks that performed poorly was analyzed by a wide range of researches. Perhaps the most influential work in this area belongs to Jegadeesh and Titman (1993) who document that investors that follow the momentum strategy can earn significant positive returns over holding periods of 3-12 months. They based their research on US data, namely the returns of stocks listed in NYSE and AMEX. The sample period was 25 years (1965-1989). The method that Jegadeesh and Titman applied to analyze this strategy included creation of winner and loser portfolios. The winner portfolio contains the decile which is formed from the best performing stocks for the previous *J* number of months, while the loser portfolio consists of the decile of the worst performing stocks over the same period. Momentum strategy implies buying the winner portfolio and/or selling short the loser portfolio. The resulting zero-investment portfolio is held for the next *K* number of months. In order to perform the analysis they ranked the stocks based on their returns over the last 3, 6, 9, and 12 months and subsequently they were held over the same periods of 3, 6, 9, and 12 months. This produced 16 strategies plus an additional 16 where the authors skipped a week between the formation period and the holding period. Jegadeesh and Titman concluded that the most successful trading strategy is to form portfolios based on their past 12-months performance and to hold them for 3 months. A detailed examination of the strategy that uses stocks based on their 6-month returns with holding period of 6 months shows that abnormal returns cannot be attributed to systematic risk; moreover, they conclude that these excess profits are not due to lead-lag

effects. Jegadeesh and Titman also find that momentum strategies generate abnormal returns on an intermediate investment horizon between 1 and 12 months. However, short-term (less than 1 month) and long-term performance of the momentum strategies proved to be unprofitable (due to return mean-reversals).

Rouwenhorst (1998) documents the presence of medium-term return continuation on international equity markets. He analyzes twelve European countries[1] for the sample period between 1980 and 1995. The method that is used in the research is similar to the one applied by Jegadeesh and Titman (1993). Rouwenhorst constructs internationally diversified relative strength portfolios investing in medium-term winners and selling past medium-term losers. Following Jegadeesh and Titman, Rouwenhorst examined 32 trading strategies and found that the most successful strategy is the one based on 12 month evaluation period and 3 month holding period. The main finding is that this portfolio earns approximately 1% per month. Such a return continuation takes place in all twelve sample countries, and it is negatively related to firm size, i.e. return continuation is stronger for small than for large firms. Momentum effect does not last longer than 1 year and can not be explained by conventional measures of risk. Rouwenhorst's results for European countries are similar to findings for US market by Jegadeesh and Titman.

Moskowitz and Grinblatt (1999) analyze the momentum effect on the industry level of stock returns. They use data for twenty value-weighted industries portfolios for the period from July 1963 till July 1995. Their paper documents the evidence that the individual momentum effect is subsumed by the industry momentum. The industry momentum appears to be highly profitable even if the portfolios are neutral regarding size, book-to-market equity, individual stock momentum, cross-sectional dispersion in mean returns, and potential microstructure influences. Momentum strategy is highly profitable at intermediate investment horizon (up to 24 months), with the paper mostly focusing on abnormal returns over 6 to 12 months.

Nijman, Swinkels, and Verbeek (2002) analyze the medium-term return continuation in Europe, the main goal of their study being to identify the sources of the momentum effect. As potential

[1] Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom

determinants of the momentum effect they consider the country, industry, size, and value factors. Moreover, they examine in detail the presence of country and industry momentum effects. The methodology applied in their study is a portfolio-based regression approach that allows decomposing overall momentum effect on individual, country and industry elements. Nijman et al use the data for 15 European countries and 23 industries for the sample period 1990-2000. The main finding is that excess returns of momentum strategies are driven by individual stock effects rather than industry or country factors. These conclusions are in contradiction with Moskowitz and Grinblatt (1999) who claim that industry momentum drives the whole momentum effect in US. The inclusion of the size and value effects into the Nijman et al model shows that momentum strategy is more profitable for small, growth stocks than for large value stocks. These results are consistent with behavioural finance theories presented by Hong and Stein (1998) and Daniel et al (1998).

The study performed by Cooper, Gutierrez, and Hameed (2004) examines overreaction theories of short-term momentum and long-term reversals in the stock returns. They analyse monthly returns from 1929 till 1995. Following previous models developed by Jegadeesh and Titman (1993) and DeBondt and Thaler (1985) they test whether market overreactions are the sources of these effects. Cooper et al examine two states: “up” when the lagged market return is non-negative and “down” when lagged three-year market return is negative. They found that short-term momentum profits follow the up state, while long-run reversals follow down state.

The summarized results of previous research on momentum are presented in *Table 2*.

Table 2.1. Previous studies of momentum strategies

Authors	Year	Method	Data	Results
N. Jegadeesh Sh. Titman	1993	Creation of winner and loser portfolios Analysis of zero-investment portfolio (winner-loser) Examination of 16 trading strategies	US market NYSE and AMEX stock returns 1965-1989 monthly	The most successful trading strategy is12-3 Momentum strategy generates abnormal returns at intermediate investment horizon
K. Rouwenhorst	1998	Creation of winner and loser portfolios Analysis of zero-investment portfolio (winner-loser) Examination of 16 trading strategies	European market 12 European countries 1980-1995 monthly	The most successful trading strategy is12-3 Momentum portfolio portfolio earns approximately 1% per month Return continuation is stronger for small than for large firms Momentum effect lasts not more than 1 year
T. Moskowitz M.Grinblatt	1999	Creation of winner and loser portfolios Simple returns model that allows to illustrate momentum sources	US market NYSE, AMEX and Nasdaq stock returns 1963-1995 monthly	Momentum profits are driven by the industry effect Momentum strategies are highly profitable even after controlling for size, book-to-market equity, and individual stock momentum Momentum strategy is profitable at intermediate investment horizon
T.Nijman L.Swinkels M.Verbeek	2002	Portfolio-based regression approach Decomposition of overall momentum effect on individual, country, and industry elements	European market 15 European countries, 23 industries 1990-2000 monthly	Excess returns of momentum strategies are driven by individual stock effects Momentum strategy is more profitable for small growth stocks
M.Cooper R.Gutierrez A.Hameed	2004	Creation of winner and loser portfolios Analysis of momentum and contrarian strategies Examination of two states "up" and "down"	US market NYSE and AMEX stock 1929-1995 monthly	Short-term momentum profits follow up state Long-run reversals follow down state
J.Conrad G.Kaul	1998	Creation of winner and loser portfolios Empirical decomposition of profits, bootstrap and Monte Carlo simulations		Momentum strategy is efficient at the medium investment horizon Contrarian strategy gives abnormal returns at long-term horizon Cross-sectional variation in expected returns of individual securities is source of the profitability of trading strategy.

2.3.2. Contrarian

For the first time the profitability of contrarian strategies was documented by DeBondt and Thaler (1985) who studied psychological aspects of individual decision making and how this behaviour affects stock prices. Up until now it is still considered the most important study documenting and explaining contrarian strategies. Promoters of behavioural finance, the authors suggest that the majority of people tend to overreact to unexpected events. Their analysis is based on CRCP monthly return data. In their research DeBondt and Thaler present evidence which states that portfolios of previous losers outperform portfolios of prior winners in long investment horizon (thirty-six months after the portfolio formation). Contrarian strategy of buying past losing stocks and to sell past winning stocks is profitable on long-term horizon (3 to 5 years). These returns of a contrarian portfolio are negatively autocorrelated. Moreover they detect the presence of the calendar effect as large positive excess returns of losers portfolios were earned every January. This effect is observed five years after portfolio formation.

Lo and MacKinlay (1990) investigate contrarian investment strategies and their probability to be due to market overreactions. They conclude that portfolios based on return reversals earn excess profits that could be explained by cross-autocorrelation effects (lead-lag relations). However Jegadeesh and Titman (1992) present another decomposition of short-term contrarian profits. The decomposition is based on single factor model. In contrast with Lo and MacKinlay they find out that lead-lag effect explains only 5% of contrarian profits while the major source of abnormal profits are market overreactions.

Conrad and Kaul (1998) in their paper examined two investment strategies - momentum and contrarian – at eight different horizons and different time periods. For this kind of analysis they applied empirical decomposition of profits, bootstrapping and Monte Carlo simulations. They document that momentum strategy is profitable on a medium investment horizon (3 to 12 months) except during the 1926-1947 sub-period, while contrarian strategy yields abnormal returns on a long-term horizon. Another important finding is that cross-sectional variation in expected returns of individual securities plays a major role in determining the profitability of trading strategy.

