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Momentum Strategies in the Portuguese Stock Market

por

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Orientada por:

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Biographical Note

Cátia da Mota Lopes was born in Vila Nova de Gaia, Portugal, on the 2nd of December, 1987.

In 2005, she entered to Faculdade de Economia do Porto where she graduated in 2009 in Economics. In the same year she joined the Master in Finance at the Faculdade de Economia do Porto, where she improved her knowledge and qualifications in subjects as portfolio management, financial theory, project management, risk management, among others.

Within the professional scope, she started her career in 2009, as credit analyst in Banco Português de Negócios. Then, in the end of 2010, she was invited by Ernst & Young to work in the assurance division. There, she had the opportunity to work with several national companies and improve her audit skills. Since September 2011, she has been working in Galp Energia, SA, in the Lisbon headquarters, in the Oil and Gas Trading department.

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Momentum Strategies in the Portuguese Stock Market

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Abstract

Over the last decades, the Efficient Market Hypothesis (EMH) has been one of the dominant topics in financial research literature. Inspired by cognitive psychology studies, "overreaction" and "underreaction" are one of the most important challenges to the EMH.

The main purpose of our study is to explore the existence of return continuation in the Portuguese Stock Market, thus investigating its efficiency at the weak form level (Fama, 1970). We demonstrate that strategies which buy stocks that have performed well in the past and sell stocks that have poor performances previously – momentum strategies – can generate significant positive returns over three to twelve months holding periods. As in Jegadeesh and Titman (1993), we found that the profitability of momentum strategies is not satisfactorily justified by delayed stock price reactions. When comparing the momentum strategy profits with the profitability of the equally weighted market portfolio, we verified that it is possible to obtain higher returns through this relative strength strategy. We also analyze the momentum profits over long horizons. In this matter, our results seem to support the underreaction hypothesis, but our outcomes are not conclusive, since there is no sufficient statistic evidence.

Keywords: Overreaction; Underreaction; Momentum; Market Efficiency; Behavioral Finance.

JEL: G1; G11 and G14.

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Resumo

Nas últimas décadas, a Hipótese de Eficiência de Mercado (HEM) tem sido um dos temas dominantes na literatura financeira. Com base na psicologia cognitiva, as hipóteses de "sobre-reação" e "sub-reação" dos preços colocam-se como um dos mais importantes desafios à HEM.

Assim, o principal objetivo do nosso trabalho é explorar a existência de continuação dos retornos no mercado de capitais português, investigando a sua eficiência na forma fraca (Fama, 1970). De acordo com os resultados obtidos, estratégias que compram ações com boas performances no passado e que vendem ações com performances fracas – estratégias de *momentum* – geram retornos positivos significativos, para períodos de manutenção de três a doze meses. Tal como em Jegadeesh e Titman (1993), descobrimos que a rendibilidade das estratégias de *momentum* não é satisfatoriamente justificada pela reação tardia dos preços das ações. Quando a rendibilidade das estratégias de *momentum* é comparada com a rendibilidade do portefólio de mercado igualmente ponderado, verificamos que é possível obter retornos mais elevados através da estratégia estudada. A rendibilidade das estratégias de *momentum* foi, também, analisada no longo prazo, tendo sido encontrada evidência que suporta a hipótese de "sub-reação". No entanto, os resultados alcançados neste domínio não são conclusivos, uma vez que não possuímos evidência estatística suficientemente significativa.

Palavras-chave: Sobre-reação; Sub-reação; *Momentum*; Eficiência e Finanças Comportamentais

Códigos JEL: G1; G11 e G14.

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1. Introduction

Over the past decades, the Efficient Market Hypothesis has been one of the dominant topics in financial research literature.

According to Fama (1970, p.383), in an efficient market, prices "always fully reflect available information". Therefore, prices could be considered an unbiased estimate of the true value of an investment at any given moment.

The concept of Efficient Market Hypothesis reached such a height of dominance around the 1970's that any deviation in financial markets has been called anomaly. Subsequently, the 1980's has witnessed the proliferation of reported anomalies, in which are included, among others, "underreaction" and "overreaction" (Wang, 2008):

> "If stock prices either overreact or underreact to information, then profitable trading strategies that select stocks based on their past returns will exist." Jegadeesh and Titman (1993, p.68)

According to these anomalies, investors may be able to conceive profitable strategies based on past returns' observation. Considering the existence of this possibility, the Efficient Market Hypothesis can be seriously questioned. For that reason, the investigation of these anomalies has attracted the interest of many financial researchers and market professionals that want to explore this inefficiency.

The seminal works by De Bondt and Thaler (1985, 1987) and Jegadeesh and Titman (1993), about overreaction and underreaction, respectively, were the first to show that it was possible to consider that stocks returns are related to their past performances.

De Bondt and Thaler (1985, 1987) based on the overreaction hypothesis, analyzed the profitability of contrarian strategies (buy the past losers and sell the past winners), concluding that stocks with poor performances in the last three to five years earn higher average returns than stocks that perform well.

On the other hand, based on underreaction hypothesis, Jegadeesh and Titman (1993) report medium-term continuation of equity returns. The authors suggested that momentum strategies (buy the past winners and sell the past losers) result in profits of about 1 percent per month in the year following the portfolios' formation.

The main base of momentum strategies is the continuation of existing trends in the market. The basic idea is that investors will buy winner and sell loser stocks, because it is more likely that a rising asset price continues to rise further than the opposite, at least in the short-term (Jegadeesh and Titman, 1993).

For the Portuguese stock market, few studies analyzed, exclusively, the predictability of Portuguese stock returns based on their past performances and even fewer have focused on the profitability of momentum strategies.

Alves and Duque (1996) studied the performance of contrarian strategies over the period of 1989 to 1994, but their results were inconclusive. Soares and Serra (2005), beyond analyzing the contrarian strategies with an extended sample[1], also investigated the existence of momentum returns. However, some of their results lack statistical significance. More recently, Pereira (2009) also focused on this issue, studying the profitability of momentum and contrarian strategies; similarly to Soares and Serra (2005) most of the obtained results are not statistically significant.

Thus, we verify that the lack of statistically significant results, that prove or disprove the existence of return predictability based on past returns in Portuguese stock market, is transversal to the studies done so far. Reason why, we decided to focus our study in this thematic, more specifically in the momentum strategies, in order to provide additional evidence to what has already been found in this regard.

Our study present some differences from the precedent studies for the Portuguese stock market, as we use an extended sample (approximately 24 years), similarly to the sample periods used in the main international studies. We will follow the Jegadeesh and Titman (1993) methodology, with the division of the sample into deciles, and, finally, our study will be the first to focus exclusively in the performance of momentum strategies.

Additionally, by examining the profitability of several momentum strategies, our work intends to investigate the efficiency of the Portuguese stock market at the weak form level, according to Fama (1970). In case this market is efficient in its weak form, current prices will fully reflect all historical information. Consequently, abnormal

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[1] Soares and Serra (2005) sample period goes from 1988 to 2003 (16 Years).

returns cannot be obtained. In conclusion, this study essentially seeks to answer the following research questions:

- Is there any possibility to predict future returns, based on past performance, in the short-term?
- Can momentum strategies generate significant positive returns over three to twelve months[2] holding periods? And can these strategies outperform the market portfolio returns?
- Do the momentum strategies exhibit long-term return reversals in the Portuguese Stock Market?

To address these issues we will follow, primarily, the Jegadeesh and Titman (1993) work, as a reference to construct the different momentum strategies and the further tests and analysis.

Using a monthly sample that goes from January 1988 to April 2012, we will construct 32 different strategies. Initially, we will verify, for each one of these strategies, the profitability of winner portfolios over losers. Later, we will focus only on one strategy aiming to analyze other variants of the portfolios and the profitability of this strategy over long horizons.

The work proceeds as follows. Firstly, section 2 provides a brief review of the relevant literature and section 3 presents the data and the methodology. In section 4 we show the empirical results and the main findings. Finally, section 5 presents the principal conclusions of our study.

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[2] The period normally used in all studies on momentum strategies is three to twelve months.

