ISCTE Business School
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Can Reversal be explained by Post-Earnings Announcement Drift or Momentum?

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Dissertation

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Resumo da Dissertação

A presente dissertação estuda a relação entre anomalias de curto prazo, momentum e post-earnings announcement drift (PEAD), e reversal (estratégia de longo prazo).

Há teorias que fundamentam que a hipótese da sub-reacção (momentum e PEAD) é causada pela dificuldade que os investidores têm em interpretar as informações que chegam ao mercado e, consequentemente, em incorporá-las no preço das acções, ou seja, existe um desvio no preço das acções face ao seu preço justo devido à heterogeneidade na forma como os investidores avaliam os preços das acções com base na informação que chega ao mercado. Por outro lado, investidores que seguem apenas tendências de mercado ("trend chasers"), motivados pelas prestações de curto prazo no período de sub-reacção, tendem a levar o preço das acções além do seu justo-valor, criando uma sobre-reacção (reversal) nos preços. Quando os investidores se apercebem que o preço está sobre-avaliado, ou seja, além do seu justo-valor, tendencialmente há uma queda no preço originand, assim, uma reversão nos mesmos, ou seja, reversal. É nosso propósito primordial testar se existe relação entre sub-reacção passada e sobre-reacção futura, usando um modelo multifactorial baseado no risco. Para o efeito, usaram-se acções do NYSE-AMEX, no período de Janeiro de 1975 a Dezembro de 2010.

Esta tese conclui que sub-reacções passadas, nomeadamente observações da anomalia PEAD que tiveram lugar dois anos antes, têm relação estatística e económica com reversal futuro.

Dissertation Summary

This thesis studies the interrelation among short-term anomalies, post-earnings announcement drift (PEAD) and momentum, and reversal, a long-term anomaly.

There are theories that argue that the underreaction hypothesis (momentum and PEAD) is a response to the way information diffuses into the market. That is, the investors have different interpretation for the same information and that creates uncertainty on how stock prices should be evaluated, making the stock prices under the fundamentals, motivating underreaction in prices. In reaction to these, there are investors that rely too much on past performance (known as "trend chasers") which, motivated by the short-term good performance at the underreaction period, tend to lead prices beyond its fundamentals, resulting in a long-term overreaction (reversal). Then, the subsequent correction on prices creates price reversals. Our major goal with this thesis is to study if future overreaction can be related/a result of past underreaction. For that, we use a multifactor risk-based model. In order to construct the models, we use NYSE-AMEX stock prices for the period starting at January 1975 to December 2010.

Our main conclusion points for a statistical and economical relation between past PEAD, namely observations that took place two years ago and future reversal on a multifactor model.

Key words

- Post-Earnings Announcement Drift
- Momentum
- Reversal
- Information

JEL Classification System

- G11 - Portfolio Choice; Investment Decisions
- G12 - Asset Pricing
- G14 - Information and Market Efficiency; Event Studies

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Sumário Executivo

Esta dissertação visa estudar anomalias (estratégias) de mercado, mais concretamente relacionadas com preços, retornos e resultados anunciados de acções. Este estudo abrange uma análise individual a cada anomalia e, também, analisa as relações multifactoriais entre elas. As três anomalias de mercado estudadas nesta tese são o *post-earnings announcement drift, momentum* e *reversal.*

O *post-earnings announcement drift*, originariamente documentado por Ball and Brown (1968) e mais recentemente por Bernard and Thomas (1989), é uma anomalia de curto prazo que resulta das diferentes expectativas que os investidores têm relativamente aos *earnings announcement* das empresas. Estas expectativas são mensuradas pelo *standardized unexpected earnings* (SUE), que tenta captar os desvio entre o *earning announcement* esperado e o observado. Esta estratégia dita que acções com elevados SUE irão obter melhores performances que acções com baixos SUE no curto prazo (até 12 meses). Desta forma, poderíamos construir um portefólio onde comprássemos acções com elevados SUE e vendessemos acções com baixos SUE na mesma proporção formando, assim, um portefólio de investimento zero com retorno positivo.

O *momentum* é, também, uma anomalia de curto prazo, primeiramente abordada por Jegadeesh and Titman (1993), que assenta no comportamento das acções no curto prazo. Esta estratégia conclui que acções com melhor (pior) performance de curto prazo (até 12 meses) continuarão a registar melhor (pior) performance no curto prazo (até 12 meses). Assim, poderíamos construir um tal portefólio de investimento zero onde as acções de melhor performance constituíriam as posições longas e as acções de pior performance constituíriam as posições curtas.

Por fim, a anomalia do *reversal* desenvolve-se numa lógica de longo prazo. De Bondt and Thaler (1985) concluíram que acções que tenham testemunhado melhores (piores) performances de longo prazo (até 5 anos) irão registar piores (melhores) performances de longo prazo (até 5 anos). Desta forma, poderíamos construir um portefolio no qual as posições longas iriam para o conjunto de acções com pior performance passada e as posições curtas iriam para as acções com melhor performance passada.

As anomalias de curto prazo, *post-earnings announcement drift* e *momentum*, e de longo prazo, *reversal*, são fundamentadas pela hipótese da sub-reacção (*underreaction*) e pela hipótese da sobre-reacção (*overreaction*), respectivamente. Estas hipóteses surgem no âmbito dos modelos comportamentais como resposta à hipótese de eficiência dos mercados. De facto, é no seguimento destas duas teorias e na relação entre elas que a génese desta tese é criada. Nós acreditamos que o *reversal* futuro está relacionado com o *post-earnings announcement drift* e *momentum* passados. Tal como Barbosa (2010) mostrou, as estratégias de curto prazo são uma resposta de sub-reacção resultante da dificuldade que os investidores têm em interpretar e incorporar nos preços as informações que chegam ao mercado. Quanto maior a dificuldade em interpretar estas informações, maior a dificuldade em ajustar os preços para o seu valor fundamental. Por outro lado, os investidores de tendência (*"trend chasers"*), tal como Hong and Stein (1999) provou, motivados pelos resultados de curto prazo, tendem a levar o preço das acções além do seu preço justo, provocando uma sobre-reacção de longo prazo. Quando os investidores se apercebem que o preço está muito para além do seu preço justo, há uma tendência de reversão nos preços, resultando, assim, em *reversal.* Desta forma, podemos concluir que poderá haver uma estreita relação entre sub-reacção passada e sobre-reacção futura. Assim, o nosso principal objectivo é estudar, através de um modelo baseado no risco - como é o caso de Fama and French (1996), Chan et al. (1996) e Chordia and Shivakumar (2006), a interacção entre estas três varíaveis, mormente se o *post-earnings announcement drift* e/ou *momentum* passados pode(m) explicar o *reversal* futuro.

Para construirmos os portefólios que representam as três anomalias, retirámos os preços das acções listadas no NYSE-AMEX-NASDAQ com dados no COMPUSTAT - de onde retirámos os resultados das empresas, para o período que começa em Janeiro de 1975 e vai até Dezembro de 2010. Para a construção dos portefólios, seguimos o trabalho de Chordia and Shivakumar (2006) para as anomalias do *post-earnings announcement drift* e *momentum* e para o *reversal* seguimos o trabalho de De Bondt and Thaler (1985) e Fama and French (1996). Assim, construímos dez portefólios para cada anomalia, os quais são formados tendo em conta o ranking do SUE, no caso do *post-earnings announcement drift,* e dos retornos passados no caso do *momentum* e do *reversal*, e um portfólio de investimento zero para cada estratégia, que é calculado através da diferença entre os décimo e primeiro portefólios.

Adicionalmente, não sendo um objectivo primordial nesta dissertação, também analisámos o efeito nos resultados caso sejam consideradas acções do NASDAQ, pelo que construímos dois *sets* de portefólios: um sem acções do NASDAQ e outro adicionando--as.

A nossa principal conclusão é que o modelo três-factores de Fama-French adicionado por uma observação passada de retornos anualizados do portefolio de investimento zero da anomalia *post-earnings announcement drift*, que compreendem retornos mensais que tiveram lugar entre o segundo e primeiro anos passados, é estatisticamente significativo em explicar os retornos futuros do portefólio de investimento zero do *reversal*, quando apenas se usam retornos de empresas listadas no NYSE-AMEX. Mais se conclui que a inclusão do NASDAQ majora os retornos dos portefólios formados na base das três anomalias mas tende a desvanecer as relações multifactoriais entre estas estratégias, já que algumas das conclusões deixam de ser estatisticamente relevantes.

1 Introduction

Pricing anomalies have been a major topic in finance research. During the last decades, scholars have analyzed and tried to understand events that have implications on how stock prices react to information. Some of those events fall outside the market efficiency hypothesis, being viewed as market anomalies. Thus, academia has looked for asset-pricing theories in order to get reasonable explanations for those market anomalies. In fact, as Fama (1998) points out, the greater our understanding about those events, the better our knowledge about the efficient market paradigm.

Perhaps the most common studied market anomalies have been the post-earnings announcement drift (PEAD), momentum and reversal. The PEAD phenomenon, also known as earnings momentum, was firstly documented by Ball and Brown (1968) and more recently by Bernard and Thomas (1989) and others. In simple terms, this anomaly consists in prices being slow to fully reflect earnings information. This means that it is possible to earn abnormal returns by going long on stocks with positive earnings surprises (measured by standardized unexpected earnings, SUE) and short on stocks with negative earnings surprises. The short-term return continuations theory, the momentum phenomenon, firstly identified by Jegadeesh and Titman (1993), identifies that short-term past winners will continue to be winners for a period of up to one year and short-term past losers will still be losers for the same length of period. Thus, an investor who bases his investment strategy on buying winners and selling losers can get abnormal returns for a period of up to one year. Lastly, the long-term return reversals theory, the reversal phenomenon, was firstly documented by De Bondt and Thaler (1985). This anomaly consists in stocks which currently have bad performance, outperforming, on the long-run (following three to five years), stocks which are currently performing well. Hence, an investor can earn positive returns over the long-run by going long on the current losers and shorting the current winners.

As Fama and French (2008) pointed out, anomalies has been viewed as such when an event study is not explained by the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965) and Black (1972). In order to understand what motivates those anomalies, scholars have been trying to find reasonable explanations, most of the times based on asset-pricing models that use the CAPM model as the starting point. Some of the new risk factors have been variables that represent those market anomalies. One of the most successful model has been the Fama-French model (Fama and French, 1993) where they present two new risk factors: one related to the firm size and the other related to firm book-to-market ratio. More recent studies have been Chan et al. (1996), who investigated the explanatory power of past returns and past earnings surprises explanatory power on future returns, Chordia and Shivakumar (2006) concluded that earnings momentum and price momentum are related in a multifactor framework and Simlai (2011) who used PEAD based zero-investment portfolios on a multifactor model to check its asymmetric role on short-term return continuations and on long-term return reversals.

In this context, our major goal with this paper is to contribute for a better understanding about the interrelationship among the three most important anomalies: PEAD, momentum and reversal. Here, our stronger focus is to see if contemporaneous reversal can be related with past PEAD and/or past momentum. Driven by this idea, one could think that past ongoings (good news or bad news), due to their difficult interpretation, originated investment decisions which could result in earnings momentum and/or price momentum, that is, underreaction hypothesis (Bernard and Thomas 1990 and Jegadeesh and Titman 1993). This short-term returns continuation could take the stock prices beyond their fair price which, after some time, investors realize that their investments are beyond its fundamentals. If this sentiment becomes generalized, they change their positions, which could create price reversals, consistent with the overreaction hypothesis from De Bondt and Thaler (1985).

In terms of methodology, we followed closely Chordia and Shivakumar (2006) and Simlai (2011). The main idea is to form 10 deciles portfolios and a zero-investment portfolio for each anomaly (formed by the difference between the extreme decile portfolios). Then, we use the PEAD or momentum based zero-investment portfolios as a fourth risk factor to extend the multifactor framework of Fama and French (1993). The biggest noverly of our paper is that we consider not only contemporaneous variables, but also lags for short-term phenomenons (PEAD and momentum) in the multifactor regressions, in order to investigate if those two past anomalies have implications on future reversals. For this portfolio formation, we use NYSE-AMEX-NASDAQ firms monthly returns with data on COMPUSTAT, for a period which starts at January 1975 and ends at December 2010. Note that, almost all studies on this topic do not include NASDAQ firms because they are not statistically relevant. It is our goal to see what happens if we add NASDAQ firms. Thus, in this sense, we use two sets of firms: one with and the other without NASDAQ firms.

Our main findings are: (i) trends and values are not far from Chordia and Shivakumar (2006) results and we were able to get the same conclusion that PEAD helps to risk-control future momentum returns (working as a fourth risk factor) and, thus, it seems that PEAD has strong statistical and economic implication on future momentum based portfolios returns. However, we do not conclude that this model is well specified to explain future momentum returns, since it does not pass the Gibbons et al. (1989) test; (ii) reversal is related with past PEAD, more precisely events that took place 1-2 years before price reversals, have impact on future reversals and, thus, past events which generated short-term anomalies can have impact on future reversals; (iii) the inclusion of NASDAQ firms creates stronger anomalies and can change some conclusions.