The summarized results of previous research on contrarian are presented in *Table 3.*

Table 2.2. Previous studies of contrarium strategies

Authors	Year	Method	Data	Results
W.Lo A.MacKinlay	1989	Creation of winner and loser portfolios Examination of expected profits of contrarian strategies under various assumptions on the return generation process		Portfolios based on return reversals earn excess profits Excess returns are explained by cross-autocorrelation effects (lead-lag relations)
F.De Bondt R.Thaler	1985	Creation of winner and loser portfolios Analysis of contrarian strategy (losers-winners)	US market CRCP monthly return data	Contrarian strategyis efficient on long-term horizon (3 to 5 years) Contrarian portfolio is negatively autocorrelated Presence of calendar effect
N. Jegadeesh Sh. Titman	1992	Creation of winner and loser portfolios Decomposition of short-term contrarian profits		lead-lag effect explains only 5% of contrarian profits the major source of abnormal profits are market overreactions

2.3.3 Behavioural finance

Behavioural finance is a research field that applies scientific research in human psychology in order to determine how economic decisions made by individuals are reflected in the allocation of resources, formation of market prices etc. In this section we present the most important research that has been done in this area and the relevant findings it has produced.

Kahneman and Tversky develop in 1979 the *Prospect theory* which can be seen as an alternative to the *expected utility theory*. It explains the way individuals make their choices under conditions of risk, how they evaluate risky alternatives by weighting potential gains and losses. The decision taking process is organized in two steps. In the first step, a benchmark is established and outcomes below it are viewed as losses whilst the ones above are viewed as gains. In the second step values of the possible outcomes are calculated and the outcome yielding the highest value is chosen. An important phenomenon documented by this paper is the *representativeness heuristic* which means that when evaluating the probability of an uncertain event a person takes into consideration "the degree to which it is (i) similar in its essential properties to the parent population, (ii) reflects the salient features of the process by which it is generated". A consequence of this fact is that even when people are confronted with a sample of random information they believe they can see patterns. This leads to an overvaluation of a company and

then to a price reversal. An interesting finding of this paper is the so-called *four-fold pattern of risk attitudes*, which answers the question: why do people buy both lottery tickets and insurance? It seems that individuals exhibit risk-averse attitude in case of moderate gains probabilities and small losses probability and, at the same time, risk-accepting attitude in case of moderate losses probability and small gains probability. This effect has come to be known as the *pseudocertainty effect*. Furthermore, the paper documents the fact that people tend to use any available information when making a decision. This can even be irrelevant information if no other is available.

Barberis, Shleifer and Vishny (1998) treat in detail the over- and underreaction phenomena. Underreaction is observed on time horizons between 1 month and 1 year, when information is gradually incorporated into the prices and the prices are positively autocorrelated. Due to this fact positive future performance can be forecasted from the past positive performance. Over longer periods of time, usually 3 to 5 years, overreaction phenomenon manifests itself as a result of positive news patterns, that is a stock with a long history of past positive returns will be highly overvalued and when future expected performance does not materialize prices tend to revert to the mean. As causes for over- and underreaction Barberis et al mention the findings of Tversky and Kahneman (1974) and Edwards (1968), namely representativeness heuristic, explained above, and conservatism, which means a slow reaction when confronted with new information. The model employed by the authors assumes earnings that follow a random walk. The investor is not aware of that and instead he thinks the earnings are moving between a mean-reverting state and a trendy state. As the transition probabilities and earning's statistical properties are rigid there is a higher probability of remaining in the same state than of switching. The investor updates his beliefs of which state he is in each period by observing the earnings. Thus repetitive positive earnings surprises increase the probability of him perceiving himself as being in the price continuation state, while a negative surprise following a positive one does the same for the mean-reverting state. Solving this model yields a confirmation of the conservatism and representativeness.

Daniel, Hirshleifer and Subrahmanyam (1997) explain security prices anomalies based on the phenomena of *investor overconfidence* and *self-attribution bias*. Overconfidence is not typical

only in the financial context but it was also documented by psychologists, engineers, attorneys, physicians etc. In the financial context particularly important are the contributions of Ahlers and Lakonishok (1983), Elton, Gruber and Gulteking (1984), Froot and Frankel (1989), DeBondt and Thaler (1990) and DeBondt (1991). The *overconfidence theory* says that "individuals overestimate their own abilities in various contexts" (Daniel et al 1997). In the authors' model, an overconfident individual is one who overestimates the accuracy of the private information he obtains regarding the value of a security. As investors have more confidence in information they are more involved with, they will be more overconfident in the private information they receive before others than in the public information everybody receives at the same time. This leads to an overreaction to private signal and to an underreaction to public signals. As time passes, overreaction effect dissipates and more public information becomes available and gets incorporated into the price, thus correcting it towards its fundamental value. The *self-attribution bias* means that investor's confidence grows when public information confirms his private information; however, when his information is infirmed, his confidence does not decrease proportionally. Broad psychological research documents the fact that individuals tend to give themselves credit for past successes whilst blaming external factors for past failures (Fischoff 1982, Langer and Roth 1975, Miller and Ross 1975, Taylor and Brown 1988).

Hong and Stein (1998) introduce a model consisting of *newswatchers* and *momentum chasers*, none of them being fully rational, both only being able to process only some subset of publicly available information. This contradicts the assumption of homogeneity, as now we are dealing with heterogeneity. The two types of traders use different information when valuing a security. Newswatchers use only private information about a company's future prospects while momentum traders rely on the past performance of a company when valuing it. Resulting from this, underreaction is exhibited when only the newswatchers are active, as the new information releases diffuse slowly within the newswatchers being thus gradually incorporated into the prices. When momentum traders come also into play, they accelerate this diffusion as they notice the above mentioned underreaction and the resulting positive autocorrelation meaning profit opportunities and they exploit them. However this mitigation of the underreaction leads to a higher sensibility to the news releases which causes in consequence overreaction. If assuming that the momentum traders use only simple strategies, i.e. not conditioned on all available

information, their intervention does not fully mitigate the underreaction and does not lead to the markets becoming efficient (or approximately efficient).

A summary of the previous research we consider most relevant for our study is provided in Table 2.3.

Table 2.3. Previous studies of behavioural finance

Authors	Year	Main focus	Results
Kahneman Tversky	1979	The way individuals make decisions under conditions of risk and the way they evaluate risky alternatives	Phenomenon of the representativeness heuristic Four-fold pattern of risk attitudes Individuals tend to use any available even irrelevant information when making a decision Pseudocertainty effect Overevaluation of the company by individuals that leads to price reversals
Barberis Shleifer Vishny	1998	Underreaction and overreaction phenomena using model which assumes earnings that follow a random walk	Underreaction is observed on time horizons between 1 month and 1 year Over 3 to 5 years periods overreaction phenomenon is a result of positive news patterns Confirmation of the conservatism and representativeness phenomena
Daniel Hirshleifer Subrahmanyan	1997	Security price anomalies	Investors' overreaction to private signal and an underreaction to public signals Self-attribution bias which means that investor confidence grows when public information confirms his private information Individuals overestimate their own abilities in various contexts
Hong Stein	1998	Two type of traders - newswatchers and momentum chasers	Newswatchers use only private information about company's future prospects Momentum traders rely on the past performance of a company when valuing it Underreaction is exhibited when the newswatchers are active Presence of momentum traders does not mitigate the underreaction and does not lead to the efficiency in the market

3. Methodology

In this chapter we present the data and the methodology that we have used, describing in detail both the method that was used in the momentum effect study and the method used for the analysis of its sources.

3.1 Data

For the empirical analysis of the different momentum strategies we use the monthly stock returns of individual companies from various industries. As the source of collecting the data we chose Thomson Datastream (Datastream), assuming the reliability of the information offered. We split the companies from our sample in 25 industries[1]. As the primary industry differentiation we used the classification presented in Datastream. However, we afterwards merged some of the related industries in order to obtain the industry classification used by the Morgan Stanley Capital International (MSCI). In consequence, *Electricity* and *Gas and Water* became *Utilities*, *Fixed Line Telecommunications* and *Mobile Telecommunications* were grouped in *Telecommunications Services*. This classification has a more widespread use and at the same time yields fewer industries than the ones found on Datastream, which makes the analysis more parsimonious and comprehensible.

The data is collected for an approximately 10-year period from January 1999 until April 2009. The main reason for choosing this period was the fact that no other momentum study is recent enough to include the current global financial crisis. As the starting point of the period we chose 1999, thus obtaining a time period bordered by to crises – the '99-00' "internet bubble" phenomenon and the current financial crisis.