2. Literature Review

The present section gives a brief literature review of the main international studies and the major evidence for the Portuguese stock market on contrarian and, specially, on momentum strategies.

The literature review will be divided into two subsections. In the first one, we introduce the different trading strategies, Contrarian and Momentum. More specifically, for momentum strategies, we refer some seasonal and size effects, as well as the evolution of momentum profits over long horizons. Subsection 2.2 will present the various models and theories that attempt to explain momentum returns.

2.1. Trading Strategies – Market (In)Efficiency

One of the most important topics in financial literature is the Efficient Market Hypothesis (EMH). This concept is the foundation for much of the theoretical and empirical research in this area (Jegadeesh, 1990).

According to Fama (1970, p.383), in an efficient market, prices "always fully reflect available information". The author characterized three forms of efficiency: weak, semi-strong and strong. In our study, we test the weak form level, which relies on the premise that current prices fully reflect all historical information. Consequently, as information is available to all, abnormal returns should not be earned.

Considerable effort has been expended testing the market efficiency hypothesis, resulting in several empirical studies that have documented consistent and significant anomalies which cast doubt over its reliability (Chan, Jegadeesh and Lakonishok, 1996, p.1681).

Among these anomalies is the possible relation between the average stock returns and the past performance. We will refer, in this literature review, to two different trading strategies that rely on this possibility: Contrarian and Momentum strategies.

2.1.1. Contrarian Strategies

Contrarian strategies are based on the assumption that investors overreact to new information and, consequently, prices tend to differ from their fundamental values. Therefore, these strategies consist on buying long-term past losers and selling long-term past winners (De Bondt and Thaler, 1985).

Challenging the notions of market efficiency and investors rationality, De Bondt and Thaler (1985, 1987) report that stocks with poor performance in the last three to five years earn higher average returns than stocks that perform well, i.e., long-term past losers tend to outperform long-term past winners over the subsequent three to five years. They found that, for NYSE market, thirty-six months after the portfolio formation, the losers' portfolio receives about 25% more than the winners' portfolio.

Chopra, Lakonishok and Ritter (1992) showed similar results and conclude that, in the long-term (three to five years), there are price reversals, which implies that contrarian strategies are profitable when implemented based on such time horizons.

Furthermore, some individual studies, performed at a country level, sustained the existence of long-term price reversals in stock returns. For instance, according to the work of Campbell and Limmack (1997), contrarian strategies yield abnormal returns (until a one-year period after the portfolio formation) in the U.K. stock market from the period of 1979 to 1990. Alonso and Rubio (1990) investigated the Spanish stock market and found existence of contrarian profits on 12 to 60 months. Mai (1995) presents similar results to French stock market and Da Costa (1994) show equivalent results to Brazilian stocks.

Analyzing the Portuguese market, we have discovered a small amount of studies regarding contrarian strategies. Alves and Duque (1996) studied in particular the performance of this long-term strategy over the period of 1989 to 1994, but their results were inconclusive.

Soares and Serra (2005) explored whether Portuguese stock returns are related to past performance for an extended sample and time period[3]. Contrarily to Alves and Duque (1996), the authors evaluated not only the existence of contrarian returns but also the existence of momentum profits. Concerning contrarian strategies, their results seem to support the overreaction hypothesis in the long run. However, most of their results lack statistical significance.

Pereira (2009) concluded that the contrarian profitability exists, but his findings are not so evident as in Soares and Serra (2005). They attribute the results' differences to the different time periods analyzed.[4]

Regarding long-term reversals, De Bondt and Thaler (1985, 1987), and Chopra *et al.* (1992) stand their results on the cognitive psychology findings of Kahneman and Tversky (1982). These authors believe that investors overweight recent information, ignoring or attributing less importance to past information in their prospects. Consequently, stock prices also overreact, moving away from their fundamental values.

In shorter horizons, Jegadeesh (1990), Lehmann (1990) and Lo and MacKinlay (1990) examined the performance of trading strategies, based on one week to one month returns and provided evidence of return reversals. Jegadeesh (1990) found that the difference between the risk-adjusted excess returns on the extreme deciles portfolios is 2.49 percent per month, over the period of 1934 to 1987.

Yet, in the short-term, contrarian strategies are not explained by overreaction. Lo and MacKinlay (1990) argued that a large part of these short-term returns are due to delayed price reaction to new information, while Jegadeesh and Titman (1993) pointed out the price pressure or the lack of liquidity in the markets as explanatory factors, since these strategies are transaction intensive.

Despite the popularity of contrarian strategies in academic literature, most recently researchers focused on momentum strategies that buys winners and sells losers.

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[3] Soares and Serra (2005) analyzed the performance of all the stocks listed in the main market between 1988 and 2003.
[4] Pereira (2009) used a sample period from 1999 to 2008, while Soares and Serra (2005) sample is from 1988 to 2003.

"Jegadeesh and Titman (1993) add a new twist to this literature by documenting that over an intermediate horizon of three to twelve months, past winners on average continue to outperform past losers, so that there is "momentum" in stock prices." Chan *et al.* (1996, p.1681)

2.1.2. Momentum Strategies

A momentum strategy aims to capitalize on the continuance of existing trends in the market. This strategy is based on the belief that large price increases of a security will be followed by additional gains and vice versa for declining values. The fundamental idea is that the investor will buy winner stocks and sell loser, because, according to this strategy, it is more likely that a rising asset price continues to rise further than to move against the trend (Jegadeesh and Titman, 1993).

In the early literature about this subject, Levy (1967) claimed that a trading rule involving a stock purchase when its current price is substantially higher than its average over the last 27 weeks tends to realize abnormal returns.

After analyzing this trading rule over an extended time period, Jensen and Bennington (1970) attribute Levy's results to selection bias, since they proved that trading strategy is not more profitable than a simple buy and hold strategy.

Adding a new twist to this literature, Jegadeesh and Titman (1993) provided evidence in favour of the profitability of momentum strategies in the US markets (NYSE and AMEX), between 1965 and 1989. The authors exposed that, over medium-term horizons (three to twelve months), stocks with higher returns will continue to outperform stocks with low past returns, over the same period of time. For instance, the six-month winners (stocks whose past six-month returns rank in the top decile) outperformed the six-month losers (stocks whose past six-month returns rank in the bottom decile) with an average excess return of about 1 percent per month, over the following six months (Jegadeesh and Titman, 1993).

Similar results can be found in Rouwenhorst (1998) with a sample of 12 European stock markets[5] during the period from 1978 to 1995. Rouwenhorst's results demonstrate that an internationally diversified relative strength portfolio, which invests in medium-term winners and sells medium-term losers, earns around 1 percent per month after accounting for risk. Additionally, Rouwenhorst (1999) found that momentum strategies are profitable, although not in the same degree, in 20 emerging markets[6].

The original findings of Jegadeesh and Titman (1993) appear to be applicable in other markets besides the United States'. Beyond the results provided by Rouwenhorst (1998, 1999), according to Hart, Slagter and Dijk (2003) there is evidence of medium-term return continuation in another 32 emerging markets[7]. Chui, Wei and Titman (2000) documented that, with exception of Japan and Korea, momentum strategies work in Asian markets[8] too. Foerster, Prihar, and Schmitz (1995) followed a similar strategy to Jegadeesh and Titman (1993), using Canadian data from 1978 to 1993, and recognized stronger evidence of momentum stock returns.

Diverging Chui *et al.* (2000) conclusions for the Japanese stock market, Chaves (2012) shows that momentum strategies can be profitable in Japan, but only when the return component due to market beta exposure is removed, thus reducing the volatility of momentum strategies (Chaves, 2012).

In the same study, Chaves (2012) examined the profitability of momentum strategies in 21 countries[9], including Portugal. Besides the limited sample[10], Portugal has one of the

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[5] Rouwenhorst (1998) considered in his sample twelve European countries: Austria, Belgium, Denmark, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and United Kingdom.

[6] Rouwenhorst (1999) examined 20 emerging markets: Argentina, Brazil, Chile, Colombia, Greece, India, Indonesia, Jordan, Korea, Malaysia, Mexico, Nigeria, Pakistan, Philippines, Portugal, Taiwan, Thailand, Turkey, Venezuela, and Zimbabwe.