The rest of this paper is organized as follows. Section 2 discusses data sample and

Section 3 discusses portfolio formation based on the three anomalies. Section 4 presents time-series regression models, whose results are discussed on Section 5 and Section 6 concludes. At the end of this paper we present an Appendix with technical details.

2 Data and Settings

2.1 Data

To study the interrelation among the three anomalies, we need to construct portfolios that reflect those anomalies. To do so, we use the WRDS[1] platform to get all NYSE-AMEX-NASDAQ monthly firms returns from Center for Research in Security Prices (CRSP) database and quarterly firms earnings from COMPUSTAT database, for the sample period of January 1975 to December 2010.[2] In addition, since our asset pricing tests are partially based on Fama and French (1993) three-factor model, we use Professor Kenneth French´s web site to get the market (MKT), size (SMB) and book-to-market equity ratio (HML) risk factors, as well as the risk-free rate (one-month treasury bill). [3]

2.2 Settings

In our paper, in order to mitigate some "*microstructure-induced biases*", Asem (2009), we excluded the penny stocks, once they can skew the normal stock behavior. Thus, we don´t consider a monthly observation whenever a stock has a price smaller than $1.

Contrary to most papers about these subjects, we included the delisting returns. To do that we followed the work of Beaver et al. (2007). In fact, they concluded that "*tests*

[1]Wharton Research Data Services.

[2]We exclude ADRs, REITs, Americus Trust Components, units, and closed-end funds from all our analyses.

[3]http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

of market efficiency are sensitive to the inclusion of delisting returns". In addition, they pointed out that *"some researchers, because of the lack of comprehension about CRSP data or design choices results in the inadvertent exclusion of delisting firm returns, could compromise the estimates of portfolio returns*". Hence, if care is not taken, we can miss important observations in our sample.

In the Appendix, we add more technical information regarding delisting returns as well as missing data and merging databases.

3 Portfolio Formation

After data collection and its refinements, we can construct our portfolios based on the three market anomalies that are going to be studied on this paper. These anomalies are PEAD, momentum and reversal. Since part of our regression analysis is based on Fama and French (1993) three-factor model, we will need market, size and book-to-market risk factors as well. On this paper we are going to present two sets of results based on two sets of firms: one from NYSE-AMEX and the other from NYSE-AMEX-NASDAQ, both with data on COMPUSTAT.

3.1 Post-Earnings Announcement Drift

The post-earnings announcement drift phenomenon, one of the most studied anomalies in the finance discipline, is based on the price change (drift from fundamentals) due to earnings announcement surprises. The main idea is to compute those earnings announcements surprises (basically a difference on earnings between two different periods) and construct portfolios based on the ranking of the earnings announcement surprises. The positions can be held up to twelve months.

To perform the construction of our portfolios, we follow the work of Chordia and

Shivakumar (2006). After getting all earnings from all firms, we compute the respective standardized unexpected earnings, SUE. This is done via a scalled seasonal random walk model without drift, which is a difference between the most recent earnings and its counterpart four quarters ago, using the standard deviation of this difference over the prior eight quarters to rescale the random walk. So, for each month t and firm i the SUE is given by

$$SUE_{it} = \frac{E_{iq} - E_{iq-4}}{\sigma_{iq}}, \tag{3.1}$$

where E_{iq} is the most recently announced earnings of firm i on a given quarter q, E_{iq-4} is the earnings announced four quarters prior to the most recent one and σ_{iq} is the standard deviation of $(E_{iq} - E_{iq-4})$ over the previous eight quarters. Therefore, computing SUE requires a minimum of eight straight earnings announcement. In cases where we face up to three quarters in a row with missing earnings, we assume $SUE = 0$, that is, the most recent earnings announcement is equal to the one announced four quarters ago. As Chordia and Shivakumar (2006) pointed out, in order to avoid using stale earnings, we only consider as the most recent earnings those that were released no earlier than four months before the end of the formation month.

After SUE computations, for each month, firms are sorted into 10 decile equally-weighted portfolios based on their SUE ranking.[4] These portfolio positions are held for 6 months, that is we consider a buy-and-hold strategy, starting at month t and ending at month $t+5$. Therefore, every month only 1/6 of the investment positions are renewed, which avoids test statistics based on overlapping returns, as noticed by Chordia and Shivakumar (2006). The first decile portfolio, denoted *Low*, corresponds to those firms with lowest SUE, whereas the tenth decile portfolio, denoted *High*, corresponds to those firms with highest SUE. The zero-investment portfolio is formed by going long on *High*

[4]For this ranking, we do not consider the $SUE = 0$ assumption.

and short on *Low* and it is denoted by *PMN* (*Positive Minus Negative*).

3.2 Momentum

This anomaly, largely documented throughout the 90's, is related to past returns. The basic idea is to, every month, rank stocks based on their past short-run (up to twelve months) returns and form portfolios according to this ranking, with positions also held for a short-period (up to twelve months).

Similarly to earnings momentum, for short-run return continuations phenomenon, we follow the Chordia and Shivakumar (2006) methodology. Thus, we form 10 equally-weighted deciles portfolios which are based on firms compounded returns ranking. This ranking is constructed in the following way: for each month t we compute the compounded 6-month return of all firms with returns between $t-6$ and $t-1$. After this, we sort all firms into 10 deciles portfolios where the investment is held for 6 months, from month t to month $t+5$, computing buy-and-hold returns (again the same approach that avoids test statistics based on overlapping returns). Similarly, the first decile portfolio contains firms with the lowest compounded returns from the formation period, the *Low* decile portfolio, and the tenth decile portfolio contains firms with the highest compounded returns from the formation period, the *High* decile portfolio. The difference between those extreme decile portfolios, that is, long position on *High* and short position on *Low*, forms the zero-investment portfolio denoted by WML^m (*Winners Minus Losers*).

3.3 Reversal

Perhaps the most controversial anomaly has been price contrarian. The long-run return reversal, basically, consists of buying firms that have performed badly in the past 5 years (60 months), and selling firms that have performed well in the same period.

For the reversal anomaly we consider the work of De Bondt and Thaler (1985); Fama and French (1996); Lakonishok et al. (1994). Each year we rank firms into decile portfolios based on their compounded returns between $t-60$ and $t-13$.[5] For each firm, we require a return observation per month throughout the formation period. Using this sorting, we form 10 equally-weighted deciles portfolios. Each position is held for 60 months, from month t to month $t+59$. Whenever a delisting occurs, positions are held until the delisting-month. Similar to momentum, the first decile portfolio receives firms with the lowest compounded returns from the formation period, and is denoted by *Low*, the tenth decile portfolio receives firms with the highest compounded returns from the formation period, and is denoted by *High*. In order to get the zero-investment portfolio, we go long on *High* and short on *Low*.[6] This zero-investment portfolio is denoted by WML^r (*Winners Minus Losers*).

4 Regression Model Specifications

During the 60's, a new asset pricing paradigm arised in finance, the well-known CAPM model.[7] Basically, the CAPM tells us that the expected return of security i is a linear function of the risk-free rate and a risk premium that compensates for the exposure of security i to market risk,

$$E(R_{it}) = R_f + \beta_{it}[E(R_{mt}) - R_f], \tag{4.1}$$

where $E(R_{it})$ is the expected return of security i at time t, R_f is the risk-free rate, $E(R_{mt})$ is the expected return for the market portfolio at time t and β_{it} security i's

[5] For reversal t represents January. That is, the ranking and investment decision is made in January of every year.

[6] Note that, on the behalf of reversal theory, the way we form the zero-investment portfolio must result in negative returns.

[7] Sharpe (1964), Lintner (1965) and Black (1972) work.

time t non-diversifiable risk factor loading on the market risk.

Some scholars have pointed out that CAPM is insufficient to explain some market anomalies. Moreover, Fama and French in their remarkable series of papers, Fama and French (1992, 1993), came out with two new explanatory factors, one related to firms market size and the other related to firms book-to-market ratio. They argue that their model can predict future returns and explain some of CAPM-related anomalies, Fama and French (1996). According to Fama and French three-factor model, the expected return of security i is given by:

$$E(R_{it}) = R_f + \beta_{it}[E(R_{mt}) - R_f] + s_{it}E(SMB_t) + h_{it}E(HML_t), \tag{4.2}$$

where s_{it} is the factor loading related to size risk (SMB) for security i at time t and h_{it} is the factor loading related to book-to-market ratio risk (HML).

Using this framework, like Chordia and Shivakumar (2006) and Simlai (2011), we extend the Fama-French three-factor model with the PEAD and momentum zero-investment portfolios. That is, each zero-investment portfolio will work as a fourth risk factor. In this way, we can check if these two anomalies, represented by those portfolios, have explanatory power on future portfolio returns based on PEAD, momentum or reversal theories. Thus, as dependent variables we use portfolios based on the three anomalies. Notice that each group of portfolios is formed by 10 decile portfolios and a zero-investment portfolio, for each anomaly. As independent variables, beyond market, size and book-to-market risk factors, we have PEAD and momentum zero-investment portfolios as a fourth independent variable, which are represented by PMN and WML^m, respectively. Therefore, we will run two sets of regressions:

Set 1

$$R_{it} - R_f = a_i + \beta_i[R_{mt} - R_f] + s_i(SMB_t) + h_i(HML_t) + p_i(PMN_t) + \varepsilon_{it}, \tag{4.3}$$

$$R_{it} - R_f = a_i + \beta_i[R_{mt} - R_f] + s_i(SMB_t) + h_i(HML_t) + w_i(WML_t^m) + \varepsilon_{it}, \quad (4.4)$$

where $R_{it} - R_f$ represents momentum and PEAD portfolios excess return to one-month t-bill rate on equations 4.3 and 4.4, respectively, p_i is the factor loading of PEAD, w_i is the factor loading of momentum, i represents each decile portfolio (out of 10) and the zero-investment portfolio, t represents monthly time and ε_{it} is the error term.

Set 2

$$R_{it} - R_f = a_i + \beta_i[R_{mt} - R_f] + s_i(SMB_t) + h_i(HML_t) + p_i(PMN_t) + \varepsilon_{it}, \quad (4.5)$$

$$R_{it} - R_f = a_i + \beta_i[R_{mt} - R_f] + s_i(SMB_t) + h_i(HML_t) + w_i(WML_t^m) + \varepsilon_{it}, \quad (4.6)$$

where $R_{it} - R_f$ represents reversal portfolios excess return to one-month t-bill rate on equations 4.5 and 4.6. Again, i represents each decile portfolio and the zero-investment portfolio.

Thus, on set 1 we have the framework of Chordia and Shivakumar (2006), where they study the interrelation between PEAD and momentum.[8] On set 2 we have, partially, the Simlai (2011) framework, where he analyzese whether contemporaneous PEAD-based portfolio returns or momentum-based portfolio returns have an implication on reversal-based portfolio returns.

As a third set, we present two regression models that show our major goal with this thesis. Apart from our Chordia and Shivakumar (2006) and Simlai (2011) replications, we want to test whether reversal has some linear relation to PEAD or momentum. The different point here, when compared to set 2, is that we want to relate reversal to past PEAD and momentum portfolio returns, that is, we use lags for these two variables. In fact, this idea comes from behavioral theories that short-run continuation (PEAD and momentum) originate from an underreaction to information and its slow incorporation

[8]The regression model equation 4.4 is also known as the Carhart (1997) four-factor model.

into prices, Bernard and Thomas (1990) and Jegadeesh and Titman (1993), and long-run reversal comes from an overreaction to the way investors form their expectations: "*investors give too much weight to the past performance of firms and too little to the fact that performance tends to mean-revert*", as Fama (1998) puts about De Bondt and Thaler (1985) conclusions. Our point is to see if overreaction can be a result from past underreaction.