[1] *Energy, Automobiles, Banks, Beverages, Chemicals, Constructions and Materials, Utilities, Electronical and Electrical Equipment, Financial Services, Telecommunication Services, Food Producers, Food and Drug Retailers, Forestry and Paper, General Industrials, Household Goods, Leisure Goods, Media, Insurance, Oil and Gas, Personal Goods, Pharmaceuticals, Biotechnology and Life Sciences, Real Estate, Software and Services, Technology Hardware and Equipment, Travel and Leisure.*

The data is collected for 15 countries that joined the Eurozone before January 1, 2009: Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovenia and Spain. Our final data sample includes 5391 companies grouped by country and industry characteristics. From the Appendix A.1 it can be seen that the distribution of companies between different countries in our data sample is not balanced. More than half (3001) of all EMU companies operate in Germany and France. Other almost 20% of firms are concentrated in Belgium, Greece and Italy. Thus 5 of the 15 Eurozone countries contain more than three quarters of the companies from our data sample.

The distribution of firms among various industries is presented in Appendix A.2. The largest amount of firms (around 12%) operates in the *General Industrials* industry. *Financial Services* and *Software* contain around 10% of companies each. So, more than 30% of all companies are concentrated in three industries, the rest 70% of the firms are distributed among other 22 industries. In order to calculate the monthly returns for each company we apply the dividend adjusted formula:

$$R_{it} = \frac{P_t + D_t}{P_{t-1}} - 1$$

Where Ri_t – stock return in month t; P_t and P_{t-1} – stock prices in month t and t-1; D_t – dividends paid in month t. For stock prices we take monthly closing prices.

We collect stock closing prices for all companies that activated in various industries in the Eurozone during the time period analyzed (January 1999 until April 2009). We include the newly established firms and the delisted companies throughout this period. The inclusion of delisted companies is particularly important in order to avoid the "survivorship bias". Omitting this aspect will lead to excessively positive results.

We also collected some additional data in order to perform our regressions. We chose the Datastream estimated EMU-DS as the market index, considering it the most relevant index, as it contains the countries and industries we included in our study. However, it is worth to be mentioned that it does not include all the companies in our sample. Other indexes as MSCI EMU

or FTSE EMU show very similar to EMU-DS performances. Based on this index we calculated the monthly market returns. We use these returns as a reflection of the Eurozone market performance. For the risk-free interest rate we took the monthly yield of 3-months bonds issued by European Central Bank (Euribor 3-months).

3.2 Method

3.2.1 Theoretical specifications

The method we use in our research resembles partly that applied by Jegadeesh and Titman (1993) and Rouwenhorst (1998). Based on the previously calculated returns we construct winner and loser portfolios in the same way the mentioned authors did. The main difference results from introducing the industry as a possible determinant of the momentum strategies profitability. We form loser and winner portfolios for the whole number of stocks from the Eurozone, as well as within each of the industries and countries. Besides analyzing the profitability of momentum strategies for the whole market, we investigate this type of strategies for each country and industry in order to determine where the profitability is more pronounced. In case of finding the momentum strategies being profitable for the Eurozone market, the country and industry factors will be used in constructing country- and industry-neutral portfolios. This will allow us to determine the degree to which these factors contribute to the total profitability, as there is some controversy among researchers related to this subject. Moskowitz and Grinblatt (1999) find that the momentum effect for US is subsumed by the industry momentum while Grundy and Martin (2001) suggest that industry and individual stock momentum are distinct. Nijman et al (2002) suggest that the momentum effect for the European market is mainly driven by the individual momentum and it is not subsumed by the industry and country momentum. Moreover, Chan et al (2000) document a six-month momentum effect on a country level while Richards (1997) finds there is no country momentum effect. We hope our findings will contribute to shedding some further light on this issue.

3.2.2 Portfolio construction

In line with Jegadeesh and Titman (1993) we construct winner and loser portfolios. At the beginning of each month *t* the stocks are ranked according to their performance in the previous *J* months, where *J* can be 1, 2, 3 or 4 quarters. The resulting ascending list is split in 10 equally-weighted deciles, where the first decile consists of the most poorly performing stocks and represents the Loser portfolio, while the last decile consists of the best performing stocks and forms the Winner portfolio. The resulting Winner and Loser portfolios are subsequently held for *K* months, where *K* can be 1, 2, 3 or 4 quarters. In each month of the holding period the zero-cost strategy we analyze sells short the Loser portfolio and buys the Winner portfolio, thus the strategy's profit is yielded by the difference between Winner portfolio's returns and Loser portfolio's returns. As the holding period is longer than the time interval over which information is available, we obtain portfolios with overlapping holding periods. This means that in each month *t* the strategies are composed of portfolios that are formed in the current month, as well as in the previous *K*-1 months. Thus for $K = 3$, the strategy will contain winner and loser portfolios formed in the current month and the previous two months. The weights of $1/K$ stocks are rebalanced each month, while the rest are carried over until the end of their respective holding period. Using overlapping holding periods increases the power of our tests (Jegadeesh and Titman, 1993).

The above mentioned procedure of forming portfolios is performed for the whole Eurozone market, as well as within each industry and within each country member of the Eurozone. Besides investigating the momentum effect for Eurozone, it will allow us to identify the potential countries or industries within which the momentum effect has the most persistent presence and thus is the most profitable. This would be of interest for investors who intend to exploit the profit possibilities resulting from the price continuation.

3.2.3 Testing for statistical significance

After calculating the momentum strategies profitability, we test these results in order to determine whether they are significant performing a *t*-test. As we analyze a zero-cost strategy, we

test our results against the null hypothesis stating that the returns are not significantly different from zero (μ). The following formula is used:

$$t_{obs} = \frac{\overline{R}_{J/K} - \mu}{\sigma / \sqrt{N}} \sim t_{n-1,\alpha}$$

Where: t_{obs} is the *t*-value; $R_{J/K}$ is the mean return of the zero-cost portfolio; μ is set to zero; σ is the standard deviation of the sample; N is the number of observations; α is the confidence level; n-1 is the number of degrees of freedom. For the results to significant we need that $t_0 > t_{n-1,\alpha}$.

3.2.4 Robustness test

A robustness test is performed for analyzing the consistency of the momentum strategies throughout different periods of time. Thus we split our time period in two subperiods, 1999-2003 and 2004-2009 and analyze the momentum strategies for each of them. Moreover, we analyze one more time sub-interval which we obtain by excluding the time period starting with September 2008 onwards, as this is considered to be the moment when the global financial crisis started to be visible in Europe. This will allow us to analyze the momentum profitability both with and without the financial crisis' influence and to draw conclusions on whether there is still observed a return continuation during the crisis or not. Performing a test of robustness makes it possible to identify any potential differences in the profitability of the momentum strategies in these sub-periods or a tilting towards one of them.

3.3 Determinants of momentum profitability

3.3.1 Relative strength portfolios by country

Following Rouwenhorst (1998) we construct country-neutral portfolios. The momentum profitability could be driven by the country, so that stocks in the Winner (Loser) portfolios can be tilted towards a better (worse) performing country. We rank the stocks in deciles based on their past performance within a certain country and we assign the top performing decile to the Winner portfolio and the bottom performing decile to the Loser portfolio, thus forming equally-weighted country-neutral portfolios. The results are analyzed for significance. Obtaining significant

momentum profits will indicate towards the fact that they are not driven by the country factor, but rather by the individual factor.

3.3.2 Relative strength portfolios by industry

As stocks belonging to some industries may be better performers than stocks belonging to others, the Winner portfolio on the Eurozone level might consist mainly of stocks of such well performing industries while the Loser portfolio might include mainly stocks from poor performing ones. If this is the case, the momentum effect can be thought as being driven by industries and not by the individual factors. To isolate the industry effect from the individual effect we construct industry-neutral portfolios. If after this procedure our momentum strategy is still profitable, we can conclude this can be attributed to the idiosyncratic firm performance rather than to the industry performance.

Industry-neutral portfolios are constructed in the following manner. Stocks are ranked into deciles according to their performance only within a particular industry. The top 10 percent stocks of each industry will be included in the winner portfolio and the bottom 10 percent in the loser portfolio. Thus our Winner and Loser portfolio will include the same percentage of stocks from each of the industries analyzed, resulting well-diversified, country-neutral portfolios. A significance test will be run for the obtained results.