[7] The 32 markets analyzed by Hart *et al.* (2003) are: Argentina, Brazil, Chile, Colombia, Mexico, Peru, Venezuela, China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Czech Republic, Greece, Hungary, Poland, Portugal, Russia, Slovakia, Turkey, Egypt, Israel, Jordan, Morocco, South Africa and Zimbabwe.

[8] Besides Japan and Korea, Chui *et al.* (2000) examine Hong Kong, Indonesia, Malaysia, Singapore, Taiwan, and Thailand.

[9] Chaves (2012) examine momentum strategies in 21 different countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Sweden, Singapore, Spain, Switzerland, and the United Kingdom.

best performances of "traditional" Momentum (without any adjustments for the market beta exposure) close to Denmark, Australia and Canada.

On the other hand, Griffin, Ji and Martin (2003) have also considered Portugal in their international sample. However, they found that there were no statistical significant momentum profits, at a five percent level, for the Portuguese stock market.

Specifically for this stock market, Soares and Serra (2005), that also studied contrarian strategies, demonstrated the profitability of momentum strategies for short-term horizons. The authors considered a sample of 82 stocks, from 1988 to 2003 (16 years), which are ranked into quintiles. They concluded that momentum effects persist even after the risks have been accounted for. Nevertheless, most results lack statistical significance.

Recently, Pereira (2009) examined the existence of momentum and contrarian profits in the Portuguese stock market, from January 1997 until December 2008. The author found that, for formation and holding periods of one to twelve months, the monthly average returns of the top winners' portfolio are 0.97 percent; while the top losers' portfolio's monthly average returns are about -0.16 percent, thus concluding that a momentum strategy can provide returns of approximately 1 percent. However, similarly to Soares and Serra (2005), most of these results are not statistically significant.

Considering the popularity and visibility of this market "anomaly", according to the Efficient Market Hypothesis (Fama, 1970), the profitability of momentum strategies should cease to exist. However, Jegadeesh and Titman (2001b) show that momentum profits have continued in the 90's[11], demonstrating that the original results were not a product of data snooping bias, as noted by Lo and MacKinlay (1990).

After Jegadeesh and Titman's (1993) revolutionary work, this thematic has attracted substantial research, which documents more details about this "anomaly". In the next subsections, we will present some of these studies that attempts to correlate momentum profits to stock characteristics.

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[10] The Portuguese sample was constituted by 267 monthly observations (about 22 years), being one of the smallest samples used on Chaves' (2012) study.

[11] Jegadeesh and Titman (1993) use a sample period from 1965 to 1989 and in their 2001 study use a sample period from 1965 to 1998.

2.1.2.1. Seasonality and Size Effect

Some researchers demonstrated that momentum strategies can exhibit an interesting pattern of seasonality, especially in January. Jegadeesh and Titman (1993) pointed out that, between 1965 and 1989, momentum strategy lost about 7 percent on average in January months, but generated positive returns in each of the other months.

More recently, Grundy and Martin (2001) found that only 15 of the 69 January months' returns, from 1926 to 1995, are positive. In January, the average return of momentum strategies is -5.85 percent. In contrast, 491 of the 759 non-January months' returns are positive, with a mean of 1.01 percent, over the same period.

The momentum strategy implemented on Jegadeesh and Titman's (2001a) sample earns a return of -1.55 percent in January and positive returns in every other calendar month. Therefore, the authors conclude that much of the size effect and long horizon return reversals are concentrated in January, while the momentum effect is entirely a non-January effect.

Then again, Jegadeesh and Titman (1993), as well as Grinblatt and Moskowitz (2004), show that momentum profits tend to be stronger in December, followed by April and November.

Several studies focus on the relation between momentum profits and stock characteristics, giving a special emphasis to the firm size. Most of them found that momentum profits are negatively correlated to the firm size (Jegadeesh and Titman, 1993, 2001b; Rouwenhorst, 1998; and Hong *et al.,* 2000). However, some texts conclude otherwise (Israel and Moskowitz, 2012).

Jegadeesh and Titman (1993, 2001b) found that both winners and losers tend to be smaller than the average firm size of the sample. In the authors' opinion, smaller firms are more likely to be in the extreme return decile portfolios, since they have more volatile returns. Yet, the average size of the winner's portfolio tends to be larger than the loser's.

Baker and Wurgler (2007) associate the high-volatility to low capitalization and unprofitable stocks, affirming that these stocks tend to be disproportionately sensitive to

investor sentiments. This occurs as small stocks are harder to arbitrage and more difficult to evaluate, "making the biases more insidious and valuation mistakes more likely" (Baker and Wurgler, 2007, p. 130).

According to Rouwenhorst (1998) return continuation is negatively related with the firm size, but it is not limited to small firms. Similarly, Hong *et al.* (2000) found that the profitability of momentum strategies tends to decline sharply with the increase of firms' size.

In contrast, the results of Chui *et al.* (2000), for some Asian stock markets, provide weak evidence that support the negative relation mentioned above.

Israel and Moskowitz (2011) found that significant momentum returns are present across size categories. According to these authors, there is no considerable evidence that sustain the higher momentum returns among small firms' stocks.

In conclusion, there are no consensual results on these matters.

2.1.2.2. Momentum Strategies over Long Horizons

In the long run, De Bondt and Thaler (1985) supported that losers tend to outperform winners. As a result, momentum strategies should not be profitable in such horizons. Their conclusion attracted momentum researchers' attention in order to study what usually happens with this type of profits in the long-term period.

Jegadeesh and Titman (1993) documented that momentum profits slowly dissipate over long horizons. For instance, a zero-cost portfolio strategy[12], based on the past six months, generates a cumulative return of 9.5 percent over the first year, but loses more than a half of this return in the following two years.

Lee and Swaminathan (2000) confirmed these results and found significant price reversals between the third and the fifth year. Additionally, the authors demonstrated that past trading volume is related with both the magnitude and the persistence of price

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[12] A zero-cost portfolio strategy consists on buying the winner's portfolio and selling the loser's portfolio (Rouwenhorst, 1998).

momentum, concluding that stocks with higher past transaction volume tend to experience faster return reversals.

Jegadeesh and Titman (1999) examined the returns in each of the 60 months following the portfolios' constitution date (formation date), founding significant positive returns in the first 12 months. However, when they considered the 13-60 months period, the returns were negative. By the end of the 60st month, the cumulative momentum returns have declined to -0.44 percent.

On the other hand, George and Hwang (2004) showed that future returns, estimated using a 52-week high criterion, don't reverse in the long run. Therefore, they suggest that short-term momentum and long-term reversals are not likely to be components of the same phenomenon.

2.2. Causes of Momentum Profits

While the momentum profitability in short horizons have been well accepted, financial economists are far from reaching consensus on the causes of momentum profits. Jegadeesh and Titman (2001a) considers the underreaction to new information as a natural explanation for those profits.

> "(…) if a firm releases good news and stock prices only react partially to the good news, then buying the stocks after the initial release of the news will generate profits. However, this is not the only source of momentum profits." Jegadeesh and Titman (2001a, p.7)

In case momentum profits are indeed driven by underreaction, the good performance of a winner portfolio will continue until all the news is incorporated in prices. Chan *et al.* (1996) and Hong *et al.* (2000) found evidence consistent with this explanation.

As we have already referred, some authors documented that momentum profits revert on long horizons. Lee and Swaminathan (2000) and Jegadeesh and Titman (2001b) interpreted this long term reversion as a consequence of, not only underreaction, but delayed overreaction. Good news in the pre-formation date period pushes post-formation prices above fundamental value. Consequently, strategies that buy winners and sell losers will be profitable in the short-run. However, these deviations from

fundamental values are only temporary and cumulative momentum profits will disappear or even turn negative in the long-run.