As we mentioned above, short-run continuation is a result of underreaction to information and its slow incorporation into prices that can lasts up to one year. We believe that as the information is more difficult to interpret (more uncertainty), the incorporation of information into prices will be more difficult and thus slower, creating larger and stronger post-earnings announcement drift and momentum, as the theoretical model of Barbosa (2010) predicts. If we assume that some investors are "*trend chasers*" as in the model of Hong and Stein (1999) (known as "*momentum traders*", that is, technical traders who rely their investment strategies on past performance), we expect to see that as investors are more uncertain about the interpretation of information, the greater the tendency of prices overshooting beyond their fundamentals. When investors realize that those prices are beyond the fair prices, prices will tend to revert, creating price reversals, as concluded by Hong and Stein (1999) (see Figure 4.1 and 4.2 for a theoretical example). Thus, to make a point, the greater the uncertainty and the difficulty to interpret the information, the more pronounced the subsequent underreaction, which results in a more pronounced overreaction later on. The former implies a stronger PEAD and momentum, whereas the latter implies a stronger correction that generates a stronger reversal. Thus, larger PEAD and momentum should be related to larger reversals, but not contemporaneously. Instead, this relationship should be lagged in time (see Figure 4.3 for a theoretical example). In addition to these theoretical work, Jegadeesh and Titman (2001) found that, over the 1965 to 1998 sample period, cumulative momentum profit increases until 12.17% at the end of month 12 and from month 13 to month 60 the momentum profits are on average negative (that is, price reversals). By the end of month 60 the cumulative momentum profit declines to -0.44%. Hence, assuming these ideas and this empirical results, we expect to see a negative correlation between past underreaction and future overreaction.[9]

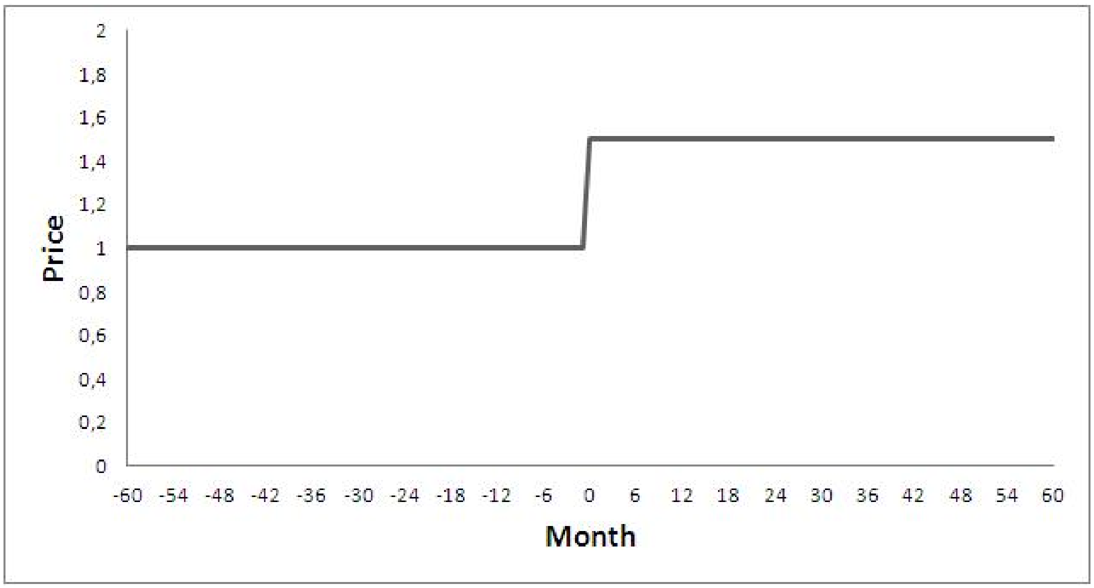

Figure 4.1: Theoretical example of a price behavior. This figure plots a perfect reaction to a new market information at time zero. The price moves upwards from 1 to 1.5, that is, there is an instantaneous change on price because all investors had the same interpretation of the information, leading to a perfect incorporation of that information into prices.

[9]Note that we expect negative correlation because reversal portfolios are constructed to have negative returns. Otherwise we would expect positive correlation.

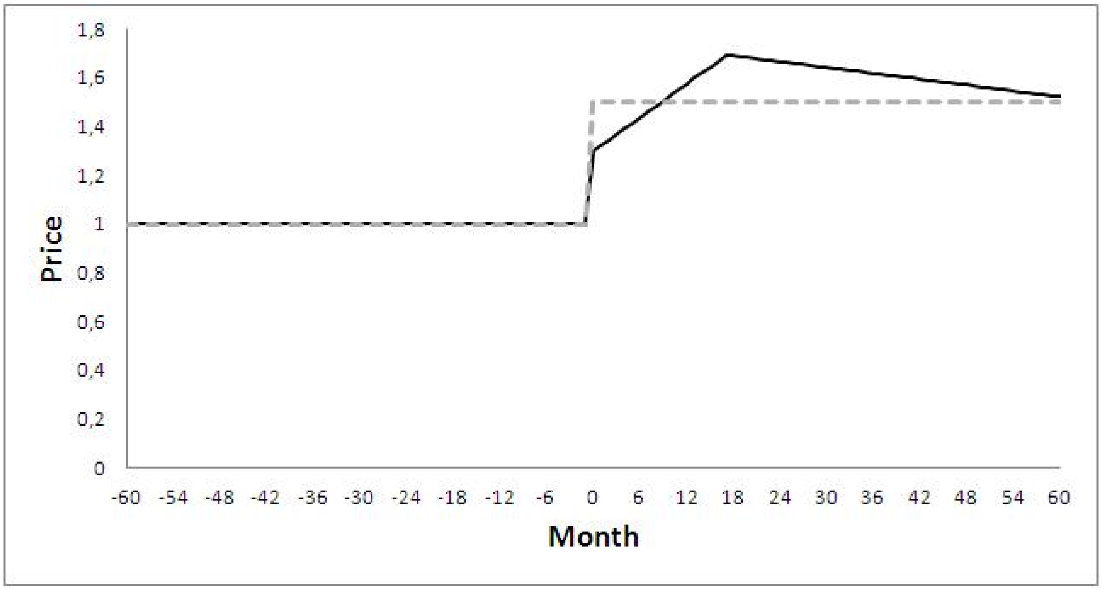

Figure 4.2: Theoretical example of a price behavior. This figure plots an uncertainty/weak interpretation of a new market information at time zero. The price moves upwards from 1 to 1.3 instantaneously, but far from its fundamental price. Then, there are an underreaction to the fair price, going slowly until 1.5. Because of the lack of understanding of this information and motivated by these shy increase, some investors known as “trend chasers”, push the price beyond its fundamental, causing an overshooting on price, until it reaches the value of 1.7, at month 18. During the month 19 and the month 60, there are a constant decreasing on price (overreaction) until it reaches its fundamental of 1.5.

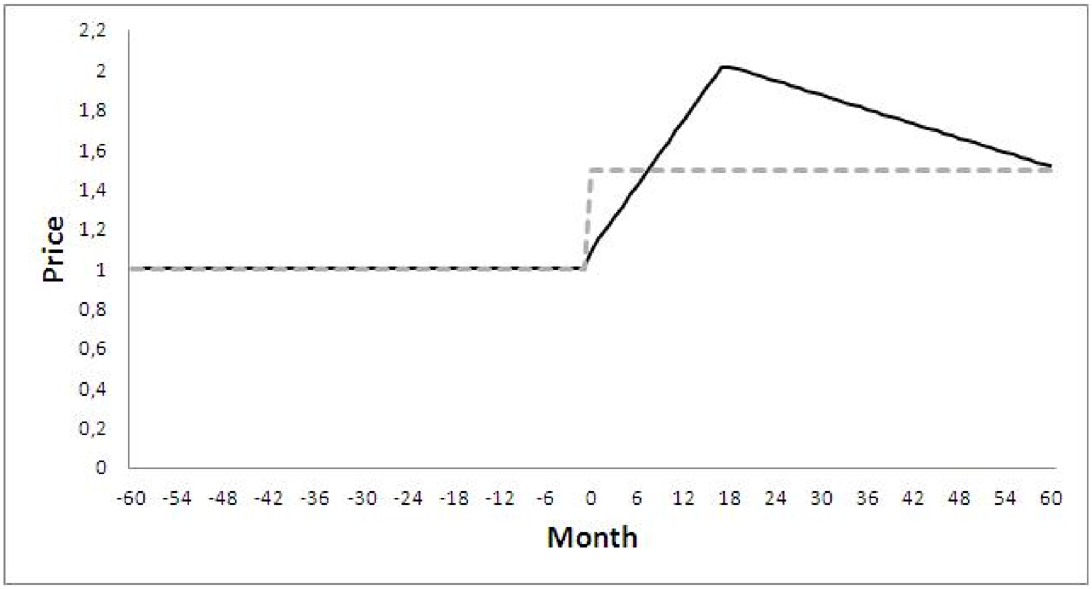

Figure 4.3: Theoretical example of a price behavior. This figure plots an uncertainty/weak interpretation of a new market information at time zero. This figure plots an uncertainty/weak interpretation of a new market information at time zero. The price moves upwards from 1 to 1.1 instantaneously, but far from its fundamental price. Then, there are an underreaction to the fair price, going slowly until 1.5. Because of the lack of understanding of this information and motivated by these shy increase, some investors known as "trend chasers", push the price beyond its fundamental, causing an overshooting on price, until it reaches the value of 2, at month 18. During the month 19 and the month 60, there are a constant decreasing on price (overreaction) until it reaches its fundamental of 1.5. The idea with this figure, comparing to Figure 4.2, is that when investors have more dificulty to interpret information, that causes more pronounced underreaction and, consequently, more pronounced overreaction.

In this sense, since we are computing reversal on five years basis, we want to add lags up to five years to the three factor model. Because we are working on monthly basis, assuming 60 lags will diminish statistical test's power. Therefore, we compute annual non-overlapping compounded portfolio returns for PEAD and momentum monthly zero-investment portfolios. Thus, for each month t, we assume that the first annualized return (the contemporaneous annual return) aggregates monthly returns from $t-11$ to t, the second aggregates from $t-23$ to $t-12$, and so on, until the fourth which aggregates monthly returns from $t-59$ to $t-48$. Thereby, we present the third and last set of regressions,

Set 3

$$R_{it} - R_f = a_i + \beta_i[R_{mt} - R_f] + s_i(SMB_t) + h_i(HML_t) + \sum_{k=0}^{4} p_{ik}(PMN_k) + \varepsilon_{it}, \quad (4.7)$$

$$R_{it} - R_f = a_i + \beta_i[R_{mt} - R_f] + s_i(SMB_t) + h_i(HML_t) + \sum_{k=0}^{4} w_{ik}(WML_k^m) + \varepsilon_{it}, \quad (4.8)$$

where $R_{it} - R_f$ represents reversal portfolios excess return to one-month t-bill rate for both equations, p_{ik} represents the factor loading of annual PMN_k returns and w_{ik} represents the factor loading of annual WML_k^m returns and k represents each annual lag of annualized PEAD zero-investment portfolio in equation 4.7 and momentum zero-investment portfolio in equation 4.8. Note that k starts at zero and goes up to four, and each lag represents the annual compounded return for PEAD and momentum monthly portfolios for a certain group of past returns.

In statistical terms, we have to test the following:

$$\begin{cases} H_0 : p_{i0} = \ldots = p_{i4} = 0 \\ H_a : \exists p_{ik} \neq 0. \end{cases}$$

$$\begin{cases} H_0 : w_{i0} = \ldots = w_{i4} = 0 \\ H_a : \exists w_{ik} \neq 0. \end{cases},$$

and in order to see results which hold our thesis, at leat one p_{ik} must be different from zero.

Additionally, for all regressions, we implement the Newey and West (1987) coefficient standard errors correction, that is, corrected for homoscedasticity and autocorrelation issues.

5 Empirical Results

We are going to present results for two sets of firms: one for firms listed on the NYSE-AMEX exchanges, the other for firms listed on the NYSE-AMEX-NASDAQ exchanges. First we are going to show some summary statistics in order to have an idea about the variables behavior and to make sure that the PEAD, momentum and reversal anomalies are present in our sample. Second, we present the results for the regression models specified on Section 4.

5.1 Summary Statistics

Starting with Table 1, panel A and B show the mean, t-stastistic, percentage of portfolios with positive return and Pearson correlation coefficients for the five variables studied on this paper, through the period starting in January of 1975 and ending in December of 2010. The market risk premium averaged a monthly 0.62% during this time frame, and this figure is statistically significant, as we can see on panel A. The Fama-French variables, size effect risk factor (SMB) and book-to-market risk factor (HML), present positive average monthly returns, 0.32% and 0.38%, respectively, being in both cases statistically significant as well. The PEAD risk factor (PMN) has an outstanding average return of 1.15% per month, which compared to the figure presented by Simlai (2011) of 0.87% and by Chordia and Shivakumar (2006) of 0.90%, means that the PEAD phenomenon is stronger in our sample. Moreover, this value is statistically significant. For the remaining two variables we can observe a positive mean (0.61%) for returns from zero-investment momentum portfolios (WML^m) but a negative average monthly return (-0.40%) for zero-investment reversal portfolios (WML^r), as we could expect on the behalf of reversal theory, being in both cases statistically significant. These figures are not far from those obtained by Chordia and Shivakumar

(2006) and Simlai (2011), since the former presents a 0.76% for momentum and the latter a -0.48% for reversal. In addition, for all 5 zero-investment portfolios, we can conclude that more than 50% of those portfolios have positive monthly return (except for reversal portfolios, as expected). Due to these results, we can conclude that those anomalies are present in our sample.

Still in Table1, panel B suggests that there is no multicollinearity problems among the variables, since Pearson correlation coefficients are relatively low. Nevertheless, the correlation between momentum based zero-investment portfolio and PEAD based zero-investment portfolio should be highlighted, since there is strong evidence that those anomalies are strongly correlated, which is consistent with the results of Chordia and Shivakumar (2006), that PEAD and momentum are related in a multifactor relation. In contrast to Simlai (2011), the correlation between reversal and PEAD and momentum is weak, suggesting a weak relation between contemporaneous underreaction and overreaction.