3.3.3 Adjustment for Market Factor

The abnormal profits yielded by a momentum strategy could be a compensation for the extra-riskiness of the stocks included in the Winners and Losers portfolios. In order to analyze this potential momentum explanation we run the following regression:

$$R_{i,t} - r_{f,t} = \alpha + \beta\,[R_{m,t} - r_{f,t}] + \varepsilon_{i,t}$$

Where $R_{i,t}$ is the monthly return of Loser or the Winner in the month t, $r_{f,t}$ is the risk-free rate and $R_{m,t}$ is the market return. We regress the monthly Winner and Loser portfolio returns in excess of the monthly risk-free rate of the 3-month Euribor bonds ($R_{i,t} - r_{f,t}$) on the monthly returns of the EMU market index in excess of the risk-free rate ($R_{m,t} - r_{f,t}$). If the momentum profits are due to an increased riskiness of the stocks in our portfolios, we should obtain a beta of the Winner-Loser portfolio larger than one. Otherwise, it can be concluded that the momentum excess returns are not a compensation for risk. We run this regression for Winners and Losers of the three distinct portfolios: the unrestricted portfolio, the country-neutral portfolio and the industry-neutral portfolio.

3.3.4 Adjustment for Market, Size and Value Factors

As documented by Fama and French (1993), smaller capitalization stocks and stocks with a higher book-to-market value tend to have a better performance. In order to analyze whether Winner and Loser stocks load heavier on the smaller capitalization stocks or higher value stocks, we include these two additional factors and perform the following regression:

$$R_{i,t} - r_{f,t} = \alpha + \beta\,[R_{m,t} - r_{f,t}] + \gamma SMB + \delta HML + \varepsilon_{i,t}$$

SMB stands for "Small Minus Big" capitalization stocks and *HML* means "High Minus Low" value stocks. Obtaining a positive and significant γ would indicate that our portfolios load heavier on small stocks and thus the momentum profits are influenced by the size of the stocks in the portfolio. Likewise, a positive and significant δ would mean that our portfolios consist of mainly high-value stocks, with the negative value meaning a tilting towards growth stocks which are more volatile. Significant coefficients for the HML factor would mean that value influences the return continuation effect.

4. Results and analysis of momentum sources

In this chapter we present our results concerning the profitability of the momentum strategies, together with testing their potential sources.

4.1 Profitability of relative strength portfolios

A. Momentum profitability on the Eurozone market

Constructing Winner and Loser portfolios for the Eurozone market resulted in a solid proof of the momentum profitability existence. For all the 16 strategies analyzed Winners outperformed the Losers by at least 0,1%; 13 out of 16 strategies yielded significant profits at the 5% level *(See table 4.1)*.

Table 4.1 Returns of Relative Strength Portfolios

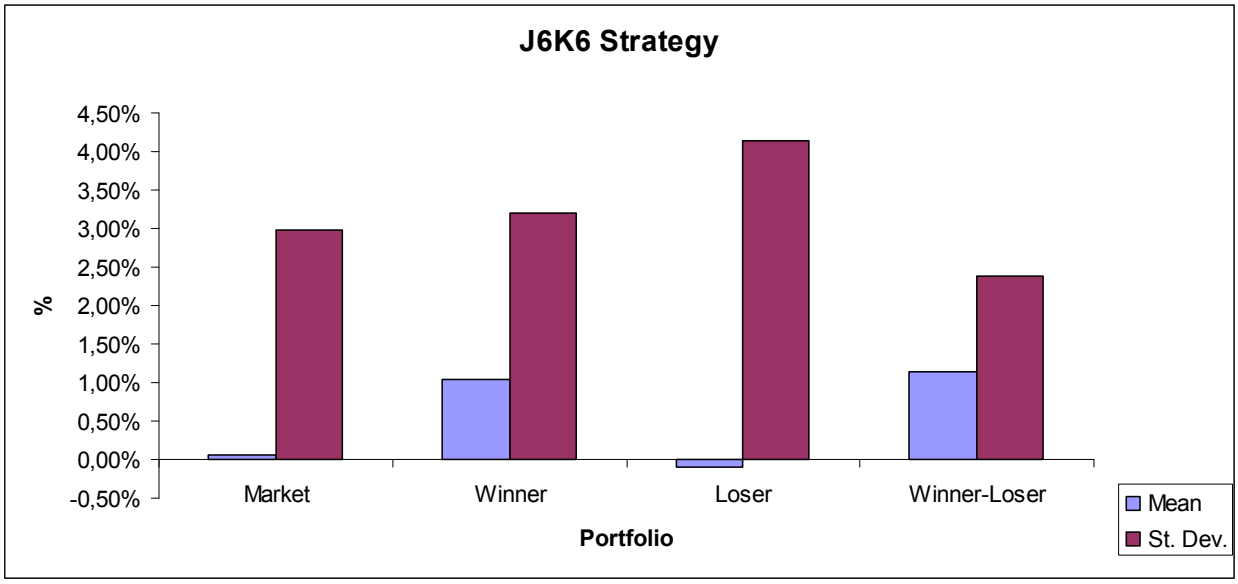
Ranking period (J)		Holding period (K) 3	6	9	12
	Loser	0,49%	0,14%	0,20%	0,26%
	Winner	1,24%	1,10%	0,97%	0,85%
3	Winner - Loser	0,75%	0,96%	0,77%	0,60%
	(t-stat)	*2,05*	*4,20*	*4,46*	*3,94*
	Loser	0,07%	-0,10%	-0,01%	0,15%
6	Winner	1,28%	1,04%	0,86%	0,70%
	Winner - Loser	1,21%	1,14%	0,87%	0,56%
	(t-stat)	*3,32*	*5,09*	*4,93*	*3,11*
	Loser	0,04%	-0,15%	0,01%	0,16%
9	Winner	0,93%	0,74%	0,59%	0,47%
	Winner - Loser	0,89%	0,89%	0,58%	0,30%
	(t-stat)	*2,59*	*3,87*	*2,82*	*1,53*
	Loser	-0,08%	-0,13%	0,06%	0,24%
12	Winner	0,62%	0,48%	0,38%	0,34%
	Winner - Loser	0,70%	0,61%	0,32%	0,10%
	(t-stat)	*1,97*	*2,34*	*1,45*	*0,51*

Insignificant profits

The average monthly return of the momentum strategies is about 0,8%, which is close to the 1% average monthly return documented by other previous studies (Jegadeesh and Titman 1993, Rouwenhorst 1998). The lowest monthly return was produced by the *J12K12* strategy (0,1%), while the highest was earned by the *J6K3* strategy (1,21%). This is somewhat different from the two above mentioned studies, which document the *J12K3* strategy as being the most profitable. In our case this strategy yields a slightly lower than the average profit, 0,70% per month. In general, our study documents that for longer formation periods combined with longer holding periods the momentum profitability and its significance decrease. Thus, the least profitable and significant strategies and are *J9K12, J12K9* and *J12K12*. This could indicate that for our data and market momentum strategies have a shorter horizon of profitability than it has been previously documented. As the time period *(J+K)* gets closer to 24 months, we observe a strong decrease in the Winner portfolio's returns together with a strong increase in the Loser portfolio's returns. This indicates towards return mean reversion on a medium-to-long term which causes the momentum profits to vanish.

In order to make comparisons with previous studies possible, we further focus on the strategy that ranks stocks according to their past six month performance and holds them for six month subsequently *(J6K6)*. The same strategy is used when analyzing the determinants of the momentum profitability. From the Graph 4.1 one can see that this zero-cost strategy clearly outperforms the market, earning 1,08% monthly in excess of an index formed by all the stocks contained in our sample. The Winner portfolio outperforms the market, having an excess return of 0,98%. Furthermore, it can be observed that both Winner's and Loser's standard deviations are higher than the market's. Loser's standard deviation is 38% higher than market's, while Winner's standard deviation is 7% in excess. As these two portfolios have a higher volatility than the market, they are more likely predisposed to a peculiar behavior.

Graph 4.1 – The J6K6 Strategy



B. Robustness test

In order to check the consistency of the momentum strategies and the eventual differences throughout the time horizon analyzed, we analyze the *J6K6* strategy for 3 sub-periods: 1999.01.01-2003.12.31, 2004.01.01-2009.04.01 and 1999.01.01-2008.08.31. The first two sub-periods represent two approximately equal sub-intervals. For the third sub-period we exclude the financial crisis, so that we can investigate whether it affects or not the momentum profitability. The start of the financial crisis in Europe we consider to be the 1st of September 2008. Our findings are presented in the *Table 4.2*:

Table 4.2 – Robustness test

Robustness test								
	1999-2009		1999-2003		2004-2009		1999-2008 (no crisis)	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Winner	1,04%	3,20%	0,75%	3,34%	1,37%	3,02%	1,37%	3,04%
Loser	-0,10%	4,14%	-0,30%	4,61%	0,13%	3,56%	0,30%	3,98%
Winner-Loser	**1,14%**	**2,37%**	**1,05%**	**3,13%**	**1,24%**	**0,95%**	**1,07%**	**2,43%**
t-stat	5,09		2,60		9,44		4,50	

One can see that the differences among the returns earned by the momentum strategies in each of these sub-periods are minor. In each sub-period the profits are above 1%, with the 2004-2009 being the most profitable sub-period; furthermore, all profits are highly significant at 5% percent level. As it was the case for the entire period, the standard deviations of the Loser portfolios are higher than the Winner's for all sub-periods. Excluding the financial crisis period causes the standard deviations of the Loser and Winner to slightly decrease, together with a decrease in the profitability of the momentum strategy. Higher differences can be observed between the 1999-2003 and 2004-2009 sub-periods, with the latter being more profitable. One possible explanation could be that the '99-00' "internet-bubble" period decreased momentum profitability for this sub-period. An interesting finding is that the current financial crisis did not affect negatively the momentum profitability; on contrary, it slightly increased it. It did however affect negatively the returns of the Winner and Loser, but it affected the returns of the Loser more drastically than the returns of the Winner (-133% compared to -24%). Due to this fact the excess returns of the Winner over the Loser in fact increased.