> "Continuation and contrarian theories say that prices underreact and overreact, respectively; the efficiency theory allows neither" Ray *et al.* (1995, p.54)

While some have argued that these results provide strong evidence of "market inefficiency," others affirmed that the returns from these strategies are either a compensation for risk (Chan, 1988; Fama and French, 1996), a product of size/seasonal anomalies (Zarowin, 1989), or a product of biases in the way that investors interpret information (Barberis, Shleifer and Vishny, 1998; Hong and Stein, 1999; and Daniel Hirshleifer and Subrahmanyam, 1998).

2.2.1. Momentum profits as a Compensation for Risk

According to the Efficient Market Hypothesis, investors cannot earn extra returns without bearing extra risk (Fama, 1970). Therefore, momentum and contrarian strategies present a challenge to the efficient market theory, by providing abnormal returns.

Some researchers identify the existence of patterns, typically called anomalies, in average stocks returns that Capital Asset Pricing Model (CAPM) cannot explain. In consequence of this limitation, Fama and French (1996) present their Three-Factor Model. This model seams to capture much of the cross-section variation. Nevertheless, it was not able to explain the returns continuation over short-term periods.

> "The main embarrassment of the three-factor model, (is) its failure to capture the continuation of short-term returns documented by Jegadeesh and Titman (1993) and Asness (1994)" Fama and French (1996, p.81)

Some authors tested whether cross-sectional differences in risk may explain momentum profits, by examining risk adjusted returns under specific asset pricing models. For example, Jegadeesh and Titman (1993) adjusted their results for risk using the CAPM[13], while Fama and French (1996) and Jegadeesh and Titman (2001b) used the Three-

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[13] Jegadeesh and Titman (1993) shows that momentum profits can't be explained by the market risk. The authors find that the best performers appear to be no more risky than the worst performers. Therefore, standard risk adjustments tend to increase rather than decrease the return spread between past winners and past losers.

Factor Model. Their results indicate that the cross-sectional differences in expected returns under the two asset pricing models cannot explain momentum profits.

> "However, it is possible that these models omit some priced factors and hence provide inadequate adjustments for differences in risk." Jegadeesh and Titman (2001a, p.10)

Conrad and Kaul (1998) admitted that it is premature to reject the rational models and have suggested a momentum risk-based interpretation. According to the authors, momentum profits could be entirely due to cross-sectional variations in mean returns rather than to any predictable time-series variations in stock returns. They started with the hypothesis that stock prices follow random walks with drifts that vary across stocks. The differences in these unconditional drifts explain momentum profits. Consequently, winner portfolios should continue to significantly outperform loser portfolios by the same magnitude, in any post-holding period.

However, as we have already referred, Jegadeesh and Titman (1999) concluded that, in the long run (13-60 months), momentum profits, not only tended to disappear, but also turned negative. This evidence clearly rejects the Conrad and Kaul (1998) hypothesis which suggests that the winners will continue to outperform the losers outside the momentum strategy holding period.

Even Jegadeesh and Titman (1999) referred their surprise, as they reached very different conclusions after examining essentially the same data as Conrad and Kaul (1998). To reconcile these conflicting findings, the authors reexamined Conrad and Kaul (1998) procedures to better understand why their conclusions were so different. They found that Conrad and Kaul (1998) had a small sample bias, which allowed extreme observations to be drawn in two, biasing momentum profits upwards. Therefore, Jegadeesh and Titman (1999) concluded that the momentum profits observed were not generated by cross-sectional variation in returns, but due to the stocks returns time-series properties.

Grundy and Martin's (2001) evidence also contradicts the risk-based explanations. The authors found that, between 1926 and 1995, the risk adjusted profitability of momentum strategies is more than 1.34 percent per month (with an associated t-statistic of 12.11).

In summary, current risk-based explanations fail to fully account for the momentum effect. Contrasting Conrad and Kaul (1998) results, the behavioral models suggest that the post-holding period returns of the momentum portfolio have a propensity to be negative.

> "Although the negative post-formation returns of the momentum portfolio appear to support the predictions of the behavioral models, based on our further analysis, we suggest that this support should be interpreted with caution." Jegadeesh and Titman (1999, p.13)

2.2.2. The Behavioral Models

Given the limitations of risk-based explanations for momentum profits, some researchers have turned their attentions to behavioral models in order to clarify this occurrence.

The behavioral models attempt to explain the momentum profits through investors' overconfidence or by the way that investors interpret firm's specific information. These models are based on the idea that momentum profits arise because of inherent biases (Jegadeesh and Titman, 2001a).

In Barberis *et al.*'s (1998) model, there is a representative investor who suffers from a conservatism bias and does not sufficiently update his beliefs when he observes new public information. As a result, prices will slowly adjust to information and, once the information is fully incorporated in prices, there is no further predictability about stock returns.

The authors argued that the representative heuristic[14] may lead investors to mistakenly conclude that a winner portfolio will continue to win in the future. Although the conservatism bias in isolation leads to underreaction, this behavioral tendency, in conjunction with the representative heuristic, can lead to price overshooting. Therefore, in the long-term, prices will readjust to their fundamental values, causing returns reversals.

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[14] Representative heuristic is the tendency of individuals to identify "an uncertain event, or a sample, by the degree to which it is similar to the parent population." Tversky and Kahneman (1974, p.1124)

> "What causes intermediate-term momentum but long-term overreaction?"[...] "The answer is heuristic-driven bias." Shefrin (2000, p.103)

Daniel *et al.* (1998) proposed a model that is also consistent with the short-term momentum and the long-term reversals (overreaction). They suggested that the behavior of informed traders can be characterized by two psychological biases:

> "(…) investor overconfidence about the precision of private information; and biased self-attribution, which causes asymmetric shifts in investors' confidence as a function of their investment outcomes". Daniel *et al.* (1998, p.1839)

According to their model, an overconfident investor overestimates his ability to generate information or to identify the significance of existing data that others neglect. The overconfident investors perceive themselves as more able to value stocks than they actually are, so, they underestimate their forecast error variance. Due to self-attribution bias, when investors receive a confirming public information, their confidence rises, but the inverse causes confident to fall only modestly, if at all. For example, investors attribute ex-post winners to their stock selection skills and the ex-post losers to external noise or bad luck. Based on their increased confidence in their signals, they push up the prices of the winners above their fundamental values, causing momentum in security prices (Daniel *et al.*, 1998). The authors concluded that overconfidence leads to negative long-run autocorrelations while biased self-attribution results in positive short-run autocorrelations.

Hong and Stein (1999) do not directly appeal to any behavioral biases, but they consider two types of investors who trade based on different sets of information. The informed investors or the "news watchers" obtain signals about future cash flows but ignore information in historical prices. The other investors, the "momentum traders", make forecasts based on history of past prices and, in addition, do not observe fundamental information. The authors assume also that information diffuses gradually across population. The information obtained by the "news watchers" is transmitted with delay and, hence, is only partially incorporated in the prices (underreaction). The "momentum trader" bases his trade only on the price changes over some prior interval and tends to push prices of past winners above their fundamental values (Hong and Stein, 1999). This model accepts the existence of return reversals when prices, eventually, revert to their fundamentals.

Using Hong and Stein (1999) example, in case we have good news at the moment *t* and no change in fundamentals after all, the "news watchers" will push the prices up, but not enough. At moment *t+1*, the "momentum traders" will buy these stocks, pushing the prices up again. This round of momentum trading creates a further price increase leading to a further round of momentum trading, and so on. When "momentum traders" implement "naive momentum strategies" based on past price trends, their trades will finally lead to overreaction in long horizons.

As we can see, behavioral models present a number of different interesting facts to explain the existence of momentum profits. However, financial investigators are far from reaching consensus on what generates momentum profits, turning this subject into an interesting area for future research.

3. Data and Methodology

This section intends to expose the data used in this study and the methodology adopted. In the following subsection (3.1), we will present the main data that we have collected for constitute our sample and in the subsequent subsection (3.2) we will detail the methodological steps that we have followed in order to reach our final results, including all the assumptions and tests made.

3.1. Data

Our study is centered in the Portuguese stock market – NYSE[15] Euronext Lisbon, more specifically in the stocks that integrate the PSI[16] Geral.