Table 2 shows the same statistics as Table 1 but now with NASDAQ firms included in the sample. Note that, although all the means are statistically relevant and the Pearson correlation is not changing too much, the PEAD, momentum and reversal zero-investment portfolios present mean return larger than those obtained when NASDAQ firms are excluded. This conclusion can be explained by the fact that NASDAQ index contains many firms that have small capitalization. This fact is extremely important because, as Hong et al. (2000) concludes, "*the profitability of momentum strategies declines sharply with market capitalization*". Thus, when we add more small firms, we may expect a performance increase on portfolios based on those anomalies.

In Table 3, which reports results for the NYSE-AMEX firms sample, we have some additional features about the 10 decile portfolios for each anomaly that we are studying. Panel A shows us clear evidence that portfolios formed by firms with the lowest SUE generate a lower average monthly return, for the period between January 1975 and December 2010, than portfolios formed by firms with the highest SUE. In fact, starting at the *Low* portfolio, which presents an average monthly return of 0.75%, we can see a monotonic increase in monthly returns as we move toward the *High* portfolio, which presents an average monthly return of 1.90%. This result is consistent with Chordia and Shivakumar (2006) and Simlai (2011), which present an increasing trend as well. Panels B and C present the 10 decile portfolios formed on the basis of momentum and reversal theories, respectively. Starting with the momentum portfolios, portfolios formed by firms that performed badly in the past, *Low* portfolio, present an average monthly return of 0.98%. On the other hand, portfolios formed by firms that performed well in the past, *High* portfolio, have a high value of 1.59%. Hence, we can observe an increase on average monthly portfolio return throughout the 10 decile momentum portfolios (from the lowest decile up to the highest decile). Although the gap between those extreme decile portfolios on Chordia and Shivakumar (2006) and Simlai (2011) are bigger, our results for momentum portfolios seem to be consistent. The reversal anomaly presents an opposite trend for the 10 decile portfolios when compared to the 10 decile momentum portfolios. In fact, for reversal portfolios we can report an average for the monthly return of the *Low* portfolio of 1.49% and 1.09% for *High* portfolio, which means that the first decile portfolio gets a higher return than the tenth decile portfolio. Even though the variance between those extreme decile portfolios is not so high as those from PEAD or momentum, we still can find a decreasing trend on the average monthly return's value from the *Low* portfolio to the *High* portfolio (which seems to be consistent with Simlai (2011) results).

Table 4 is basically a replication of Table 3 but adding NASDAQ firms. As in Table 3, PEAD and momentum decile portfolios present a positive trend in their average monthly returns, and reversal portfolios present a negative trend from decile 1 to decile 10. Note again that, although those tables present similar results, when we add NASDAQ firms we obtain larger gaps between extreme deciles. Thus, as we concluded from the comparison between Table 1 and Table 2, NASDAQ can increase the strength of PEAD, momentum and reversal anomalies.

5.2 Post-Earnings Announcement Drift and Momentum

5.2.1 Momentum vs Post-Earnings Announcement Drift

On this subsection we present regression analysis for the interrelation between PEAD and momentum phenomenons. The idea is to replicate the work of Chordia and Shivakumar (2006) and Simlai (2011). As we mentioned on Section 4, we show the results for the Fama-French model (equation 4.2) and its extension by including the PEAD zero-investment portfolio (equation 4.3). Thus, we start with Table 5 where the period under study starts at January 1975 and ends at December 2010, and where the NYSE-AMEX firms set are being used. On panel A we have the results for the regression from equation 4.2. Here, the dependent variables are the 10 decile portfolios and the zero-investment portfolio WML^m, formed on the basis of momentum theory, and the independent variables are the well known market, SMB and HML portfolio returns. Comparing to Chordia and Shivakumar (2006), the results have some similarity. The trend in the regression intercepts is similar, starting at -0.63% for the *Low* portfolio and increasing monotonically until 0.25% for the *High* portfolio. The value obtained for the intercept of WML^m suggests that the zero-investment portfolio that exploits the momentum anomaly generates abnormal returns.[10]Furthermore, the Gibbons et al. (1989) test shows that the Fama-French three factor model is not well specified to capture the behavior of portfolios returns based on momentum strategy.

[10]Note that the intercept from WML^m is 0.43%, while the difference between the extreme deciles gives a value of 0.88%. This happens because we are working with excess returns, thus, we expect those values to be different.

On panel B we have the four-factor model (equation 4.3) which is, basically, the extension of the Fama-French three factor model with the PMN risk factor. As in Chordia and Shivakumar (2006), the trend on intercept coefficients changes, now it starts at 0.68% for the decile one and monotonically decreases until -0.38% for the decile ten, when momentum are being risk-controlled for PEAD risk factor. In fact, the WML^m portfolio's intercept is -1.49%, which shows that controlling for the PMN risk factor the WML^m portfolio has a negative abnormal return. Similarly to Chordia and Shivakumar (2006), the earnings-based zero-investment portfolio (*PMN*) is statistically significant for most of the decile portfolios, whose loadings increase from -0.99% for the first decile portfolio to 0.50% for the tenth decile portfolio. Highlighting the zero-investment portfolio (WML^m), only the *PMN* factor has a high significance level of 8.89 for the *t*-statistic. Moreover, when we use a three-factor model we get a very low 4.77% for the adj.R^2, but adding the *PMN* factor, we get a higher adj.R^2 of 55.17%. Regarding the Gibbons et al. (1989) test, we cannot conclude the same as Chordia and Shivakumar (2006). In fact, in our case this test indicates that the four-factor model with *PMN* as the fourth risk factor is not well specified to explain momentum based portfolio returns. Nevertheless, this four-factor model has a higher explanatory power on momentum portfolios when compared to the Fama-French three-factor model. These differences could be related to the fact that our sample is different from Chordia and Shivakumar (2006) and/or our sample specifications are different as well (for example, we are using the delisting returns approach outlined by Beaver et al. 2007). This indicates that the findings of Chordia and Shivakumar (2006) are not very robust (their conclusions are valid only at 1% significance level).

On Table 6 we have the results for the regression model of equation 4.2 on panel A and for the regression model of equation 4.3 on panel B, but now using the NYSE-AMEX-NASDAQ firms set. As we can see, all the trends and even the values are quite similar to Table 5 (without NASDAQ firms). However, notice that although the Gibbons et al. (1989) statistic concludes that none of the models is well specified to explain momentum returns, on panel A (where we are using the Fama-French model) 7 out of 10 intercept coefficients are statistically significant, but on panel B (where the Fama-French model gets a fourth risk factor - *PMN*) only 4 out of 10 intercept coefficients are statistically significant. That is, the inclusion of PEAD risk factor seems to help control the variation on future returns based on momentum strategies. Even though these models are not well specified, there is a clear evidence that PEAD strongly helps to predict future momentum portfolio returns.

5.2.2 Post-Earnings Announcement Drift vs Momentum

Like Chordia and Shivakumar (2006), we also want look at the linear relation between momentum as the dependent variable and PEAD as the independent variable, as in the regression model of equation 4.4. Similarly, we show results where we use the Fama-French three-factor model and a four-factor model known as Carhart (1997) model. The results for the former are shown on panel A from Table 7. The intercept coefficient increases monotonically from -0.70% for the *Low* portfolio to 0.64% for the *High* portfolio, whereas the intercept when the zero-investment portfolio *PMN* is used as dependent variable is a highly statistically significant 0.89%. The results for the latter appears on panel B from the same table and, even after controlling for momentum effect, we have a significant positive abnormal return for the PMN portfolio of 0.56%. We can also conclude that Carhart (1997) model is not well specified to explain PEAD based portfolios, as Chordia and Shivakumar (2006) pointed out, since the Gibbons et al. (1989) statistic says that this model is not well specified to explain future PEAD portfolio returns. Additionally, we can observe an increase on adj.R^2 from 9.96% to 57%, when we add the momentum factor as explanatory variable.

On Table 8 we have the results for the same regressions as on Table 7 but with NASDAQ firms. The values and trends are similar. Comparing to the conclusion from Table 5 and Table 6, momentum based zero-investment portfolio does not control the risk variation of PEAD based portfolio returns. Even though when we add WML^m as a fourth risk factor the explanatory power increases, the specification of the model is not so strong as when PMN works as a fourth risk controller for momentum based portfolios, as we can conclude from Gibbons et al. (1989) statistic.

5.3 Reversal vs Post-Earnings Announcement Drift and Momentum

5.3.1 Contemporaneous variables

On Table 9 we present the results for the third set of regression models. For these regressions we are using the NYSE-AMEX set of firms, throughout the period starting at January 1975 and ending at December 2010. On this table we have three panels: on panel A we present results for the Fama-French factor model, on panel B we extend the momentum zero-investment portfolio (WML^m) as a risk factor and on panel C we have the PEAD zero-investment portfolio (PMN) working as a fourth risk factor.

Starting with panel A, the three risk factors from Fama-French model present loadings statistically significant for all of 10 decile portfolios and for the zero-investment portfolio (WML^r), in terms of independent test (t-test), which shows the strength of the model. In terms of the specificity of the model, the conclusion seems to be the same as in Fama and French (1996), once all 10 decile reversal based portfolios have intercepts equal to zero, based on the Gibbons et al. (1989) statistic test where we don´t reject the null at 1% significance level. Hence, one can reassure that the three-factor model from Fama and French (1993, 1992) model is well specified to explain reversal phenomenon.

This conclusion cannot be extended to the zero-investment portfolio (WML^r) because the intercept coefficient is not statistically different from zero. On panel B, where we have WML^m as the fourth risk factor, we can see that the momentum zero-investment portfolio has implication on reversal based portfolios, since all momentum factor loadings are statistically significant. In addition, the Gibbons et al. (1989) statistic shows that this model is well specified to explain reversal returns. However, the t-test value for the intercepts are smaller for the Fama-French model than the model given by equation 4.6 and the increase on the adj-R^2 is almost null. Beyond that, there is no statistical relation with the reversal zero-investment portfolio, once the WML^m does not have explanatory power on WML^r. Thus, it does not seem to bring much to explain future reversal returns. Finally, panel C presents the results for the regression model where the three-factor model is augmented by the PEAD risk factor, that is, the PMN variable. We can easily see that there is no suggestion that PEAD has some linear relation with reversal anomaly, once almost all factor loadings for PEAD are statistially insignificant at 5% level (note that these results are similar to the ones from Simlai 2011).

Lastly on this subsection, we would like to notice that when we add NASDAQ firms, the results for the regression model are different. In fact, as we can see on Table 10, panel A shows that the p-value of Gibbons et al. (1989) test statistic is zero, which means that the Fama-French three factor model is not well specified to explain future reversal returns. Thus, one could argue about the strong predictability of future reversal returns by the Fama and French (1993) three-factor model as it was shown on Fama and French (1996).

Concluding, although one could argue about some linear relation between contemporaneous momentum and reversal, the results don't show a clear-cut conclusion about that. In fact, the three Fama-French factors have explanatory power on the reversal zero-investment portfolio, but the PEAD and momentum portfolios do not. Hence, the inclusion of contemporaneous underreaction (PEAD and momentum) does not bring much to risk-control reversal returns.

5.3.2 Non-contemporaneous variables

On section 4 we present a set of regression models where the major idea is to see if past underreaction (PEAD and momentum) have impact on future overreaction (reversal). Thus, on Table 11 we have results for the models of set 3, where the dependent variable is the reversal based portfolios, divided into 10 deciles portfolios and a zero-investment portfolio, which is the difference between the extreme portfolios (*High* minus *Low*), and the independent variables are the Fama-French three-factor model augmented by PEAD returns portfolio and momentum returns portfolio, *PMN* and WML^m, respectively. In this case, instead of having only contemporaneous monthly returns, we have lags for the annualized returns. As we explained on section 4, we want to see what happens if we add 60-month of lags but, once that would be too much to put in a regression model, we prefer to use annualized returns which, turns out, we only have 5 lags to include. Hereupon, on panel A we have the results for equation 4.7, that is, the factor loadings and the t-statistic for each coefficient. As one can see, although market, size and book-to-market factor loadings are statistically significant all over the 10 decile portfolios, the lags on *PMN* are not. But, on reversal zero-investment portfolio (WML^r), one can find that the Fama-French risk factors are statistically significant and there is one *PMN* lag that is statistically significant, *PMN(-1)*. That is, the first lag for annualized *PMN*, which holds monthly *PMN* returns from $t-23$ to $t-12$, has impact on reversal returns with a magnitude of -0.03. Further, note that the value of the loading is negative, which implies that this lag has a negative impact on reversal. This is exactly what we expected regarding the relation between past underreaction (which is what we have here) and future overreaction, where the larger the past underreaction, the larger the reversal (note that, as we already mentioned, the way we construct reversal portfolios we expect a negative value for this loading). Moreover, the intercept is not significant, that is, it is statistically equal to zero, hence, the model is well specified.[11] In this sense, we have an important finding that the variation on reversal based zero-investment portfolio returns can be expressed by the variation on the three-factor risk factor model from Fama and French (1993, 1992) and the lag 1 from PEAD based zero-investment portfolio annualized returns. Finally, concerning the 10 decile portfolios, the Gibbons et al. (1989) statistic shows that this model is well specified, but this result could be biased by the fact that we are adding too many variables. Panel B gives us the results for equation 4.8, where lags for momentum based portfolio returns are being added. There are some lags that are statistically significant for some decile portfolios but there are no consistency throughout them. In the case of the zero-investment portfolio (WML^r) there are no momentum lag that has statistical relevance. Therefore, the momentum anomaly past observations do not have impact on future reversal.