We can conclude that the momentum strategies are consistent throughout the time horizon analyzed, yielding returns over 1% in each sub-period.

4.2 Sources of the relative strength portfolios profits

In this subsection we try to identify the sources of the momentum profits, analyzing the country and industry factors, as well market risk and firms' size and value as potential explanations of the momentum excess returns.

4.2.1 Relative strength portfolios by country

We focus on the relative strength portfolios formed on a country basis. As it was mentioned earlier more than a half of the 5391 companies from our sample operate in Germany (1601) and France (1400) and more then 75% of all the firms are concentrated in five countries: Belgium (278), France (1400), Germany (1601), Greece (374), and Italy (414). A strong momentum effect

which is present (only) in these countries could drive the overall effect for the whole Eurozone area. Due to this fact we analyse this potential source of the return continuation phenomenon in order to determine whether the overall effect is driven by the country factor.

For each of the 15 countries we form relative strength portfolios with the evaluation and holding periods being equal to 6 months. This means that at the end of each month stocks from every local market are ranked based on their previous six months performance within that market and divided into deciles. The top decile companies are considered to be a part of the Winner portfolio while the bottom decile companies are grouped in the Loser portfolio. This zero-investment strategy of buying the Winner portfolio and selling the Loser portfolio holds these portfolios for six months. The resulting country-neutral and equally-weighted portfolio yields an average excess return of 1,01% per month. This suggests that overall the momentum profitability is not country-driven. However, a very high profitability of some countries could lead to the momentum strategy being profitable even if in the absence of such type of profitability in the other countries. From table 4.3 we can see that this is not the case, though.

Table 4.3 Returns of Relative Strength Portfolios by Country

Portfolio	Mean	St.dev.	*t* (mean)
1 Austria	0,77%	3,26%	*2,48*
2 Belgium	1,37%	2,29%	*6,34*
3 Cyprus	-0,02%	6,18%	*-0,04*
4 Finland	1,89%	3,59%	*5,57*
5 France	0,63%	2,85%	*2,35*
6 Germany	1,10%	2,76%	*4,23*
7 Greece	0,77%	4,37%	*1,87*
8 Ireland	1,67%	3,45%	*5,11*
9 Italy	1,68%	2,51%	*7,10*
10 Luxembourg	0,99%	2,60%	*4,02*
11 Malta	1,03%	1,68%	*6,49*
12 Netherlands	0,77%	4,01%	*2,04*
13 Portugal	-0,01%	5,08%	*-0,02*
14 Slovenia	1,36%	4,25%	*3,38*
15 Spain	1,15%	2,13%	*5,70*
All stocks (Country-neutral)	**1,01%**	**1,61%**	***2,43***

Insignificant at 5% level

In 13 out of 15 countries included in the sample momentum profits are present. Only two countries exhibit slightly negative monthly returns, Cyprus and Portugal. However, as it can be seen in the Appendix A.1, these two countries account for just 5% of all firms in the data sample. Moreover, as these returns are insignificant, no strong inferences regarding momentum unprofitability within these two markets can be drawn. All the other countries demonstrate positive monthly returns that vary in average from 0,63% for France to 1,68% for Italy. In terms of significance, Greece is the only country with positive, but insignificant excess returns at 5% level; at 10% level they are significant, however.

Controlling for country composition lowers the returns of the *J6K6* strategy very slightly, from 1,14% to 1,01%. The average standard deviation of each country's excess returns is 1,61% compared to 2,37%, which is the standard deviation of our reference portfolio. This suggests that a country-neutral portfolio is better diversified. At the same time, the average individual country standard deviation (3,40%) is more than two times higher than that of the resulting internationally diversified portfolio (1,61%), meaning that a great amount of momentum profits volatility is specific to a particular country and can be diversified internationally.

Our findings show that evidence of return continuation is found in almost all the Eurozone countries, where the *J6K6* strategy earns about 1% per month. There are not very big differences among the profits observed in each country; all the significant returns are revolving closely around 1%. We can therefore conclude that the country factor has a negligible importance in explaining the profitability of the momentum strategies for the Eurozone market. Our finding is in line with the results of some other previous research. Rouwenhorst (1999) analyzed 12 European local markets came to the same conclusion; Nijman et al (2002) investigated the same number of European countries as we did (15) and could not find evidence of country factor driving the momentum profits. On the other hand, our results come in contradiction with Chan et al (2000) who state that winner portfolios consist mainly of stocks from the smaller countries.

4.2.2 Relative strength portfolios by industry

The companies in the sample are not equally distributed among the industries. As it was mentioned earlier more than one third of the 5391 companies operate in *General Industrials* (640), *Software* (562) and *Financial Services* (546) industries. Therefore, it is important to determine whether the continuation effect is driven by industry momentum effects.

In this section we focus on the relative strength portfolios formed on an industry basis. For each of the 25 industries we form relative strength portfolios with evaluation and holding periods equal to six months. At the end of each month stocks from each industry are ranked based on the previous six months performance and divided into deciles. The companies of the top decile are considered to be a part of Winner portfolio while those of the bottom decile are grouped in Loser portfolio. This zero-investment strategy of buying the Winner and selling the Loser holds these portfolios for six months. The return of the industry-neutral portfolio is calculated as the average of momentum returns in each country. Table 4.4 presents the average monthly returns of zero-investment portfolios, standard deviation and *t*-statistic for the *J6K6* strategy in different industries of Eurozone for the period 1999-2009.

Out of the 25 industries analyzed, 21 exhibit positive excess returns of Winners over Losers; 17 of them yield significant profits at 5% level. Positive, but insignificant returns produced the *Electronic&Electrical Equipment, Food Producers, Personal Goods*, and *Telecommunications* industries. We have identified four industries (*Chemicals, Financial Services, Media* and *Technology*) where the *J6K6* strategy produced negative returns, all of them, however, insignificant. Our momentum strategy resulted in profits in the range of 0,33% (for Telecommunications) to 2,84% (for Energy). The strongest continuation effect is observed in the *Energy* industry (2,84%), followed by *Oil&Gas* (1,97%), *Leisure Goods* (1,60%), and *Banks* (1,58%).

Table 4.4 Returns of Relative Strength Portfolios by Industry

	Portfolio	Mean	St. Dev.	*t (mean)*
1	Automobiles	1,35%	4,87%	*2,93*
2	Banks	1,58%	2,56%	*6,54*
3	Beverages	1,11%	2,09%	*5,63*
4	Chemicals	-1,41%	14,00%	***-1,07***
5	Construction and materials	0,89%	4,81%	*1,96*
6	Electronics&el.equipment	0,73%	4,37%	***1,77***
7	Energy	2,84%	8,52%	*3,52*
8	Financial Services	-0,75%	8,41%	***-0,95***
9	Food Producers	0,42%	3,89%	***1,14***
10	Food Retailers	1,06%	3,92%	*2,86*
11	Forestry	1,26%	4,74%	*2,82*
12	General Industries	1,03%	2,27%	*4,81*
13	Household	1,25%	4,66%	*2,84*
14	Insurance	0,69%	2,66%	*2,74*
15	Leisure goods	1,60%	4,79%	*3,53*
16	Media	-0,14%	4,53%	***-0,34***
17	Oil&Gas	1,97%	5,65%	*3,69*
18	Personal goods	0,01%	5,23%	***0,02***
19	Pharmaceuticals	1,14%	4,23%	*2,86*
20	Real estate	0,71%	3,28%	*2,29*
21	Software	0,99%	3,23%	*3,25*
22	Technogoly	-0,11%	5,76%	***-0,20***
23	Telecommunications	0,33%	10,56%	***0,33***
24	Travel&Leisure	1,07%	5,15%	*2,21*
25	Utilities	0,79%	2,99%	*2,79*
	All stocks (Industry-neutral)	**0,82%**	**1,92%**	**4,50**
			Insignificant at 5% level	

The resulting industry neutral portfolio has an average monthly return of 0,82% which is significant at 5% level. Controlling for industry composition lowered the returns of our strategy by 39%, i.e. from 1,14% to 0,82%. The average individual industry standard deviation (5,09%) is almost three times higher than that of the resulting internationally diversified portfolio (1,92%). This fact indicates that a great amount of momentum profits volatility is specific to a particular industry and thus can be diversified.