The sample period runs from January 1988 to April 2012 (about 23 years), in order to meet the needs of data required by this kind of empirical studies. For instance, Rouwenhorst (1998) considered 17 years (from 1978 to 1995) and Jegadeesh and Titman (1993) used 24 years (1965 to 1989) in their samples. Thus, our study provides the most extensive sample used for the analysis of momentum profitability in the Portuguese stock market.

For a specific stock to be included in our sample, it must belong to the PSI Geral and must have been traded continuously at least for 25 months, since one of our strategies needs 12 months as observation period (J), 1 month of delay between the observation and the formation of the portfolio and 12 months of holding period (K).

Using Datastream database, we have collected the Total Return Index (TRI) instead of daily prices. Thereby, we can obtain the stock returns adjusted for stock splits, dividends and right issues.

All stocks, except one, comply with the limitations established for our sample. Thus, we have not included the "Teixeira Duarte" data, since, in the analysis period, this stock only had 20 months of negotiation. Therefore, although we could use this stock data for some strategies, with smaller observation and holding periods, we decided to consider

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[15] NYSE - New York Stock Exchange
[16] PSI - Portuguese Stock Index

the same number of stocks in all strategies, avoiding taking into account some stock returns in one and not in other strategies (and its consequent bias).

As a result, the number of stocks in the sample varies between 11 at the beginning and 51 stocks at the end of the studied sample. Since in the beginning, our sample only has 11 stocks, winner and the loser portfolios are constituted by one stock each, however this only happens in the first three months.

In addition to the Total Return Index (TRI), we have collected, from Datastream, the Market Capitalization Values and the Datastream Historical Betas[17]. In both cases, there are some data gaps, especially for periods prior to 1995.

Essentially, this is the data required to implement the methodology presented in the following subsection.

3.2. Methodology

In the empirical part of our study, we have used the work of Jegadeesh and Titman (1993) as a reference to construct the different momentum strategies, as well as the further tests and analysis.

Hence, the strategies implemented in this study select stocks based on their past returns over the last 3, 6, 9 and 12 months and holds the selected stocks from 3, 6, 9 and 12 months. By examining the profitability of a number of these strategies, our study investigates the efficiency of the Portuguese stock market.

For the construction of the relative strength strategies, we needed to transform the daily data into monthly data. Thus, with the Total Return Index (TRI) we have calculated the monthly returns, as follows:

$$Monthly\ Return_{t} = ln\ (TRI_{last\ day\ of\ month\ t}\ /\ TRI_{last\ day\ of\ month\ t-1}) \tag{1}$$

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[17] "The beta factor is derived by performing a least squares regression between adjusted prices of the stock and the corresponding Datastream market index. The historic beta so derived is then adjusted using Bayesian techniques to predict the probable behavior of the stock price on the basis that any extreme behavior in the past is likely to average out in the future. This adjusted value, or "forecast" beta, is represented by the BETA datatype. The Datastream beta factor is calculated using stock prices and market indices as the only variables." In Datastream Definitions Guide.

The relative strength strategies are constructed in the following way: at the end of each month t, all stocks are ranked into deciles based on their past J-month returns (J equals 3, 6, 9 or 12). Based on these rankings, the stocks are assigned to one of ten decile portfolios, which are equally weighted at formation. In the extreme deciles we have the winner and the loser portfolios. In each month t, the strategy buys the winner portfolio and sells the loser, holding this position[18] for the K subsequent months (K equals 3, 6, 9 or 12 months) (Jegadeesh and Titman, 1993).

A strategy with a J-month ranking period and a K-month holding period is a J-month/K-month strategy. As J and K can be equal to 3, 6, 9 or 12 months we studied a total of 16 strategies.

Since bid-ask spread bounce can attenuate the continuation effect, we have reported a second set of 16 strategies that skip a month between the portfolio formation and the holding period. By delaying a month, as in Rouwenhorst (1998), we avoid some of the bid-ask spread, price pressure and lagged reaction effects that underlie the evidence documented in Lehmann (1990).

To increase the power of these tests, the strategies we examined include portfolios with overlapping holding periods, i.e., in any given month t, the strategies hold a series of portfolios that are selected in the current month, as well as in the previous K-1 months. For instance, the winner portfolio of a 6-month/6-month strategy in December comprises 10% of the stocks with the highest returns over the previous June to November, May to October and so on, up to the previous January to June period.

Following this approach, we have computed the average monthly returns of the different buy (winner) and sell (loser) portfolios, as well as the zero-cost (winners minus losers portfolios) and, for each of the ranking and holding periods, we have tested the significance[19] of the excess returns from buying winners and selling losers (Rouwenhorst, 1998).

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[18] During the holding period (K months) the portfolios are not re-balanced.
[19] We used a t-test, whose the null hypothesis is that, for the same holding period, there is no difference in the average returns of winner and loser portfolios.

As a reference, we have calculated the average monthly returns of the market portfolio, which contains the whole sample of stocks used in this study weighted equally, for all the holding periods (3, 6, 9 our 12, with or without 1 month delay).

To make the comparison between the zero-cost and the market portfolios, we have focused on the strategies that have 6 month ranking periods, with no delay in the formation of the portfolios. For each holding period, we conducted a hypothesis test to determine whether the difference between the average monthly returns of these two portfolios, in order to verify if the zero-cost strategy had significantly different average returns from those achieved by the market portfolio. In case we confirm that, we can conclude the existence of abnormal returns from this trading strategy.

Since many of the studies on small capital markets[20] have adopted a division of the stock data into quintiles instead of deciles, we have decided to rank the data into five portfolios for all the holding periods, in order to verify whether the obtained results are significantly altered. Therefore, the winner portfolio comprises 20% (instead of 10%) of the stocks with the highest returns over the previous 6 months period and the loser portfolio 20% of the stocks with the lowest returns. Thus, we present the average monthly returns in accordance with the portfolio construction suggested by Soares and Serra (2005) for the Portuguese stock market.

As in the main literature, the remainder of our study will concentrate on portfolios formed on the basis of 6 month ranked returns and held for 6 months (6-month/6- month strategy), that does not skip a month between the portfolio formation period and the holding period.

Centering on this strategy, we have calculated the average returns and standard deviations of its 10 deciles portfolios. Toward analyze the equality of returns of the relative strength portfolios, as in Rouwenhorst (1998), we have performed an F-test.

To present a summary statistic for this strategy, we have estimated the portfolios' averages for the two most common indicators of systematic risk: the post-ranking betas

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[20] For example, Soares and Serra (2005) for the Portuguese stock market and Bildik and Gülay (2002) for the Istanbul Stock Market divided the data into quintiles.

of the ten 6-month/6-month relative strength portfolios and the average market capitalization of the stocks included on these portfolios.

As mentioned in the previous subsection, the Betas and the Market Capitalization had some data flaws, especially in periods previous to 1995. In order to overcome this limitation, we have considered that stocks with missing data have a Beta or Market Capitalization equal to the average of the portfolio in which they belong.

We did not examine the profitability of the 6 month/6 month relative strength strategies within size and beta subsamples, as in Jegadeesh and Titman (1993), due to the reduced number of stocks in the Portuguese stock market. This kind of analysis would allow us to examine whether the profitability of the strategy is confined to any particular subsample stocks. This way, we would only be able to characterize the portfolios concerning to size or average beta.

In addition, we have examined the returns of the momentum portfolio, also known as relative strength portfolio, in "Event Time" as Jegadeesh and Titman (1993). This analysis can provide some evidence about the profitability of momentum strategies over long horizons for the Portuguese stock market. In case we observe significant positive returns in the months beyond the holding period (K=12), that would suggest that the zero-cost portfolio systematically selects stocks that have higher than average unconditional returns and, in case we observe significant negative returns, that would indicate that price changes during the holding period are at least partially temporary. Therefore, we have calculated the average monthly and cumulative returns of the zero-cost portfolio in the 36 months after the portfolio formation date. We have also performed significance tests for the monthly average returns.

Essentially, the tests and analysis that we present in this subsection, will allow us to verify the existence of return continuation over 3 to 12 months and to provide some evidence about the most relevant sources of momentum profitability, as the portfolio beta and the average size of stocks and as the long horizon momentum reversal study.