The last table (Table 12), shows the results for the models of set 3, but adding NASDAQ firms. The conclusion about the impact of annualized PEAD based zero-investment portfolio returns remains. As one can see, the first lag of *PMN* annualized returns, *PMN(-1)*, has a significantly negative (as we predicted) impact of -0.03 on reversal based zero-investment portfolio (WML^r). Although the intercept coefficient is statistically equal to zero, when we regress only with the Fama-French three-factor plus the first lag of the annualized *PMN*, the intercept is no longer statistically equal to zero, which makes this model not well specified. Thus, when we add NASDAQ firms these model is not enough to explain future reversal returns. Panel B shows the results for the equation 4.8, where some lags from momentum based zero-investment portfolio annualized returns are added to Fama-French three-factor model. Like annualized *PMN*,

[11]We get the same results when we only put the first lag for the annualized *PMN* on the regression model.

annualized WML^m does not have impact on any of the 10 decile portfolios (at 5% level of significance) but, on the WML^r portfolio, the fourth lag, that is, accumulated monthly momentum returns from zero-investment portfolios starting at $t-59$ to $t-48$ (WML^m*(-4)*), has a small negative but statistically significant impact of -0.01. Looking at the intercept t-test we can conclude that its value is statistically significant, that is, different from zero, and, therefore, the expected return for this portfolio doesn't belong to the minimum variance boundary when risk controlled by this model. Hence, this model is not well specified to explain reversal returns.

In short, these results, although not surprisingly robust, point in the direction of our initial hypothesis: there is evidence that past underreaction can have an impact/be one explanatory variable for future overreaction. More precisely, we found evidence that past observations of PEAD based portfolio returns, namely the ones that took place between $t-23$ to $t-12$, have statistical implication on future reversal portfolio returns. Beyond that, the model given by the equation 4.7 showed to be sufficient to explain future zero-investment portfolios based on reversal theory, that is, the WML^r portfolio. Hereupon, this investigation based on risk-based models tries to help the behavioral finance understanding about these anomalies, that they are a deviation from fundamentals due to the lack of comprehension/understanding of the information, which can cause an inefficient incorporation of that information into prices. At a certain point in time, this lack of comprehension can create short-term anomalies (PEAD and momentum) and the greater the difficulty to incorporate the information into prices, the greater the overshooting on them during the medium-term, creating price reversals in the long-term when investors adjust the price to its fundamentals. Hence, it does not only make sense to think about a theoretical economic relation between past underreaction and future overreaction, but can also be an empirical observation.

6 Conclusion

In the last thirty years, we have seen an increase on the willing to find explanations for some anomalies that are not sufficiently captured by the widely used CAPM model. In fact, even after some relevant studies that have explained the behavior and interrelationships among these anomalies, they still persist nowadays. This paper appears with the purpose of helping on a deeper understanding and knowledge about these anomalies *per se* and the relation among them. Our paper shows that for the period from January 1975 to December 2010 we still observe post-earnings announcement drift, price momentum and price reversal phenomenons. In addition, the replication of the results from Fama and French (1996) and Chordia and Shivakumar (2006) give us similar conclusions. We have the same conclusion as Fama and French (1996) that the three factor Fama-French model is well specified to explain reversal (at decile portfolios level, this conclusion is not valid to the zero-investment portfolio). Although our results do not conclude that the Fama-French model augmented by the PEAD is not well specified to explain momentum returns as Chordia and Shivakumar (2006) did, we still conclude that those variables are strongly related and there is strong evidence that PEAD returns have stronger explanatory power to explain momentum returns than the opposite. We should add to this that our sample and its refinements (delisting returns, merging data issues, etc.) can be part of the explanations for those differences. Nevertheless, it seems that the same work-base is being used. The new part comes from some of the behavioral theories about these anomalies. They point that there is a relation between underreaction (PEAD and momentum) and overreaction (reversal). In simple terms, there are investors that create underreaction at the short-term, some of them, known as "trend chasers", creates an overshooting on prices, leading them to possible price reversals at long-term. Thus, our major purpose with this thesis is, using a risk-based model, to see if there exist a statistical relation between past underreaction and future overreaction (non-contemporaneous relation). The main finding on this work is that past post-earnings announcement drift based portfolio returns (the zero-investment portfolio PMN) successfully explains future reversal based portfolio returns (the zero-investment portfolio WML^r).

For a final remark, we would like to mention some points about the inclusion of NASDAQ firms. As we mentioned, we worked with two sets of firms: NYSE-AMEX and NYSE-AMEX-NASDAQ. The technological NASDAQ index is mostly formed by small firms. As we highlighted, the size effect creates stronger PEAD, momentum and reversal. As we saw, this can be proved once our portfolios formed on the basis of those anomalies showed stronger results when we worked with NYSE-AMEX-NASDAQ. Other important point is our conclusions about the regression models with variables formed when NASDAQ firms are added. First, the Chordia and Shivakumar (2006) replication work seems to present the same figures, that is, we can still conclude a strong relation between PEAD and momentum but we still conclude that this model is not enough to risk-control each other. Second, the findings made by Fama and French (1996), where the three factor model successfully explains reversal returns, are not subsumed with NASDAQ firms, once the model is no more well specified to explain future reversal returns. Third and last, our findings about the relation between past underreaction and future overreaction, partially still persist. There is a relevant value for the second lag of annualized PMN loading, but the intercept is statistically different from zero when only this lag is added to the Fama-French model. Additionally, the momentum theory seems to have some implication, once the lag 4 of annualized WML^m is statistically relevant, but the intercept loading is statistically relevant, that is, not different from zero. Thus, NASDAQ firms can have an important impact, changing the strength of PEAD, momentum and reversal anomalies and some conclusions about models when only NYSE-AMEX firms are being used.

References

Asem, E. (2009, March). Dividends and Price Momentum. *Journal of Banking & Finance 33*(3), 486–494.

Ball, R. and P. Brown (1968). An Emprirical Evauation of Accounting Income Numbers. *Journal of Accounting Research 6*(2), 159–178.

Barbosa, A. (2010). Differential Interpretation of Information and the Post-Announcement Drift: A Story of Consensus Learning. *Working Paper*, ISCTE Business School.

Beaver, W., M. Mcnichols, and R. Price (2007, July). Delisting returns and their effect on accounting-based market anomalies. *Journal of Accounting and Economics 43*, 341–368.

Bernard, V. L. and J. K. Thomas (1989). Post-Earnings-Annoucement Drift: Delayed Price Response or Risk Premium? *Journal of Accounting Research 27*, 1–36.

Bernard, V. L. and J. K. Thomas (1990). Evidence that Stock Prices do not fully reflect the implications of Current Earnings for Future Earnings. *Journal of Accounting and Economics 13*, 305–340.

Black, F. (1972). Capital Market Equilibrium with Restricted Borrowing. *The Journal of Business 45*(3), 444–455.

Carhart, M. M. (1997). On Persistence in Mutual Fund Performance. *Journal of Finance 52*(1), 57–82.

Chan, L. K. C., N. Jegadeesh, and J. Lakonishok (1996, September). Momentum strategies. *Journal of Finance 51*(5), 1681–1713.

Chordia, T. and L. Shivakumar (2006). Earnings and price momentum. *Journal of Financial Economics 80*, 627–656.

De Bondt, W. and R. Thaler (1985). Does the Stock Market Overreact? *The Journal of Finance 40*(3), 793–805.

Fama, E. F. (1998). Market efficiency, long-term returns and behavioral finance. *Journal of Financial Economics 49*, 283–306.

Fama, E. F. and K. R. French (1992). The Cross-Section of Expected Stock Returns. *Journal of Finance 47*(2), 427–465.

Fama, E. F. and K. R. French (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics 33*, 3–56.

Fama, E. F. and K. R. French (1996). Multifactor Explanations of Asset Pricing Anomalies. *Journal of Finance 51*(1), 55–84.

Fama, E. F. and K. R. French (2008). Dissecting Anomalies. *The Journal of Finance 63*(4), 1653–1678.

Gibbons, M. R., S. A. Ross, and J. Shanken (1989). A Test of the Efficiency of a given Portfolio. *Econometrica 57*, 1121–1152.

Hong, H., T. Lim, and J. C. Stein (2000). Bad news travels slowly: Size, analyst coverage and the profitability of momentum strategies. *Journal of Finance 55*, 265–295.

Hong, H. and J. C. Stein (1999). A Unified Theory of Underreaction, Momentum Trading, and Overreaction in Asset Markets. *The Journal of Finance 54*(6), 2143–2184.

Jegadeesh, N. and S. Titman (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *Journal of Finance 48*(1), 65–91.

Jegadeesh, N. and S. Titman (2001). Momentum. *Working Paper*, University of Illinois.

Lakonishok, Shleifer, and Vishny (1994). Contrarian Investment, Extrapolation and Risk. *Journal of Finance 49*, 1541–1578.

Lintner, J. (1965). The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *The Review of Economics and Statistics 47*(1), 13–37.

Newey, W. K. and K. D. West (1987). Hypothesis Testing with Efficient Method of Moments Estimation. *International Economic Review 28*(3), 777–787.

Sharpe, F. W. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance 19*(3), 425–442.

Simlai, P. (2011). Momentum, reversal, and the asymmetric role of post-earnings announcement drift. *Working Paper*, University of North Dakota.

Appendix

Missing Data

Sometimes, stocks have no closing price for last trading day. Hence we cannot compute returns for that month. In this case, CRSP allows us to use two possible proxy approaches. One of them is the average for bid-ask prices at the last trading day. That is, we assume that the average of bid and ask prices are the price of the last trading day and, in this way, we can compute a monthly return.

The other solution is the alternative prices. Even though the price for last trading day of the month is missing, we can use the last month-day with price - last non-missing price.

Merging Databases

One set of portfolios, based on one of the anomalies, needs earnings data to be computed: the PEAD anomaly. Thus, we need to relate CRSP returns and COMPUSTAT earnings. To do so, we have to merge both databases. Hence, we used the CUSIP[12] method to match the PERMNO[13] and GVKEY[14]. Due to this matching, we may face some issues. The first one is related to fiscal year changes. We need to delete repeated earnings announcements and, taking into account the earnings quarter, fiscal earnings quarter and date of EPS (Earnings Per Share) reporting, get as many consecutive earnings as possible. The second one is related to M&A duplications. In order to solve this, we look for duplications at price, date of EPS reporting and EPS level. When we have PERMNO with more than one GVKEY, we choose the one that has price continuation on CRSP.

[12]Common identifier between those databases.
[13]Main identifier from CRSP.
[14]Main identifier from COMPUSTAT.

Delisting Returns

In simple terms, a delisting return is a return that comes from the comparison between the security´s value after being delisted, that is, when a stock is removed from a stock exchange, and its price on the last trading day (before being delisted). The most common reasons for a delisting are mergers and acquisitions and poor performance. We should add delisting returns to our portfolios because, as Beaver et al. (2007) puts, "*the omission of delisting returns is likely to affect estimates of portfolio returns because the expected return conditional on the reason for delisting is not generally zero.*", and it adds that "*if the market return measure does not include delisting returns, market and market-adjusted returns will be affected.*". There are three big reasons for a careless exclusion of delisting returns: "*First, requiring future earnings excludes two-thirds of delisting firm-years. Second, nearly half of all delistings occur outside the date range provided by the CRSP/Compustat merged database, so valid delisting firm-years are excluded if one does not include matches outside the CRSP-specified date range. Third, when using monthly delisting returns, researchers unfamiliar with the details of CRSP data who use replacement values for firms with missing delisting returns will not identify all missing delisting returns because monthly delisting returns generally contain a partial month return even when the delisting return is missing. Treating partial month returns as valid delisting returns implicitly assumes a delisting return of zero, which can affect estimated portfolio returns.*", Beaver et al. (2007). Although, at the simple case, the way to treat delisting returns is straightforward (just compute an arithmetic return), we may face some challenges regarding the time of delisting, missing delisting returns or the way CRSP records these delists[15].

[15] See Beaver et al. (2007) to know more on this.