The momentum effect within the industries is not as uniform as it was the case with the countries. The individual industry excess returns vary to a greater extent from the average, for some industries exceeding the average monthly return by 2-3 times. The standard deviation of the

industry-neutral portfolio is 20% higher than that of the country-neutral portfolio (1,92% compared to 1,61%). Although the momentum profits are present in the majority of industries, the results are not that straightforward as in the previous situation. We conclude that the industry factor can not be considered as the main force that drives the excess returns. However, it is of some importance, since controlling for it leads to an average return decrease from 1,14% to 0,82%.

Our findings do not indicate towards the industry factor as being the main determinant of the momentum effect, being rather similar to the results that Nijman, Swinkels, and Verbeek (2002) reached. They analyzed 23 European industries using a portfolio-based regression approach and found that industries had a rather weak influence on the overall momentum effect, at the same time being stronger than the country influence, but much weaker than the individual stock factor. Moskowitz and Grinblatt (1999), on the other hand, state that, for the US market, industries are the ones responsible for the momentum effect.

4.2.3 Adjustment for Market Factor

Thus far we could not find a sound explanation for the existence of the continuation effect. In this subsection we regress the monthly excess returns of our portfolios on the market risk premium in order to identify a potential relation between the market risk and the momentum profits. We perform this regression for each of the unrestricted, country-neutral and industry-neutral Winner and Loser portfolios.

Before estimating the regressions all data has to be tested for stationarity. One commonly used method for checking the existence of a unit root in the data is the Dickey-Fuller test. The results of this test are presented in Appendix B. The regression parameters are estimated using the OLS method. However, in order to use the OLS estimation technique, five fundamental assumptions have to be fulfilled. The results of checking the underlying OLS assumptions are presented in Appendix C. Conducting unit root, heteroscedasticity, serial correlation, and normality tests, we find the data being stationary and homoskedastic. The errors are autocorrelated therefore some necessary adjustments were made *(See Appendix C3)*. The normality assumption is violated for

several regressions; however, we decide to use this data based on the fact that the regression estimators are still unbiased and have the smallest variance.

The regression results obtained for the unrestricted portfolios are shown in the Table 4.5. The alpha coefficient of the Winner (0,0140) is highly significant, whereas the Loser portfolio alpha (-0,0031) is insignificant. The alpha of the resulting Winner-Loser portfolio is 0,0171 and it is significant. We see that in fact adjusting for the market risk leads to the growth of the excess returns from 0,0114 to 0,0171 per month.

Table 4.5. Unrestricted relative strength portfolio

	α	t(α)	β	t(β)
Winner	0,0140	6,18	-0,06	-1,55
Loser	-0,0031	-0,83	0,24	4,04
Winner-Loser	0,0171	6,04	-0,31	-2,16

Both the Winner and the Loser have significant betas. The Loser's higher beta (0,24) compared to the Winner's (-0,06) indicates towards its greater riskiness. These rather low betas we believe to be the caused by the market index that we have used, which, although does include the same countries and industries as we do, is still consisting of a much lower number of stocks than our sample. The beta coefficient of the resulting Winner-Loser portfolio is negative and significant, meaning that the momentum abnormal profits are not a compensation for bearing an extra-risk.

The results of regressing the country-neutral excess returns are presented in Table 4.6. The alpha of the Winner portfolio is significant and equal to 0,0071, while the alpha of the Loser is negative (-0,0024) and insignificant. The zero-investment portfolio earns an excess return of 0,96% which is highly significant and at the same time slightly smaller than if no adjustment for market risk is made. The beta coefficient of the resulting Winner - Loser country-neutral portfolio is negative, that shows, as it was mentioned above, that the momentum profits are not driven by the extra-risk.

Table 4.6. Country-neutral relative strength portfolio

	α	t(α)	β	t(β)
Winner	0,0071	3,11	0,15	3,33
Loser	-0,0025	-0,97	0,19	3,32
Winner-Loser	0,0096	3,62	-0,03	-0,21

For industry-neutral portfolios we obtain similar results (see Table 4.7). The Winner-Loser portfolio earns an excess return of 1,02%, which is indicated by a significant alpha. Thus, the market risk adjustment increases the excess returns from 0,82%, to 1,02%. The Loser beta is slightly higher than the Winner beta coefficient (0,1815 and 0,1800 respectively), showing that the Loser portfolio is slightly riskier than the Winner. The Winner-Loser has a negative insignificant beta (-0,015).

Table 4.7. Industry-neutral relative strength portfolio

	α	t(α)	β	t(β)
Winner	0,0105	4,01	0,18	3,55
Loser	0,0004	0,12	0,18	4,21
Winner-Loser	0,0102	3,85	0,00	-0,03

Controlling for the market risk factor does not lead to an explanation of the return continuation phenomenon. The Loser portfolio stocks are slightly riskier than the Winner's, which could suggest that it contains smaller companies with a higher volatility. The negative betas we have obtained in all of the three cases lead to the rejection of the hypothesis that the excess returns could be a risk compensation.

4.2.4 Adjustment for Market, Size and Value Factors

We add two factors to the previous regression, namely the size and value and we run it for the unrestricted relative strength portfolios, as well as for country-neutral and industry-neutral relative strength portfolios. The results obtained for the unrestricted portfolios are presented in the table 4.8. We obtain a significant alpha for the Winner (0,0148) and an insignificant alpha for the Loser (-0,0033). The alpha of the resulting Winner-Loser portfolio is 0,0180 and it is highly significant. Thus, adjusting for market, size and value factors increases the momentum return from 0,0114 to 0,0180.

Table 4.8 Unrestricted relative strength portfolios

	α	t(α)	β	t(β)	γ	t(γ)	δ	t(δ)
Winner	0,0148	6,33	-0,08	-2,36	-0,13	-1,17	-0,13	-1,10
Loser	-0,0033	-0,89	0,26	4,43	0,27	1,95	-0,12	-0,61
Winner - Loser	0,0180	6,35	-0,34	-7,78	-0,40	-3,40	-0,02	-0,13

Both the Loser and the Winner have significant betas, the Loser being however riskier than the Winner (0,26 compared to -0,08). The resulting negative beta of the Winner-Loser shows that the excess returns are not a compensation for bearing an extra-risk. The insignificant size coefficient of the Winner does not provide any information related to its size factor loading. The Loser size coefficient is at the edge of significance at 5% level and it is significant at 10% level. This is likely to indicate that Loser stocks are slightly tilted towards small firms. The Winner-Loser portfolio has a significant negative size coefficient of -0,40, thus suggesting that the Loser contains more small size companies than the Winner. The coefficients we obtain for the value factor are insignificant for all three portfolios, making us unable to draw any inferences regarding its influence.

Like in the previous situation, regressing the country-neutral excess returns *(see table 4.9)* yields a positive and significant alpha for the Winner (0,0076, t = 3,40) and a negative and insignificant alpha for the Loser (-0,0028, t = -1,11). The zero-cost portfolio earns an excess return of 1,04% which is highly significant and at the same time slightly higher than in the case of no adjustment for the three factors.

Table 4.9 Country-neutral relative strength portfolios

	α	t(α)	β	t(β)	γ	t(γ)	δ	t(δ)
Winner	0,0076	3,40	0,15	4,33	0,11	1,27	-0,21	-2,16
Loser	-0,0028	-1,11	0,20	3,68	0,21	2,47	-0,03	-0,19
Winner - Loser	0,0104	4,63	-0,05	-1,17	-0,10	-1,29	-0,18	-1,70

Moreover, its beta is negative, strengthening our conclusion that the momentum profits are not driven by extra-risk. The Loser size coefficient indicates its positive loading on the small companies. For the zero-cost portfolio however this coefficient in insignificant. The value coefficient of the Winner (-0,21, t = -2,16) indicates a negative loading on this factor.