In the next section, we will report the main findings provided by the presented methodology.

4. Main Findings

We have decided to divide this section into three subsections. In the first one, we will present the main results of the 32 different strategies concerning to the average monthly returns. We will also establish a comparison between those results and the average returns of the equally weighted market portfolio. The second subsection, enumerates the major findings regarding the causes of momentum strategies, while, in the last one, we will report the results of the long horizon analysis.

4.1. Returns of Relative Strength Portfolios

This subsection documents the average returns of the momentum portfolios, between January 1988 and April 2012, using data from the Portuguese Stock Market.

Table I reports the average returns of the different buy and sell portfolios, as well as the zero-cost (winners minus losers' portfolios) for the 32 described strategies. The portfolios within Panel A are formed at the end of the performance ranking period, while the portfolios within Panel B are formed with one-month delay.

The returns of all zero-cost portfolios are positive, i.e., past winners outperformed past losers. All excess returns of winners over losers are statistically significant at a 5 percent level, being the strategies with smaller ranking periods significant at a 1 percent level.

Regarding the possibility of momentum profits existence due to delayed reaction to new information, our results proved otherwise, since the average monthly returns in Panel B were higher than the average monthly returns in Panel A.

The most successful zero-cost strategy, which provided the highest returns among the other strategies, select stocks based on their returns over the previous 3 months, skipping a month between the ranking period and the portfolio formation, and then holds the portfolio for 3 months (3-month/3-month strategy in Panel B). This zero-cost portfolio yields 1.84 percent per month (superior to the performance of the most successful zero-cost portfolio in Jegadeesh and Titman's (1993) sample). For the same ranking and holding period, the bottom decile (loser) portfolio in Panel A performed

negative returns of -0.83 percent, 1.56 percent less than the top decile (winner) portfolio, which returns 0.73 percent.

In Panel A, the most profitable zero-cost portfolio is the 6-month/3mmonth strategy, with an average monthly return of 1.74 percent.

Table I
Returns of Relative Strength Portfolios

The relative strength portfolios are formed based on J-month lagged returns and held for K months. The values of J and K for the different strategies are indicated in the first column and row, respectively. The stocks are ranked into deciles based on the previous J-month performance and an equally weighted portfolio of the stocks in the bottom decile (lowest previous performance) is the *loser* portfolio and that in the top decile (highest previous performance) is the *winner* portfolio. The average monthly returns of these portfolios are reported in this table, as well as the average monthly returns of an equally weighted market portfolio. The portfolios in Panel A are formed immediately after the ranking period and the formation of the relative strength portfolios in Panel B occurs one month after the ranking takes place. The t-statistics reported are significant at 1 percent level (*) and at 5 percent level (**). The sample period is from January 1988 to April 2012.

Ranking Period (J)	Portfolio	Panel A								Panel B							
		Holding Period (K)								Holding Period (K)							
		3		6		9		12		3		6		9		12	
3	Loser	-0,0083		-0,0088		-0,0089		-0,0075		-0,0107		-0,0101		-0,0090		-0,0074	
	Winner	0,0073		0,0057		0,0039		0,0026		0,0078		0,0053		0,0036		0,0020	
	Winner-Loser	0,0156		0,0145		0,0128		0,0101		0,0184		0,0154		0,0126		0,0094	
	(t-stat)	3,5272	*	4,3236	*	4,4450	*	4,1147	*	4,1277	*	4,7249	*	4,4002	*	3,8624	*
6	Loser	-0,0121		-0,0112		-0,0096		-0,0087		-0,0121		-0,0107		-0,0094		-0,0082	
	Winner	0,0052		0,0033		0,0020		0,0008		0,0060		0,0028		0,0014		0,0005	
	Winner-Loser	0,0174		0,0145		0,0116		0,0095		0,0181		0,0135		0,0108		0,0087	
	(t-stat)	3,9276	*	4,2062	*	4,0134	*	3,8142	*	3,9977	*	3,9891	*	3,8366	*	3,5043	*
9	Loser	-0,0099		-0,0094		-0,0085		-0,0077		-0,0102		-0,0093		-0,0084		-0,0073	
	Winner	0,0048		0,0019		0,0001		-0,0009		0,0037		0,0008		-0,0006		-0,0014	
	Winner-Loser	0,0146		0,0113		0,0086		0,0068		0,0140		0,0101		0,0078		0,0059	
	(t-stat)	3,2575	*	3,3793	*	3,0589	*	2,7224	*	3,2135	*	3,0731	*	2,7882	*	2,3790	**
12	Loser	-0,0083		-0,0077		-0,0078		-0,0072		-0,0087		-0,0083		-0,0078		-0,0069	
	Winner	0,0008		-0,0003		-0,0006		-0,0012		-0,0002		-0,0003		-0,0008		-0,0011	
	Winner-Loser	0,0091		0,0074		0,0071		0,0060		0,0085		0,0079		0,0070		0,0058	
	(t-stat)	2,0650	**	2,2550	**	2,4938	**	2,3993	**	1,9932	**	2,4348	**	2,5142	**	2,4004	**
Average Monthly Returns of a Equally Weighted Market Portfolio		-0,0010		-0,0008		-0,0006		-0,0003		-0,0009		-0,0007		-0,0009		-0,0003	

As in Rouwenhorst (1998) we verified that, independently of the interval used for ranking, the average monthly returns tend to fall for longer holding periods.

In Table I, we report, as a reference, the average monthly return of an equally weighted market portfolio. When compared, the average monthly returns of the zero-cost portfolios, for each of the 32 strategies, are higher than the average monthly returns of the market portfolio.

We can conclude, from the results of Table I, that relative strength strategies are on average quite profitable, as in Jegadeesh and Titman (1993). For each of the ranking and holding periods, we can observe that past winners have outperformed past losers by about 1.1 percent per month. The monthly return ranges from 0.58 percent, in the 12-month/12-month Panel B strategy, to 1.84 percent, in the 3-month/3-month Panel B strategy.

In Table II, we report the differences between the relative strength portfolios and the market equally weighted portfolio, for the different K holding periods.

As mentioned in the last section, many of the studies on small capital markets divided the stock data into quintiles instead of deciles. Nevertheless, we have decided to rank the data into five portfolios for all the holding periods, in order to verify whether the obtained results were significantly altered. Thus, we present the average monthly returns in accordance with the portfolio construction suggested by Soares and Serra (2005) for the Portuguese stock market and we have also compared them with the average returns of the market equally weighted portfolio.

Although, for all the holding periods, the quintile zero-cost portfolios presented smaller average returns than the decile zero-cost portfolios, the main findings are the same and the difference between the monthly average returns is not significant.

Thus, we have continued to use the decile portfolios in the remainder of our study, continuing to follow the portfolio construction presented by Jegadeesh and Titman (1993).

The hypothesis test performed to determine whether the zero-cost strategy had significant different average returns from those achieved by the market portfolio, allows us to conclude the existence of abnormal returns based on this trading strategy.

Table II
Relative Strength Portfolios and Market Portfolio

The relative strength portfolios are formed based on six-month lagged returns and held for K months, with no delay in the portfolio formation. The values of K for the different strategies are indicated in the first column. In the second column the stocks are ranked into deciles and in the last column the stocks are ranked into quintiles. For each holding period, we conduct a hypothesis test to determine the difference between the average monthly returns of the relative strength portfolio and the market portfolio. All t-stat are significant at 1 percent level.

Holding Period (K)		Average Return Deciles	Average Return Quintiles
3	Winner	0,0052	0,0051
	Loser	-0,0121	-0,0096
	Winner - Loser	0,0174	0,0147
	Average Monthly Returns of a		
	Equally Weighted Market Portfolio	-0,0010	-0,0010
	T-stat	4,5570	4,6341
6	Winner	0,0033	0,0036
	Loser	-0,0112	-0,0089
	Winner - Loser	0,0145	0,0125
	Average Monthly Returns of a		
	Equally Weighted Market Portfolio	-0,0008	-0,0008
	T-stat	5,0487	5,2061
9	Winner	0,0020	0,0024
	Loser	-0,0096	-0,0078
	Winner - Loser	0,0116	0,0102
	Average Monthly Returns of a		
	Equally Weighted Market Portfolio	-0,0006	-0,0006
	T-stat	4,8390	4,9607
12	Winner	0,0008	0,0016
	Loser	-0,0087	-0,0064
	Winner - Loser	0,0095	0,0079
	Average Monthly Returns of a		
	Equally Weighted Market Portfolio	-0,0003	-0,0003
	T-stat	4,4334	4,2578

We can verify that, for the quintile strategies, the zero-cost portfolio have positive average returns, i.e., the six-month past winners outperformed the six-month past losers, for each of the K holding periods.