Table 1: Mean, t-stat, Pearson correlation coefficients of risk factors and percentage of positive monthly returns. Those risk factors are: *Market* risk, $R_m - R_f$, that is, monthly market index excess return of one-month t-bill; *Size* risk, *SMB*, which stands for *Small Minus Big* and it is monthly return of a portfolio based on firms market size; *Book-to-market* ratio, *HML*, which means *High Minus Low* and this portfolio is contructed on the basis of book-to-market ratio; *Post-Earnings Announcement drift* (*PEAD*) risk factor, denoted by *PMN* which means *Positive Minus Negative* and this zero-investment portfolio is formed on the basis of earnings surprises, which is oftenly used the *SUE* (Standardized Unexpected Earnings) measure: for each month t, $SUE = (E_{iq} - E_{iq-4})/\sigma_{iq}$, where E_{iq} is the most recent earnings announcement (no longer than four months) for firm i on quarter q, and σ_{iq} is the standard deviation of $(E_{iq} - E_{iq-4})$ for the prior eight quarters. After this, firms are sorted into 10 decile portfolios and the *PEAD* risk factor is the difference of the tenth decile portfolio (also known as *High*) and the first decile portfolio (also known as *Low*), where the investment is held for 6-months; *Momentum* risk factor, portfolio known as *Winners Minus Losers* (WML^m), which is a zero-investment portfolio where long positions come from the portfolio with the highest past six-months return and short positions come from the portfolios with the lowest past 6-months return, and positions are held for 6-months; *Reversal* risk factor, portfolio known as *Winners Minus Losers* (WML^r), which is a zero-investment portfolio where long positions come from the portfolio with the lowest past 60-months return and short positions come from the portfolio with the highest past 60-months return, and positions are held for 60-months. January 1975 to December 2010. NYSE-AMEX firms.

Panel A: Mean, t-stat and %>0

	$R_m - R_f$	SMB	HML	PMN	WML^m	WML^r
Mean(%)	0.62	0.32	0.38	1.15	0.61	-0.40
t-stat	2.80	2.13	2.54	8.60	2.44	-3.19
%>0	59.95	53.24	56.25	77.89	65.02	44.09

Panel B: Correlations

	$R_m - R_f$	SMB	HML	PMN	WML^m	WML^r
$R_m - R_f$	1.00					
SMB	0.23	1.00				
HML	-0.34	-0.32	1.00			
PMN	-0.18	-0.19	-0.13	1.00		
WML^m	-0.18	-0.08	-0.10	0.76	1.00	
WML^r	0.16	-0.31	-0.30	0.13	0.13	1.00

Table 2: Mean, *t*-stat, Pearson correlation coefficients of risk factors and percentage of positive monthly returns. January 1975 to December 2010. NYSE-AMEX-NASDAQ firms.

Panel A: Mean, t-stat and %>0						
	$R_m - R_f$	SMB	HML	PMN	WML^m	WML^r
Mean(%)	0.62	0.32	0.38	1.35	0.69	-0.59
t-stat	2.79	2.13	2.54	11.73	2.57	-4.95
%>0	59.95	53.24	56.25	82.41	65.96	39.25

Panel B: Correlation						
	$R_m - R_f$	SMB	HML	PMN	WML^m	WML^r
$R_m - R_f$	1.00					
SMB	0.23	1.00				
HML	-0.34	-0.32	1.00			
PMN	-0.11	-0.26	-0.03	1.00		
WML^m	-0.12	0.02	-0.08	0.63	1.00	
WML^r	0.20	-0.34	-0.23	0.15	-0.01	1.00

Table 3: Summary statistics (mean, t-test and percentage of positive monthly returns) for monthly portfolio returns based on *PEAD*, *Momentum* and *Reversal*. For each anomaly are formed 10 decile portfolios based on a certain ranking. *PEAD* is based on *SUE* ranking, *Momentum* is based on the short-run cumulative returns ranking and *Reversal* is based on the long-run cumulative returns ranking. January 1975 to December 2010. NYSE-AMEX firms.

	Low	2	3	4	5	6	7	8	9	High
Panel A: PEAD portfolios										
Mean(%)	0.75	0.95	1.06	1.20	1.31	1.50	1.64	1.75	1.73	1.90
t-stat	2.51	3.47	3.92	4.41	4.83	5.67	6.25	6.79	6.62	7.36
%>0	59.30	61.06	61.81	62.81	66.08	66.08	68.34	67.09	65.33	67.34
Panel B: Momentum portfolios										
Mean(%)	0.98	1.16	1.29	1.32	1.34	1.37	1.35	1.37	1.44	1.59
t-stat	2.67	4.05	4.99	5.52	5.80	6.05	5.91	5.80	5.72	5.44
%>0	55.63	59.15	61.97	64.08	65.26	65.73	66.43	66.67	65.73	65.73
Panel C: Reversal portfolios										
Mean(%)	1.49	1.39	1.36	1.27	1.29	1.27	1.24	1.22	1.15	1.09
t-stat	4.80	5.10	5.31	5.26	5.36	5.38	5.21	4.86	4.34	3.65
%>0	61.29	65.32	66.67	66.67	65.86	67.74	66.13	65.32	64.52	59.68

Table 4: Summary statistics (mean, *t*-test and percentage of positive monthly returns) for monthly portfolio returns based on *PEAD*, *Momentum* and *Reversal* (10 decile portfolios). January 1975 to December 2010. NYSE-AMEX-NASDAQ firms.

	Low	2	3	4	5	6	7	8	9	High
Panel A: PEAD portfolios										
Mean(%)	0.71	0.87	1.01	1.20	1.36	1.58	1.72	1.85	1.91	2.06
t-stat	2.38	3.12	3.58	4.21	4.86	5.86	6.36	6.82	7.00	7.69
%>0	57.54	58.54	60.05	61.81	65.08	65.33	66.58	66.08	66.33	69.10
Panel B: Momentum portfolios										
Mean(%)	1.07	1.06	1.17	1.28	1.29	1.38	1.40	1.49	1.56	1.75
t-stat	2.70	3.45	4.43	5.36	5.73	6.24	6.27	6.28	5.88	5.28
%>0	58.45	60.09	61.74	65.02	65.26	66.43	67.37	66.67	65.96	64.32
Panel C: Reversal portfolios										
Mean(%)	1.73	1.55	1.47	1.35	1.34	1.32	1.28	1.25	1.16	1.14
t-stat	5.48	5.72	5.80	5.68	5.87	5.64	5.49	5.16	4.50	3.71
%>0	64.78	65.86	66.40	66.13	67.20	66.94	66.94	67.20	64.52	60.75

Table 5: Results from time series regressions. Panel A gives results for equation *4.2* regression model, where *Momentum* decile portfolios and the zero-investment portfolio WML^m work as dependent, and the three Fama-French variables are the independent; panel B gives results for equation 4.3 regression model, where *Momentum* decile portfolios and the zero-investment portfolio are being risk controlled by a four-factor model, that is, the Fama-French model augmented by *PMN*. The Gibbons et al. (1989) test statistic and the associated p-values are also being presented. January 1975 to December 2010. NYSE-AMEX firms.

	Low	2	3	4	5	6	7	8	9	High	WML^m
Panel A: Momentum portfolios–three-factor model											
MKT	1.28	1.10	1.04	0.99	0.96	0.94	0.95	0.97	1.00	1.07	-0.21
SMB	0.85	0.60	0.49	0.43	0.41	0.39	0.38	0.42	0.50	0.74	-0.10
HML	0.61	0.58	0.55	0.51	0.48	0.45	0.42	0.41	0.36	0.28	-0.33
INTERCEPT	-0.63	-0.27	-0.07	0.02	0.07	0.13	0.11	0.12	0.17	0.25	0.43
t (*MKT*)	15.42	21.74	28.12	34.61	37.24	32.09	27.13	26.38	21.65	23.17	-1.86
t (*SMB*)	5.26	5.07	4.67	4.54	4.80	4.81	4.62	4.85	5.90	9.27	-0.83
t (*HML*)	4.02	6.08	6.92	7.05	6.90	6.26	5.43	5.11	4.09	3.14	-1.73
t (INTERCEPT)	-3.45	-2.25	-0.65	0.23	0.89	1.51	1.28	1.45	1.89	2.48	2.02
F-test	392.30	692.59	936.91	1219.19	1450.99	1485.38	1398.02	1280.96	1080.53	898.83	8.09
Prob (F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Adj – R^2(%)	73.42	83.00	86.85	89.58	91.10	91.29	90.79	90.03	88.40	86.37	4.77
GRS test statistic	3.60										
GRS (p-value)	0.00										

	Low	2	3	4	5	6	7	8	9	High	WML^m
Panel B: Momentum portfolios–four-factor model with PMN											
MKT	1.18	1.05	1.01	0.97	0.96	0.95	0.96	1.00	1.04	1.12	-0.06
SMB	0.64	0.49	0.42	0.39	0.38	0.38	0.39	0.45	0.55	0.81	0.17
HML	0.35	0.44	0.46	0.46	0.45	0.45	0.44	0.45	0.44	0.38	0.02
PMN	-0.99	-0.51	-0.30	-0.14	-0.05	0.06	0.16	0.27	0.40	0.50	1.47
INTERCEPT	0.68	0.40	0.32	0.21	0.15	0.05	-0.10	-0.22	-0.35	-0.38	-1.49
t (*MKT*)	19.21	25.45	28.83	30.68	32.79	30.88	29.41	34.02	35.55	38.73	-1.02
t (*SMB*)	3.70	3.92	3.81	3.99	4.44	4.79	4.96	5.62	7.45	11.70	1.21
t (*HML*)	2.56	4.69	5.37	5.75	5.97	6.01	5.92	6.54	6.72	5.86	0.14
t (*PMN*)	-6.63	-5.11	-3.91	-2.54	-1.15	1.58	4.78	9.54	11.50	10.87	8.89
t (INTERCEPT)	2.12	1.87	1.82	1.45	1.17	0.46	-0.94	-2.32	-3.85	-3.01	-4.10
F-test	493.77	673.24	749.47	862.18	982.25	1008.77	1020.47	1072.62	1109.86	940.03	123.13
Prob (F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	83.24	87.14	88.29	89.67	90.81	91.03	91.13	91.52	91.78	90.44	55.17
GRS test statistic	5.50										
GRS (p-value)	0.00										

Table 6: Results from time series regressions. Panels A and B give the results for *Momentum* portfolios using Fama-French model equation 4.2 and the four-factor model equation 4.3. The Gibbons et al. (1989) test statistic and the associated p-values are also being presented. January 1975 to December 2010. NYSE-AMEX-NASDAQ firms.

	Low	2	3	4	5	6	7	8	9	High	WML^m
Panel A: Momentum portfolios–three-factor model											
MKT	1.19	1.04	0.96	0.91	0.87	0.86	0.86	0.88	0.92	1.02	-0.17
SMB	1.04	0.81	0.68	0.61	0.57	0.56	0.60	0.68	0.82	1.10	0.06
HML	0.15	0.23	0.30	0.33	0.35	0.34	0.30	0.24	0.13	-0.10	-0.24
INTERCEPT	-0.38	-0.27	-0.11	0.04	0.07	0.17	0.20	0.28	0.33	0.47	0.41
t (*MKT*)	14.70	22.98	30.94	40.68	42.67	38.91	33.52	33.58	33.95	35.04	-1.69
t (*SMB*)	6.41	6.65	6.61	7.22	7.19	7.89	10.07	16.37	26.93	19.89	0.30
t (*HML*)	0.79	1.95	3.50	5.07	6.02	6.36	6.05	5.30	2.39	-1.26	-0.98
t (INTERCEPT)	-2.15	-2.32	-1.18	0.48	1.03	2.56	3.04	4.60	4.81	4.26	1.85
F-test	331.61	588.14	895.51	1369.70	1729.07	2086.43	2341.01	2572.90	2166.48	1439.81	3.99
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
$\text{Adj}-\text{R}^2(\%)$	70.00	80.56	86.33	90.62	92.42	93.64	94.29	94.78	93.86	91.04	2.07
GRS test statistic	6.18										
GRS (p-value)	0.00										

	Low	2	3	4	5	6	7	8	9	High	WML^m
Panel B: Momentum portfolios–four-factor model with PMN											
MKT	1.15	1.02	0.95	0.90	0.87	0.86	0.86	0.89	0.92	1.02	-0.13
SMB	0.76	0.65	0.57	0.54	0.53	0.54	0.60	0.70	0.86	1.14	0.39
HML	-0.03	0.12	0.23	0.29	0.32	0.32	0.30	0.25	0.14	-0.08	-0.05
PMN	-1.33	-0.76	-0.46	-0.25	-0.10	0.00	0.09	0.18	0.24	0.29	1.61
INTERCEPT	1.51	0.79	0.52	0.37	0.20	0.16	0.07	0.02	-0.00	0.08	-1.87
t (*MKT*)	19.31	26.50	30.87	35.91	36.53	36.60	34.93	40.48	46.20	41.60	-1.81
t (*SMB*)	4.17	4.82	5.20	6.21	6.73	7.84	10.54	18.14	28.49	19.21	1.74
t (*HML*)	-0.21	1.07	2.60	4.14	5.28	6.07	6.45	6.73	3.15	-1.08	-0.22
t (*PMN*)	-5.50	-4.63	-4.09	-3.38	-1.87	0.08	2.17	5.07	5.03	3.65	5.37
t (INTERCEPT)	3.35	2.64	2.44	2.42	1.62	1.49	0.73	0.33	-0.02	0.42	-3.33
F-test	458.13	661.13	834.03	1080.61	1203.53	1427.08	1646.13	1994.22	1746.11	1110.89	72.75
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	82.16	86.93	89.35	91.58	92.38	93.49	94.31	95.26	94.62	91.79	41.96
GRS test statistic	6.83										
GRS (p-value)	0.00										

Table 7: Results from time series regressions. Panel A gives results for equation *4.2* regression model, where *PEAD* decile portfolios and the zero-investment portfolio *PMN* work as dependent and the three Fama-French variables are the independent. Panel B gives results for equation 4.4 regression model (Carhart (1997) model), where *Momentum* decile portfolios and the zero-investment portfolio are being risk controlled by a four-factor model, that is, the Fama-French model augmented by WML^m. The Gibbons et al. (1989) test statistic and the associated *p*-values are also being presented. January 1975 to December 2010. NYSE-AMEX firms.