Table 4.10 Industry-neutral relative strength portfolios

	α	t(α)	β	t(β)	γ	t(γ)	δ	t(δ)
Winner	0,0109	3,89	0,18	3,80	0,13	1,27	-0,19	-1,24
Loser	0,0001	0,02	0,20	4,52	0,20	1,78	-0,04	-0,25
Winner - Loser	0,0109	3,99	-0,01	-0,32	-0,07	-0,69	-0,15	-1,09

In the case of industry-neutral portfolios we obtain similar results *(see Table 4.10)*. Factor-adjustment increases the excess returns to 0,0109, $t = 3,99$. The Loser portfolio is slightly riskier than the Winner, while the Winner-Loser has a negative insignificant beta. The rest of the coefficients are insignificant, thus showing no relation between the excess returns on one hand and size and value on the other hand.

Adding the size and value factors to our regressions did not add some further clarity, unfortunately. We still obtained negative betas for the zero-cost portfolio. Furthermore, as we supposed, the Loser portfolio is somewhat orientated towards smaller stocks, these not being the case for the Winner or the Winner-Loser portfolios. Therefore, a higher risk associated with smaller firms cannot explain the excess returns. Even less edifying are the coefficients of the value factor, which, with one exception, are never significant, thus having no explanatory power for the momentum profitability.

4.2.5 Behavioural finance interpretation

As none of the factors analyzed proved to be of a major importance in the return continuation phenomenon, we turn to the explanations proposed by the behavioural finance literature. Investors tend to behave rather irrationally, under-reacting and over-reacting to the new information released. They underreact to the public information, as they are less involved with it. On the other hand, they overreact to the private information they obtain, having excessive confidence in its reliability. This type of behaviour leads to a slow incorporation of the public information into the price which in consequence causes the performance of the stocks to persist on a medium term. However, on longer terms, more and more information becomes available and as the overreaction effect disappears, the returns tend to revert to their intrinsic value, causing the momentum profits to vanish. Here, another aspect of investor irrationality comes into play. When the investors' predictions and expectances are fulfilled, their self-confidence is rocketed up, but,

when they fail to materialize, it is not shaken to the same level. This peculiarity causes the momentum effect to be persistent in time, being documented by all the research done in this area starting with the early ‘90s and continuing to the present days.

5. Conclusion

In this chapter we summarize our findings, specifying which of them are in line with the previous studies and which of them bring something new. We also make some further research suggestions.

5.1 Concluding remarks

Our study investigates the profitability of the momentum strategies on a market formed of the 15 countries members of the Eurozone as of December 2008. These strategies are also analyzed at the country and industry level in order to i) determine their profitability at a more disaggregated level and ii) construct country- and industry-neutral portfolios, thus controlling for these two factors. We analyze 16 different strategies which combine formation *(J)* and holding *(K)* periods of 3, 6, 9 and 12 months. We rank the stocks according to their performance in the previous *J* months and hold them subsequently for *K* months. The top 10% stocks form the Winner portfolio and the bottom 10% stocks form the Loser portfolio. In each month we buy the Winner and sell short the Loser, thus the momentum profit is represented by the excess return of the Winner over the Loser.

All the strategies earn positive momentum profits, with 13 of them being significant. We find a significant average excess return of the Winners over the Losers of 0,8% per month, which is close to the 1% return documented by the previous studies (e.g. Jegadeesh and Titman 1993, Rouwenhorst 1998, Nijman et al 2002). The most profitable strategy for the Eurozone market is the one that ranks the stocks according to their past six month performance and holds them for three months. We find a slightly shorter horizon of momentum profitability compared to the previous studies, which document the *J12K3* strategy as being the most profitable.

For further tests and identification of the momentum profits sources we analyze in detail the strategy that constructs Winners and Losers on the basis of their past six month performance and holds them for other six months. Performing a robustness test indicates towards the consistency and the similarity of the momentum profits throughout different time sub-periods. The current financial crisis does not reduce these profits, due to the fact that it affects the Losers more negatively than the Winners, causing the excess returns to actually increase.

Analyzing the momentum profits at the country and industry level shows similar results. Significant and positive excess returns are present in 12 of the 15 countries and in 17 of the 25 industries included in our sample. However, on the country level these profits are more uniform and have a lower standard deviation than on the industry level. Moreover, controlling for the country composition reduces the excess returns by only 13%, whereas controlling for the industry composition causes a decrease of 39%. This suggests that the country factor is irrelevant in explaining the continuation effect, whilst the industry factor could be thought as being partly responsible for the excess returns.

As other potential sources of the momentum profits we analyze the CAPM beta and the Fama-French size and value factors, performing regressions for the unrestricted, country-neutral and industry-neutral portfolios. Both models show similar results for the three portfolios. We obtain a negative beta for the Winner-Loser portfolio which leads to the rejection of the hypothesis that the excess returns could be a compensation for bearing an extra-risk associated with this portfolio. Including the size and value factors does not provide much of additional insights. We obtain a similar negative beta for the Winner-Loser portfolio. The Loser portfolio seems to load heavier on the small size companies; however, the Winner-Loser portfolio has insignificant coefficients for both the size and value factors.

None of the country, industry, risk, size or value factors seems to be the main force driving the momentum profits. In such conditions, we believe that only relevant explanations could be those offered by the behavioural finance research. According to them, the momentum effect is caused by a slow incorporation of the public information into the prices due to investors' higher confidence in their private information (to which they overreact) than in the public information (to which they underreact). As the publicly available information is finally incorporated into the price, the overreaction is mitigated away and the momentum profits tend to vanish.

Our findings indicate towards the rejection of both the efficient market hypothesis and the investor behaviour as being rational.

In general, the results we have reached are in line with the main studies investigating momentum. However, we have identified a series of particular aspects that characterize our time period and data sample. Firstly, the time horizon over which momentum strategies are profitable seems to be shorter than previously documented, strategies with higher *J*'s and *K*'s yielding the lowest excess returns. This might be an indication that, due to the improved information technology and the speed the information circulates, the markets are becoming more efficient. Secondly, although the current financial crisis decreases the returns of the Winner and Loser portfolios, the latter is more drastically affected, which leads to the zero-cost momentum strategy being actually more profitable. Lastly, we find the industries as being partly responsible for the momentum effect; when it comes to the main momentum source, however, the only explanation that stands seems to be investor irrationality.

5.3 Suggestions for further research

As our study, in line with the previous ones, could not identify among the factors analyzed one which could be considered as the main force behind the return continuation phenomenon, we believe that the further research should be focused on this aspect. Thus far, the explanations offered by behaviourists seem to be the only ones that hold; however, they are just a supposition. Therefore, elaborating a model that could capture the momentum determinants represents, in our opinion, the main area of further research. Moreover, as there has been documented a correlation between European and American stock markets (Rouwenhorst 1998), it seems that there is a unique factor that drives their behaviour. In this sense, further studies could incorporate stocks from all the major global markets, in order to obtain a panoramic view on the return continuation.

On a smaller scale, other areas of interest are represented by three increasingly important markets – Eastern Europe, Russia and China, for which we could not find any momentum dedicated research. For the time being, it might be rather complicated to gain the necessary information for these markets, due to a lack of transparence; however, in the near future this should be possible. On the other hand, the development of these markets will probably cause them to behave like the already developed ones, in consequence exhibiting the same characteristics, while an investigation of the current situation might lead to extremely interesting findings.

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Appendix A. Country and Industry Statistics

Table A.1 shows the distribution of companies among different countries in the data sample

Table A.1. Country Statistic

Country	Number	% of total
Austria	181	3,36%
Belgium	278	5,16%
Cyprus	117	2,17%
Finland	183	3,39%
France	1400	25,97%
Germany	1601	29,70%
Greece	374	6,94%
Ireland	72	1,34%
Italy	414	7,68%
Luxembourg	51	0,95%
Malta	15	0,28%
Netherlands	249	4,62%
Portugal	139	2,58%
Slovenia	75	1,39%
Spain	242	4,49%
Total	*5391*	*100,00%*

The distribution of firms among various industries is presented in Table A.2

Table A.2. Industry Statistic

Industry	Number	% of total
Automobiles	98	1,83%
Banks	240	4,46%
Beverages	105	1,94%
Chemicals	135	2,50%
Construction and materials	287	5,32%
Electronics&electrical equipme	178	3,31%
Energy	50	0,92%
Financial Services	546	10,13%
Food Producers	252	4,67%
Food Retailers	48	0,88%
Forestry	53	0,98%
General Industrials	640	11,88%
Household	142	2,63%
Insurance	122	2,27%
Leisure goods	78	1,44%
Media	295	5,48%
Oil&Gas	62	1,15%
Personal goods	209	3,88%
Pharmaceuticals	234	4,34%
Real estate	444	8,23%
Software	562	10,42%
Technogoly	154	2,86%
Telecommunications	85	1,58%
Travel&Leisure	226	4,19%
Utilities	145	2,69%
Total	*5391*	*100,00%*

Appendix B. Stationarity

In case with 12 regressions the augmented Dickey-Fuller test will be performed. The outcomes of White's test are presented in table A.1. For all regressions the value of *t*-statistic is higher than the critical value for 5% level. It means that the null hypothesis stating that there is a unit root in the data is rejected, and the data is stationary.