In conclusion, for all the K holding periods, the winners minus losers portfolios significantly outperformed the equally weighted market portfolio. This market portfolio, for the different holding periods presented negative monthly average returns (although near zero), while the monthly average returns of the "buy past winners and sell past losers" strategies were positive.

4.2. Causes of Relative Strength Profits

The rest of our study concentrates on portfolios formed on six-month ranked returns basis, formed at the end of the ranking period and held for six months (6-month/6-month strategy), following the main literature (Jegadeesh and Titman, 1993, 2001b; Rouwenhorst, 1998; etc.)

In this subsection, we analyze the average returns and standard deviations of the ten relative strength portfolios (P1 to P10, being P1 the loser Portfolio and P10 the winner), connecting the obtained results with the two most common indicators of systematic risk: Betas and Market Capitalization.

Focusing on the average returns, we can verify that the lowest past returns portfolios (from Loser Portfolio to P5) continued to have the worst performances in the six subsequent months and the ninth decile portfolio (P9) had the higher average return.

Accordingly, the first column shows that higher past six-month returns is on average associated with stronger future six-month returns. Similarly to Rouwenhorst (1998) we have performed an F-test, that strongly rejected the equally hypothesis between the monthly average returns of the 10 relative strength portfolios.

Rouwenhorst (1998) found a U-shaped standard deviation of decile portfolios. In our sample, the standard deviations were not perfectly U-shaped, although the winner and loser portfolios had higher standard deviations than the portfolios in the middle deciles.

Portfolios with higher standard deviations, *caeteris paribus*, are more likely to show more volatile performances (Rouwenhorst, 1998). The standard deviation of the excess return of winners over losers is about 2.4 percent per month.

Table III
Betas and Market Capitalizations of Relative Strength Portfolios

The relative strength portfolios are formed based on six-month lagged returns and held for six months. The equally weighted portfolio of stocks in the lowest past return decile is the P1 or Loser Portfolio, the portfolio in the next decile is P2, and so on, being P10 the Winner Portfolio. The average returns of the ten portfolios and their standard deviation, average Beta and Market Capitalization (as a proxy of firm size) are reported here. The F-Statistic test for equality of average returns of the ten relative strength portfolios and it is significant at 1 percent level. The sample period is January 1988 to April 2012.

	Average Return	Standard Deviation	Beta	Market Capitalization (m€)
Loser	-0,0112	0,0425	1,0203	496,6
P2	-0,0061	0,0400	0,8162	2621,2
P3	-0,0014	0,0369	0,7747	2301,2
P4	-0,0015	0,0344	0,8039	2590,6
P5	-0,0017	0,0378	0,7897	2778,2
P6	0,0013	0,0327	0,8104	2933,8
P7	0,0016	0,0353	0,8176	3101,2
P8	0,0018	0,0331	0,8327	3405,5
P9	0,0040	0,0337	0,8861	3007,4
Winner	0,0033	0,0389	0,9409	2586,5
Winner - Loser	0,0145	0,2401	-0,0793	
Average			0,8492	2582,2
F-Test	4,4962			

In the third column, we report the average betas for the ten portfolios. Accordingly to the Jegadeesh and Titman's (1993) results, the extreme decile portfolios have higher betas than the average beta (for the full sample).

Since the beta of the losers' portfolio is higher than the winners' portfolio beta, the zero-cost portfolio has a negative beta not statistically different from zero, i.e., not significant. This leads us to conclude that the excess returns of winners over losers is unlikely explained by their covariance with the market, since, according to

Rouwenhorst (1998), it would be necessary for the beta of the winners to exceed the beta of the losers by about two, so that market risk could explain a continuation effect of 1 percent per month.

In the last column, we report the average market capitalizations of the decile portfolios. The findings are not surprising: as in Rouwenhorst (1998), the losers' portfolio presents the lowest average size and both (winners and losers) are, on average, smaller than the mean.

We did not examine the profitability of the 6-month/6-month relative strength strategies within size and beta subsamples, as in Jegadeesh and Titman (1993), due to the reduced number of stocks in the Portuguese stock market. As we have already mentioned, this kind of analysis would allow us to examine whether the profitability of the strategy is confined to any particular subsample stocks, since extent empirical evidence indicates that size and beta are related to expected returns.

Although this limitation, we can conclude that the deciles used in the winners-losers strategy are usually constituted by small-firms stocks. We can also suggest that the excess momentum returns cannot be explained by their portfolios' betas.

4.3. Performance of Relative Strength Portfolios in Long Horizons

As in all the other studies on this subject, we could not fail to analyze the performance of Relative Strength Portfolios in each of the 36 months following the portfolio formation date.

This analyzes can also provide additional insights about whether the profits are due to overreaction or to underreaction.

Table IV reports the average monthly and the cumulative returns of the zero-cost portfolio over 36 months after the formation date.

The average monthly returns in the first year are positive, but, only in the first four months after the portfolio formation date, they show significant positive returns. The average monthly returns are both positive and negative during the second and the third year, which does not happen in the first year.

Table IV
Performance of Relative Strength Portfolios in Long Horizons

The relative strength portfolios are formed based on six-month lagged returns. The equally weighted portfolio of the stocks in the bottom decile (lowest previous performance) is the sell portfolio and in the top decile (highest previous performance) is the buy portfolio. This table reports the average returns of the zero-cost, Winners minus Losers, portfolio in each month t following the formation period and the cumulative average returns. The sample goes from January 1988 to April 2012. We also present the t-statistic for the monthly returns. The marked t-statistics are significant at a 1(*), 5(**) and 10 (***) percent level.

t	Monthly Return		Cumulative Return	t	Monthly Return	Cumulative Return	t	Monthly Return		Cumulative Return
1	0,0129		0,0129	13	0,0007	0,1111	25	-0,0054		0,1134
t-stat	2,1737	**		t-stat	0,1228		t-stat	-1,1174		
2	0,0236		0,0364	14	0,0040	0,1151	26	0,0033		0,1166
t-stat	3,6444	*		t-stat	0,6732		t-stat	0,6841		
3	0,0177		0,0542	15	0,0024	0,1174	27	-0,0006		0,1160
t-stat	2,7567	*		t-stat	0,4410		t-stat	-0,1331		
4	0,0118		0,0659	16	0,0049	0,1224	28	0,0028		0,1188
t-stat	1,8769	**		t-stat	0,9076		t-stat	0,6526		
5	0,0095		0,0754	17	0,0036	0,1260	29	-0,0042		0,1146
t-stat	1,4764	***		t-stat	0,7114		t-stat	-0,8588		
6	0,0073		0,0828	18	-0,0021	0,1239	30	0,0047		0,1193
t-stat	1,2197			t-stat	-0,3693		t-stat	0,9962		
7	0,0042		0,0870	19	-0,0039	0,1201	31	-0,0078		0,1115
t-stat	0,7161			t-stat	-0,6969		t-stat	-1,3304	***	
8	0,0094		0,0964	20	-0,0017	0,1184	32	0,0045		0,1160
t-stat	1,4964	***		t-stat	-0,2665		t-stat	0,7456		
9	0,0036		0,1000	21	-0,0021	0,1163	33	-0,0035		0,1125
t-stat	0,6442			t-stat	-0,3591		t-stat	-0,5553		
10	0,0046		0,1046	22	-0,0013	0,1149	34	0,0007		0,1133
t-stat	0,8438			t-stat	-0,2329		t-stat	0,1176		
11	0,0021		0,1068	23	0,0000	0,1149	35	0,0048		0,1181
t-stat	0,3782			t-stat	-0,0030		t-stat	0,8325		
12	0,0037		0,1104	24	0,0038	0,1188	36	-0,0008		0,1173
t-stat	0,6574			t-stat	0,7820		t-stat	-0,1451		

The cumulative returns reach a maximum of 12.6 percent at the end of 17 months. However, we verified that, in the following months, this cumulative return does not reverse, standing approximately in 11 percent, which is a small decrease in relation to the maximum cumulative return reached.