	Low	2	3	4	5	6	7	8	9	High	PMN
Panel A: SUE portfolios–three-factor model											
MKT	1.13	1.07	1.04	1.05	1.05	1.05	1.03	1.01	1.03	1.02	-0.11
SMB	0.58	0.52	0.53	0.58	0.58	0.48	0.46	0.47	0.46	0.40	-0.17
HML	0.62	0.50	0.50	0.50	0.56	0.50	0.46	0.41	0.43	0.38	-0.24
INTERCEPT	-0.70	-0.41	-0.30	-0.17	-0.08	0.16	0.32	0.46	0.43	0.64	0.89
t (*MKT*)	21.19	27.18	34.58	34.65	40.97	36.04	31.58	36.14	36.18	29.30	-1.76
t (*SMB*)	6.34	5.49	5.45	5.87	7.38	4.73	4.63	4.99	4.71	3.63	-2.91
t (*HML*)	6.45	6.54	7.02	7.23	8.15	6.73	6.23	5.55	5.60	4.51	-2.24
t (INTERCEPT)	-6.44	-4.66	-3.35	-1.70	-0.84	1.65	3.41	4.81	4.84	6.34	7.99
F-test	727.42	1032.77	1121.14	1285.32	1329.92	1226.30	1146.44	1118.41	1103.72	937.06	15.65
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	84.59	88.63	89.43	90.66	90.94	90.25	89.64	89.41	89.29	87.61	9.96
GRS test statistic	14.59										
GRS (*p*-value)	0.00										

	Low	2	3	4	5	6	7	8	9	High	PMN
Panel B: SUE portfolios–four-factor Carhart model											
MKT	1.05	1.02	1.00	1.02	1.03	1.03	1.02	1.00	1.02	1.02	-0.03
SMB	0.54	0.49	0.52	0.56	0.57	0.47	0.45	0.47	0.46	0.40	-0.14
HML	0.51	0.43	0.44	0.46	0.53	0.47	0.44	0.41	0.42	0.39	-0.12
WML^m	-0.33	-0.21	-0.17	-0.13	-0.09	-0.09	-0.07	-0.01	-0.02	0.03	0.35
INTERCEPT	-0.39	-0.21	-0.14	-0.04	0.01	0.24	0.38	0.48	0.45	0.61	0.56
t (*MKT*)	43.32	37.40	39.49	33.71	37.77	37.20	31.77	35.98	35.58	31.56	-0.86
t (*SMB*)	8.58	6.40	6.04	6.26	7.78	4.85	4.71	4.92	4.66	3.52	-2.02
t (*HML*)	9.26	7.61	7.64	7.37	7.28	6.56	5.94	5.42	5.62	4.77	-1.84
t (WML^m)	-8.74	-6.08	-6.04	-5.75	-2.86	-2.71	-1.79	-0.49	-0.59	1.04	14.42
t (INTERCEPT)	-4.15	-2.48	-1.57	-0.42	0.10	2.44	3.63	4.71	4.74	5.80	4.96
$\mathrm{Adj} - \mathrm{R}^2(\%)$	92.71	92.44	92.11	92.27	91.70	90.93	90.04	89.41	89.29	87.67	57.00
F-test	1263.47	1213.91	1158.95	1184.90	1097.66	996.17	898.39	838.54	828.15	706.93	132.58
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRS test statistic	16.56										
GRS (p-value)	0.00										

Table 8: Results from time series regressions. Panels A and B give the results for *PEAD* portfolios using Fama-French model equation 4.2 and the Carhart (1997) model equation 4.4. The Gibbons et al. (1989) test statistic and the associated *p*-values are also being presented. January 1975 to December 2010. NYSE-AMEX-NASDAQ firms.

	Low	2	3	4	5	6	7	8	9	High	PMN
Panel A: SUE portfolios–three-factor model											
MKT	1.03	1.00	0.99	0.99	1.00	0.99	0.99	0.98	0.98	1.00	-0.04
SMB	0.78	0.69	0.74	0.77	0.75	0.68	0.67	0.67	0.68	0.58	-0.19
HML	0.33	0.28	0.28	0.29	0.31	0.30	0.29	0.22	0.21	0.21	-0.12
INTERCEPT	-0.64	-0.42	-0.30	-0.11	0.04	0.29	0.43	0.59	0.65	0.82	1.01
t (MKT)	28.17	35.17	45.32	40.91	43.22	49.58	42.52	50.27	46.37	39.41	-0.79
t (SMB)	13.00	10.35	13.14	10.00	10.52	10.43	8.77	11.56	10.04	7.70	-3.86
t (HML)	4.74	4.78	5.27	4.77	6.23	6.30	5.73	4.77	4.28	4.06	-1.57
t (INTERCEPT)	-7.07	-5.53	-4.20	-1.45	0.57	4.02	5.82	7.81	8.67	9.87	9.84
F-test	884.87	1234.94	1358.21	1322.45	1653.33	2009.36	1834.32	2153.32	1817.42	1643.09	10.54
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	86.98	90.31	91.12	90.90	92.58	93.82	93.27	94.21	93.21	92.54	6.73
GRS test statistic	26.18										
GRS (p-value)	0.00										

	Low	2	3	4	5	6	7	8	9	High	PMN
Panel B: SUE portfolios–four-factor Carhart model											
MKT	0.98	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.99	0.01
SMB	0.80	0.71	0.75	0.78	0.76	0.69	0.67	0.68	0.68	0.58	-0.21
HML	0.26	0.22	0.23	0.24	0.27	0.27	0.26	0.20	0.20	0.20	-0.06
WML^m	-0.29	-0.23	-0.20	-0.21	-0.16	-0.11	-0.11	-0.08	-0.07	-0.04	0.25
INTERCEPT	-0.37	-0.21	-0.11	0.08	0.19	0.39	0.53	0.66	0.72	0.86	0.78
t (*MKT*)	46.68	43.39	47.49	40.55	39.71	47.67	42.94	46.02	43.69	40.58	0.37
t (*SMB*)	28.95	23.69	26.20	17.40	17.15	14.86	11.77	14.78	12.47	8.64	-2.69
t (*HML*)	7.75	7.65	7.99	6.71	6.83	6.39	6.05	4.45	4.54	4.30	-1.04
t (WML^m)	-13.55	-8.31	-6.46	-6.61	-9.48	-5.89	-5.54	-4.43	-3.04	-1.59	8.35
t (INTERCEPT)	-4.13	-2.62	-1.37	0.94	2.53	5.53	7.24	8.48	8.74	9.91	6.98
F-test	1714.43	2184.42	1939.51	1872.08	1970.71	1945.12	1697.29	1818.83	1492.38	1261.33	75.54
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\text{Adj} - \text{R}^2(\%)$	94.52	95.65	95.13	94.96	95.20	95.14	94.47	94.82	93.76	92.70	42.89
GRS test statistic	27.29										
GRS (p-value)	0.00										

Table 9: Results from time series regressions. Panel A shows results for equation 4.2 regression model which is the same as Fama-French model, where *Reversal* based 10-decile and a zero-investment (WML^r) portfolios are the dependent variables; panels B and C show the results for equations 4.6 and 4.5, respectively, where the former is a Fama-French model plus a fourth factor that is the *Momentum* risk factor and the latter is a Fama-French model plus a fourth factor that is the *PEAD* risk factor, and the dependent is the *Reversal* based 10-decile and a zero-investment portfolio (WML^r). The Gibbons et al. (1989) test statistic and the associated p-values are also being presented. January 1975 to December 2010. NYSE-AMEX firms.

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel A: Reversal portfolios–three-factor model											
MKT	1.08	1.02	1.00	0.96	0.96	0.96	0.96	1.01	1.05	1.15	0.07
SMB	0.78	0.59	0.44	0.37	0.32	0.26	0.22	0.26	0.32	0.41	-0.35
HML	0.59	0.55	0.58	0.53	0.53	0.48	0.43	0.42	0.37	0.28	-0.31
INTERCEPT	0.11	0.09	0.09	0.04	0.07	0.08	0.07	0.02	-0.06	-0.16	-0.70
t (MKT)	31.11	35.42	38.05	40.26	40.70	38.62	40.32	40.49	43.08	41.99	2.68
t (SMB)	6.34	6.03	4.93	4.47	3.77	3.15	2.70	3.00	3.55	4.37	-6.18
t (HML)	6.98	8.60	9.09	8.73	8.27	7.28	6.46	5.93	5.27	3.67	-5.80
t (INTERCEPT)	0.81	0.84	0.97	0.53	0.89	0.99	0.74	0.21	-0.69	-1.68	-6.34
F-test	739.28	1140.98	1204.87	1248.01	1195.30	1145.78	1074.52	1028.57	1128.62	1118.61	49.25
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Adj – R^2(%)	85.65	90.21	90.68	90.98	90.62	90.25	89.67	89.26	90.12	90.04	28.07
GRS test statistic	1.98										
GRS (p-value)	0.035										

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel B: Reversal portfolios–four-factor model with Momentum											
MKT	1.03	0.98	0.97	0.93	0.95	0.94	0.95	0.99	1.02	1.11	0.08
SMB	0.75	0.57	0.42	0.36	0.31	0.25	0.22	0.25	0.30	0.39	-0.35
HML	0.52	0.50	0.54	0.51	0.51	0.46	0.41	0.40	0.33	0.23	-0.30
WML^m	-0.19	-0.13	-0.11	-0.08	-0.06	-0.06	-0.05	-0.07	-0.10	-0.15	0.03
INTERCEPT	0.29	0.21	0.19	0.12	0.13	0.15	0.12	0.09	0.03	-0.01	-0.73
t (MKT)	28.88	34.06	41.70	43.46	43.01	39.62	40.78	41.88	49.31	52.18	2.75
t (SMB)	7.10	6.58	5.27	4.63	3.81	3.16	2.67	3.03	3.70	4.78	-6.38
t (HML)	7.21	8.99	9.45	8.33	8.11	6.86	6.13	5.54	4.91	3.15	-5.59
t (WML^m)	-5.87	-5.60	-3.97	-3.11	-2.54	-2.24	-2.08	-2.43	-3.33	-5.72	0.85
t (INTERCEPT)	2.35	2.29	2.35	1.59	1.84	1.81	1.35	0.97	0.36	-0.15	-6.40
F-test	702.63	1048.48	1061.53	1025.00	950.35	911.40	835.45	821.94	945.70	1061.64	37.49
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	88.32	91.87	91.96	91.69	91.10	90.75	90.00	89.85	91.06	91.96	28.24
GRS test statistic	1.69										
GRS (p-value)	0.082										
Panel C: Reversal portfolios–four-factor model with PEAD portfolios											
MKT	1.06	1.00	0.99	0.95	0.96	0.95	0.96	1.00	1.04	1.13	0.07
SMB	0.74	0.57	0.43	0.36	0.31	0.26	0.22	0.25	0.30	0.38	-0.35
HML	0.55	0.52	0.56	0.52	0.53	0.47	0.43	0.41	0.34	0.24	-0.31
PMN	-0.18	-0.10	-0.08	-0.04	-0.02	-0.02	-0.01	-0.05	-0.10	-0.17	-0.00
INTERCEPT	0.35	0.22	0.19	0.10	0.10	0.12	0.08	0.09	0.07	0.06	-0.70
t (MKT)	26.46	30.82	38.27	38.34	39.06	36.91	37.81	38.11	41.97	43.26	2.45
t (SMB)	6.06	5.85	4.74	4.37	3.75	3.11	2.72	2.93	3.38	3.99	-6.34
t (HML)	6.09	7.72	8.59	8.01	7.82	6.70	6.02	5.30	4.59	2.91	-5.28
t (PMN)	-2.46	-1.79	-1.27	-1.00	-0.46	-0.43	-0.28	-0.96	-1.70	-2.83	-0.05
t (INTERCEPT)	1.82	1.47	1.42	0.91	0.97	0.95	0.75	0.73	0.55	0.47	-5.19
F-test	580.57	877.11	919.00	939.65	895.02	858.57	804.08	775.71	867.26	891.50	36.84
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	86.20	90.43	90.82	91.01	90.60	90.24	89.65	89.31	90.33	90.57	27.87
GRS test statistic	1.013										
GRS (p-value)	0.43										

Table 10: Results from time series regressions. Panels A, B and C give the results for *Reversal* portfolios using Fama-French model and four-factor model (with *Momentum* or *PEAD* as a fourth risk factor). The Gibbons et al. (1989) test statistic and the associated p-values are also being presented. January 1975 to December 2010. NYSE-AMEX-NASDAQ firms.