Table B.1. Outcomes from Dickey-Fuller test

		t-statistic	Critical Value
Momentum strategy	**Buy**	-5,06	-2,89
	Sell	-2,97	-2,89
Country neutral	**Buy**	-2,95	-2,89
	Sell	-2,91	-2,89
Industry neutral	**Buy**	-3,22	-2,89
	Sell	-3,08	-2,89
Market risk premium		-9,37	-2,89
SMB		-10,92	-2,89
HML		-5,67	-2,89

Appendix C. Testing OLS assumptions (Brooks 2007)

There are five underlying assumptions that should be tested.

1. $E(u_t) = 0$

This assumption requires the average value of the errors to be equal to zero. It is obviously fulfilled as far as constant term α_t is included in the regression equation.

2. $\text{var}(u_t) = \sigma^2 < \infty$

The assumption of homoscedasticity requires the variance of the errors to be constant. To avoid heteroscedasticity in the regression models we use heteroscedasticity-consistent standard error estimates. This option is available in econometrics software package EViews 6.0.

One of the popular statistical tests for heteroscedasticity is White's test. One of its advantages is that it does not require normal distribution of errors. To conduct White's test the auxiliary regression should be built. For CAPM it will look as following:

$$\hat{u}_t^2 = \alpha_1 + \alpha_2\left(r_{m,t} - r_{f,t}\right) + \alpha_3\left(r_{m,t} - r_{f,t}\right)^2 + v_t$$

where v_t is a normally distributed disturbance term independent of u_t.

For Fama-French model the auxiliary regression will look as following:

$$\hat{u}_t^2 = \alpha_1 + \alpha_2\left(r_{m,t} - r_{f,t}\right) + \alpha_3 SMB + \alpha_4 HML + \alpha_5\left(r_{m,t} - r_{f,t}\right)^2 + \alpha_6 SMB^2 + \alpha_7 HML^2 + v_t .$$

Given that the auxiliary regressions should be estimated, R^2 obtained from the regression should be multiplied by the number of observations, T, such as:

$$TR^2 \sim \chi^2(m),$$

where m is the number of regressors in the auxiliary regression. For CAPM m is equal to 2, for Fama-French m is equal to 6.

The outcomes of White's test are presented in table B.1. For all regressions the value of TR^2 is less than the critical value of χ^2-test statistic for 5% level. It means that the joint null hypothesis that errors are homoscedastic can not be rejected.

Table C.1. Outcomes from White's test

		CAPM		Fama-French	
		TR^2	Critical value	TR^2	Critical value
Momentum strategy	**Buy**	0,81	10,60	14,22	18,55
	Sell	0,16	10,60	2,76	18,55
Country neutral	**Buy**	7,56	10,60	17,58	18,55
	Sell	8,32	10,60	15,02	18,55
Industry neutral	**Buy**	5,14	10,60	12,92	18,55
	Sell	0,20	10,60	1,39	18,55

3. $\text{cov}(u_i, u_t) = 0$

This assumption requires that errors are uncorrelated over time, or that there is no autocorrelation in error term. To test if the errors are autocorrelated, the Durbin-Watson (DW) test can be used. DW is a test for first order autocorrelation. To apply DW test several conditions should be fulfilled, among them are presence of constant term in the regression, non-stochastic regressors, and absence of lags of dependent variable. All these conditions are fulfilled in all the regressions.

The null hypothesis of DW test is that errors at time *t-1* and *t* are independent. DW test statistic can be calculated as follows (approximate value):

$$DW = 2(1-\rho),$$

where ρ is a estimated correlation coefficient. DW test has two critical values: upper and lower.

The outcomes of Durbin-Watson test are presented in table B.2. For all regressions the value of *t* statictic is less than the critical value of d_L. It means that the null hypothesis that errors are uncorrelated over time is rejected, and there is autocorrelation between errors.

According to Durbin-Watson test we obtained positive autocorrelation in the residuals. This result is logical because momentum strategy implies positive autocorrelation on a medium-term horizon. However positive autocorrelation leads to inefficient regression coefficients, which means that they are not BLUE for this regression. To avoid these consequences of autocorrelation some measures should be taken to deal with it.

Table C.2. Outcomes from Durbin-Watson test

		CAPM			Fama-French		
		t-statistic	d_L	d_U	t-statistic	d_L	d_U
Momentum strategy	**Buy**	0,47	1,52	1,56	0,52	1,48	1,60
	Sell	0,38	1,52	1,56	0,38	1,48	1,60
Country neutral	**Buy**	0,37	1,52	1,56	0,42	1,48	1,60
	Sell	0,42	1,52	1,56	0,40	1,48	1,60
Industry neutral	**Buy**	0,34	1,52	1,56	0,36	1,48	1,60
	Sell	0,40	1,52	1,56	0,39	1,48	1,60

One of the popular approaches to deal with autocorrelation is Cochrane-Orcutt procedure. To apply this approach the model for CAPM case should be specified as follows:

$$R_{i,t} - r_{f,t} = \alpha + \beta\,[R_{m,t} - r_{f,t}] + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} = \rho\varepsilon_{i,t-1} + u_t\,.$$

For Fama-French model the regression should be specified as follows:

$$R_{i,t} - r_{f,t} = \alpha + \beta\,[R_{m,t} - r_{f,t}] + \gamma SMB + \delta HML + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} = \rho\varepsilon_{i,t-1} + u_t\,,$$

where ρ represents correlation coefficient for both models.

According to Cochrane-Orcutt procedure both equations were estimated using OLS method for unrestricted, country-neutral, and industry-neutral portfolios. As a result of these regressions the residuals were obtained and were used to run the additional regression:

$$\hat{\varepsilon}_{i,t} = \rho\hat{\varepsilon}_{i,t-1} + u_t .$$

From the regression above we get estimations of correlation coefficients $\hat{\rho}$ for all the models. Using obtained $\hat{\rho}$ new regressions can be run:

$$(R_{i,t} - r_{f,t})^* = \alpha^* + \beta\,[R_{m,t} - r_{f,t}]^* + u_{i,t}$$

$$(R_{i,t} - r_{f,t})^* = \alpha^* + \beta[R_{m,t} - r_{f,t}]^* + \gamma SMB^* + \delta HML^* + u_{i,t},$$

where:

$$(R_{i,t} - r_{f,t})^* = (R_{i,t} - r_{f,t}) - \rho\,(R_{i,t-1} - r_{f,t-1})$$

$$\alpha^* = (1-\rho)\,\alpha$$

$$[R_{m,t} - r_{f,t}]^* = [R_{m,t} - r_{f,t}] - \rho\,[R_{m,t-1} - r_{f,t-1}]$$

$$SMB_t^* = SMB_t - \rho\, SMB_{t-1}$$

$$HML_t^* = HML_t - \rho\, HML_{t-1}$$

$$u_t = \varepsilon_{i,t} - \rho\varepsilon_{i,t-1}$$

These models contain error terms that are free from autocorrelation; therefore we can run the regression and get unbiased and efficient coefficients.

4. $\operatorname{cov}(u_t, x_t) = 0$

This assumption requires the data to be non-stochastic. However, the regression estimators are consistent and unbiased even if the stochastic regressors are present.

5. $u_t \sim N(0.\sigma^2)$

This assumption requires the disturbances to be normally distributed. To test for normality Bera-Jarque (BJ) test is applied. Test statistic for BJ test looks as following:

$$W = T\left[\frac{b_1^2}{6} + \frac{(b_2 - 3)^2}{24}\right],$$

were T is the sample size, b_1 and b_2 are coefficients of skewness and kurtosis respectively. The test statistic follows $\chi^2(2)$ distribution.

The p-values of Bera-Jarque test are presented in Table B.3. For six of 12 regressions p-value from Bera-Jarque test is smaller than 0,05 (or 5%), it means that for these regressions the null hypothesis of normality at 5% level is rejected.

Table C.3. Outcomes from Bera-Jarque test

		CAPM	Fama-French
Momentum strategy	**Buy**	0,00	0,00
	Sell	0,62	0,58
Country neutral	**Buy**	0,84	0,84
	Sell	0,00	0,01
Industry neutral	**Buy**	0,73	0,00
	Sell	0,05	0,00

However it is possible to use this data for the purposes of the analysis. Estimators of the regressions still will be unbiased and will have smaller variance.