Figure I

Evolution of the monthly and cumulative average returns in long horizons

Figure I present the monthly and cumulative average returns of the zero-cost portfolio reported in Table IV. In the monthly returns we can observe significant positive returns and the graphics show perfectly the mixture of positive and negative returns verified specially in the third year. The line for the cumulative returns shows the inexistence of momentum return reversals over the 36 months period, especially when compared with the Jegadeesh and Titman (1993)'s cumulative returns.
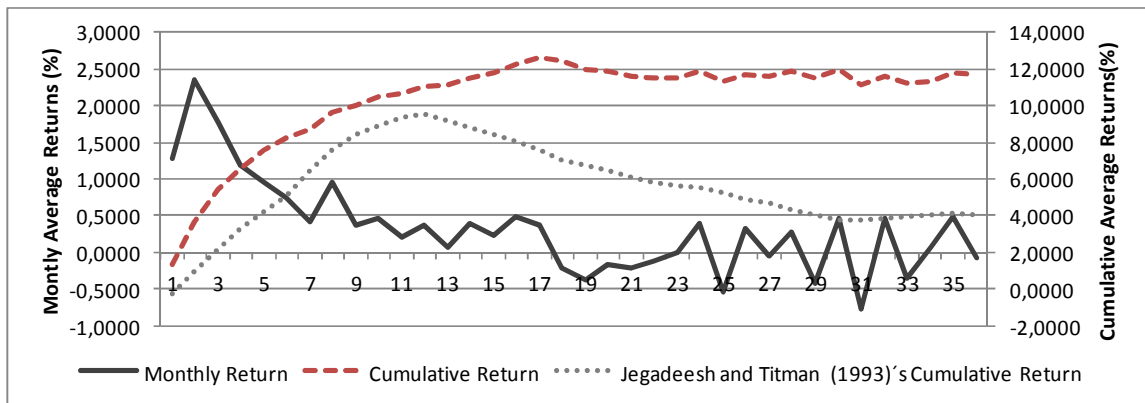
In their sample, Jegadeesh and Titman (1993) observed negative returns beyond the 12th month, suggesting that the positive returns over the first 12 months may not be permanent. Contrarily to their findings, we did not observe consistently negative average monthly returns in the months beyond the holding period, but a mixture of, non-significant, positive and negative returns.

Through our results, we are led to conclude that momentum strategies for the Portuguese stock market do not show any return reversal over long horizons.

However, we cannot rule out that the positive returns in the first 12 months are due to overreaction or underreaction, since our results are a mixture of positive and negative

returns and, moreover, we did not find significantly different from zero monthly returns, at a 5 percent level, beyond the fourth month.

Nevertheless, our results seem to draw some clues indicating underreaction as the main cause of the momentum profitability in this market, in line with the non-reversal returns in the long-term.

5. Conclusions

By challenging the notions of Efficient Market Hypothesis, momentum strategies have attracted financial researchers to, not only, study the momentum profitability in different stock markets, but also to study different causes and explanations for these profits.

Although several studies found evidence of momentum profitability, specifically for the Portuguese stock market, the studies done so far didn't found statistically significant results that prove or disprove the existence of return predictability based on past returns. Therefore, our purpose was to explore, with an extended sample period, the existence of return continuation, as well as investigate the Portuguese stock market efficiency at the weak form level (Fama, 1970).

As we have reported in the last section, the main findings of our study indicate the existence of momentum profitability in the short-run, confirming, thus, most of the results found in the main international literature, for large and liquid markets.

Following Jegadeesh and Titman (1993) methodology, we analyzed 32 different momentum strategies. For all of them, past winners significantly outperform the past losers portfolio in about 1.1 percent per month, for each ranking and performance periods. For instance, a strategy that selects stocks based on their past 6-month returns and holds them for 6 months presents a 1.45 percent monthly return.

Therefore, we were led to conclude that it is possible to predict future returns based on past performance, at least in the short run. Our findings seriously call into question the Market Efficiency Hypothesis in the Portuguese stock market, since, according to this assumption, there is no possibility to conceive profitable strategies based on past returns' observations.

Although the main findings of our study point to the existence of momentum profits in the Portuguese stock market, the momentum causes are not, yet, fully ascertained. Due to the reduced number of stocks, we are not able to perform size and beta subsamples, as in the Jegadeesh and Titman (1993). Nevertheless, following the Rouwenhorst (1998)

example, we characterized all the deciles' portfolios regarding to their volatility, their beta and firms size.

Through this characterization, we could verify that winner's and loser's portfolios presented higher volatility than the portfolios in the middle deciles, and both winner's and loser's portfolios are constituted by small stocks on average, being the losers smaller than the winners. Concerning to the most common risk factor, our portfolios' betas seem to suggest that momentum profits are unlikely explained by risk, since the winners' beta are even lower than the losers'. However, it should be noted that these findings were obtained through a portfolios' characterization and we didn't performed statistical tests that allow us to obtain conclusive results. Therefore, especially the risk explanations could be an interesting matter for further investigations.

Lastly, concerning to the performance of momentum profits over long horizons, we found that there is no significant return reversals over long horizons, contrarily to Jegadeesh and Titman's (1993) findings. After reaching maximum cumulative return, at the 17th month, the return reversals are very low (about 1 percent).

However, we cannot rule out that the positive returns in the first 12 months are due to overreaction or underreaction, since our results are not consistent, in the long run. Moreover, we did not find monthly returns significantly different from zero, at a 5 percent level, beyond the fourth month.

Nevertheless, our findings seem to draw some clues indicating underreaction as the main cause of the momentum profitability in this market, in line with the non-reversal returns in the long-term.

The explanations for the existence of underreaction can be extracted from behavioral models. However, these models consider both short-term momentum and long-term reversals (overreaction). Therefore, the evidence of underreaction found can be associated to a slowly adjustments from the investors, as in the Barberis *et al.* (1998) model, for instance. According to this, investors suffer from a conservative bias and do not update their beliefs after observing new public information, causing the prices to underreact. This model also admitted the possibility of price overshooting due to

representative heuristic, thus, in the long-term, prices would readjust to their fundamental values, causing returns reversals.

The research questions, exposed in the introductory section, can be satisfactorily answered with the obtained results. We are able to conclude, with statistical significance, that:

- It is possible to predict future returns using past performance observations, resulting in significant positive returns over three to twelve months holding periods.
- Momentum strategies can outperform the market portfolio returns.
- Although our results are not statistically significant regarding the long-term performance, our data seems to support the underreaction hypothesis.

However, we should always present these results with some caution, because there may be limitations derived from the methodological choices that we have made. For instance, in our sample we only take into account stocks that belong to PSI Geral, i.e., we only consider stocks that remain "alive", contrarily to Soares and Serra (2005), which can induct a "survivorship bias" to our results. Concerning to this option, our choice can be justified by our pretension to obtain the largest sample period possible compared to the available data. Nevertheless, although we did not know the impact due to "survivorship bias" in their results, we cannot rule out the hypothesis that our results may have been influenced by this bias.

Beyond the achieved results, have remained some interesting questions to consider, such as the momentum profitability when the risks are adjusted by the CAPM or the Fama and French Three Factor Model. Jegadeesh and Titman (1993, 1996) perform this analysis, as well as Soares and Serra (2005) for the Portuguese stock market, however with different conclusions regarding to the significance of the risk component in momentum profitability.

Thus, it is possible to verify that there are some issues to address, not only regarding to the risk based explanations, but also concerning to the behavioral perspective. It would be of interest, for instance, further research attempting to identify other momentum explanations.

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