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel A: Reversal portfolios–three-factor model											
MKT	0.99	0.94	0.92	0.89	0.88	0.90	0.90	0.93	0.98	1.09	0.11
SMB	0.98	0.75	0.65	0.54	0.47	0.44	0.41	0.43	0.48	0.62	-0.35
HML	0.33	0.39	0.42	0.43	0.43	0.42	0.39	0.34	0.29	0.10	-0.24
INTERCEPT	0.46	0.32	0.26	0.17	0.18	0.15	0.13	0.10	-0.01	-0.05	-0.95
t (MKT)	38.43	43.40	51.62	47.36	42.27	39.70	42.21	44.69	46.89	44.01	3.66
t (SMB)	12.46	10.24	10.11	8.81	6.78	5.75	5.39	5.85	5.98	7.12	-6.00
t (HML)	4.83	7.74	9.71	10.06	8.94	8.25	6.84	6.18	5.04	1.63	-3.75
t (INTERCEPT)	3.97	3.88	4.07	2.62	2.74	1.99	1.61	1.18	-0.12	-0.63	-8.87
F-test	892.88	1430.85	1881.53	1985.17	1737.26	1660.41	1404.70	1477.46	1623.04	1638.03	48.05
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\text{Adj}-\text{R}^2(\%)$	87.82	92.04	93.83	94.13	93.35	93.06	91.90	92.27	92.92	92.98	27.56
GRS test statistic	5.54										
GRS (p-value)	0.00										

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel B: Reversal portfolios–four-factor model with Momentum											
MKT	0.95	0.91	0.90	0.87	0.87	0.89	0.89	0.91	0.96	1.05	0.10
SMB	0.98	0.76	0.65	0.55	0.47	0.44	0.41	0.44	0.48	0.63	-0.35
HML	0.29	0.36	0.39	0.41	0.41	0.41	0.37	0.32	0.27	0.05	-0.24
WML^m	-0.18	-0.14	-0.11	-0.08	-0.06	-0.07	-0.06	-0.08	-0.10	-0.18	-0.01
INTERCEPT	0.64	0.45	0.37	0.24	0.25	0.22	0.19	0.17	0.09	0.12	-0.94
t (MKT)	31.47	36.31	49.05	46.90	44.50	43.54	45.65	47.39	51.18	70.10	3.53
t (SMB)	18.12	15.49	15.45	12.04	8.37	7.08	6.47	7.44	7.96	12.18	-6.01
t (HML)	5.19	8.45	11.74	10.39	9.05	8.31	6.66	5.96	4.57	1.05	-3.65
t (WML^m)	-5.73	-6.24	-6.65	-4.52	-2.61	-2.81	-2.30	-3.22	-3.84	-9.29	-0.13
t (INTERCEPT)	5.56	5.80	5.89	4.18	4.14	3.34	2.65	2.40	1.22	1.77	-8.01
F-test	896.50	1512.14	1978.58	1824.95	1454.03	1409.32	1146.42	1269.05	1495.33	2189.56	35.97
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Adj-R^2(\%)$	90.61	94.22	95.52	95.16	94.00	93.82	92.51	93.18	94.16	95.93	27.38
GRS test statistic	7.17										
GRS (p-value)	0.00										
Panel C: Reversal portfolios–four-factor model with PEAD portfolios											
MKT	0.98	0.93	0.92	0.89	0.88	0.90	0.90	0.93	0.98	1.08	0.11
SMB	0.92	0.72	0.63	0.53	0.46	0.43	0.40	0.42	0.46	0.57	-0.35
HML	0.30	0.37	0.41	0.43	0.43	0.42	0.39	0.34	0.28	0.07	-0.23
PMN	-0.28	-0.15	-0.11	-0.07	-0.01	-0.02	-0.02	-0.05	-0.08	-0.25	0.03
INTERCEPT	0.87	0.54	0.42	0.26	0.20	0.18	0.15	0.17	0.11	0.31	-0.99
t (MKT)	30.38	35.41	46.46	43.75	41.14	38.31	40.67	42.47	43.82	47.30	3.56
t (SMB)	11.83	9.81	9.81	8.75	6.89	5.87	5.54	5.92	5.94	6.52	-6.50
t (HML)	4.19	6.91	9.04	9.43	8.72	7.91	6.62	5.80	4.58	1.07	-3.57
t (PMN)	-2.50	-1.79	-1.77	-1.55	-0.28	-0.54	-0.36	-1.11	-1.92	-3.81	0.31
t (INTERCEPT)	3.95	3.14	3.36	2.65	2.18	1.73	1.46	1.52	1.01	2.15	-5.37
F-test	739.10	1131.93	1463.25	1514.11	1300.02	1244.71	1051.47	1114.12	1238.38	1401.84	36.08
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$Adj-R^2(\%)$	88.84	92.42	94.04	94.22	93.34	93.06	91.89	92.31	93.03	93.79	27.44
GRS test statistic	6.36										
GRS (p-value)	0.00										

Table 11: Results from time series regressions. Panels A and B give the results for set 3 regression models. The 10-decile portfolios and a zero investment portfolio (WML^r) work as dependent and the three risk factors from Fama-French and four lags for *PEAD* (equation 4.8) and *Momentum* (equation 4.7) based zero-investment portfolio annual returns as independent variables. The Gibbons et al. (1989) test statistic and the associated p-values are also being presented. January 1975 to December 2010. NYSE-AMEX firms.

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel A: Reversal portfolios - PEAD annual returns											
MKT	1.08	1.02	1.00	0.95	0.96	0.95	0.95	0.99	1.04	1.14	0.06
SMB	0.78	0.59	0.45	0.37	0.31	0.26	0.21	0.26	0.30	0.41	-0.37
HML	0.62	0.57	0.60	0.56	0.55	0.51	0.46	0.46	0.40	0.32	-0.30
PMN(0)	-0.01	-0.00	-0.01	0.00	0.00	0.01	0.01	0.00	-0.00	-0.00	0.00
PMN(-1)	0.02	0.01	0.00	-0.00	0.00	0.01	-0.00	-0.00	-0.01	-0.01	-0.03
PMN(-2)	-0.01	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00
PMN(-3)	0.01	-0.01	-0.00	0.00	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.02
PMN(-4)	0.00	0.01	0.01	0.00	0.00	0.00	-0.00	0.01	0.00	-0.01	-0.02
INTERCEPT	-0.00	0.35	0.22	0.13	0.05	0.00	0.27	0.19	0.44	0.34	0.23
t (MKT)	29.91	32.76	37.76	36.63	37.07	35.13	37.82	39.32	41.76	41.33	2.06
t (SMB)	6.15	5.96	4.89	4.45	3.75	3.14	2.67	3.03	3.52	4.40	-5.84
t (HML)	6.72	8.26	8.82	8.64	8.30	7.46	7.18	6.70	5.81	4.36	-5.21
t(PMN(0))	-0.68	-0.18	-0.82	0.49	0.40	0.84	0.82	0.28	-0.12	-0.05	0.32
t(PMN(-1))	1.23	0.45	0.38	-0.08	0.47	0.54	-0.26	-0.11	-0.74	-0.69	-2.75
t(PMN(-2))	-0.92	-1.49	-1.66	-1.14	-0.79	-0.58	-0.91	-1.04	-1.23	-0.89	0.30
t(PMN(-3))	0.58	-0.92	-0.28	0.04	-0.29	-0.36	-0.51	-0.75	-1.31	-0.59	-1.75
t(PMN(-4))	0.19	0.86	1.64	0.41	0.63	0.54	-0.44	0.70	0.11	-1.08	-1.54
t (INTERCEPT)	-0.01	0.70	0.56	0.35	0.13	0.01	0.71	0.45	1.02	0.80	0.47
F-test	247.25	382.25	403.48	413.42	412.16	382.69	389.06	360.22	393.56	388.10	18.62
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj} - \mathrm{R}^2(\%)$	85.36	90.02	90.50	90.71	90.68	90.03	90.18	89.48	90.28	90.16	29.43
GRS test statistic	1.139										
GRS (p-value)	0.332										

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel B: Reversal portfolios - Momentum annual returns											
MKT	1.08	1.01	1.00	0.96	0.96	0.95	0.96	1.00	1.05	1.15	0.07
SMB	0.76	0.58	0.44	0.36	0.31	0.25	0.22	0.25	0.31	0.41	-0.35
HML	0.57	0.54	0.57	0.53	0.53	0.47	0.43	0.41	0.36	0.28	-0.31
WML^m(0)	-0.02	-0.01	-0.01	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.01	0.01
WML^m(-1)	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
WML^m(-2)	-0.01	-0.00	-0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01
WML^m(-3)	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
WML^m(-4)	0.00	0.01	0.00	0.00	0.00	-0.00	-0.01	-0.01	-0.00	-0.01	-0.01
INTERCEPT	0.43	0.20	0.23	0.00	-0.00	-0.01	0.04	0.09	-0.05	-0.05	-0.80
t (MKT)	33.08	36.95	42.53	40.90	40.79	38.78	40.65	42.42	43.80	43.16	2.55
t (SMB)	6.18	5.89	4.84	4.35	3.66	3.00	2.61	2.89	3.46	4.31	-5.97
t (HML)	6.92	8.76	9.38	8.84	8.32	7.26	6.50	5.87	5.24	3.61	-5.45
t(WML^m(0))	-2.95	-2.74	-2.57	-1.05	-0.65	-0.57	0.49	-0.24	-0.38	-0.86	1.69
t(WML^m(-1))	-0.80	-1.11	-1.34	-1.09	-0.77	-0.31	-1.16	-1.01	-1.10	-0.79	-0.71
t(WML^m(-2))	-0.66	-0.17	-0.41	0.41	0.50	1.10	0.75	0.44	0.72	0.35	0.83
t(WML^m(-3))	0.15	0.31	0.45	1.51	1.73	1.55	1.23	0.44	0.56	0.37	0.32
t(WML^m(-4))	0.22	0.81	0.52	0.30	0.02	-0.65	-0.98	-0.92	-0.54	-0.88	-0.85
t (INTERCEPT)	1.91	1.10	1.49	0.00	-0.02	-0.04	0.22	0.45	-0.25	-0.24	-3.35
F-test	274.92	417.17	448.44	453.77	431.79	405.24	387.52	361.66	397.93	397.79	19.78
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	85.69	90.10	90.72	90.82	90.40	89.83	89.42	88.74	89.67	89.66	29.10
GRS test statistic	1.02										
GRS (p-value)	0.424										

Table 12: Results from time series regressions. Panels A and B give the results for set 3 regression models. The 10-decile portfolios and a zero investment portfolio (WML^r) work as dependent and the three risk factors from Fama-French and four lags for *PEAD* (4.8) and *Momentum* (4.7) based zero-investment portfolio annual returns as independent variables. The Gibbons et al. (1989) test statistic and the associated *p*-values are also being presented. January 1975 to December 2010. NYSE-AMEX-NASDAQ firms.

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel A: Reversal portfolios - PEAD annual returns											
MKT	0.99	0.95	0.93	0.89	0.89	0.90	0.90	0.92	0.98	1.09	0.10
SMB	0.98	0.76	0.66	0.54	0.46	0.43	0.40	0.43	0.47	0.60	-0.37
HML	0.34	0.41	0.43	0.45	0.45	0.45	0.42	0.37	0.32	0.12	-0.23
PMN(0)	-0.01	0.00	-0.00	0.00	0.01	0.01	0.01	0.01	0.01	-0.01	0.00
PMN(-1)	0.03	0.01	0.00	-0.00	0.00	0.00	0.00	-0.00	-0.01	-0.01	-0.03
PMN(-2)	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02	-0.02	-0.01	-0.01
PMN(-3)	-0.00	-0.01	-0.01	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.02	-0.02
PMN(-4)	-0.00	-0.01	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01	-0.02	-0.02
INTERCEPT	0.41	0.62	0.51	0.53	0.38	0.35	0.30	0.36	0.74	0.98	0.38
t (MKT)	38.28	43.63	52.93	45.38	41.37	39.45	42.74	46.03	46.12	42.11	3.16
t (SMB)	11.45	9.77	9.54	8.66	6.86	5.80	5.63	6.03	6.08	6.98	-6.24
t (HML)	4.62	7.26	8.97	9.88	9.18	8.77	8.01	7.10	5.87	1.96	-3.47
t(PMN(0))	-0.65	0.27	-0.20	0.11	0.82	0.96	1.16	1.13	0.56	-0.57	0.14
t(PMN(-1))	1.40	0.55	0.02	-0.26	0.22	0.29	0.01	-0.08	-0.60	-0.50	-2.25
t(PMN(-2))	-0.38	-1.60	-1.43	-1.53	-1.70	-1.51	-1.31	-1.60	-1.88	-1.04	-0.37
t(PMN(-3))	-0.24	-0.65	-0.66	-0.47	-0.66	-0.60	-0.69	-0.86	-1.55	-1.79	-1.47
t(PMN(-4))	-0.27	-0.46	0.52	-0.37	-0.28	-0.60	-0.57	-0.48	-1.24	-1.50	-1.35
t (INTERCEPT)	0.45	0.98	0.99	1.11	0.77	0.70	0.62	0.71	1.37	1.53	0.51
F-test	293.97	466.13	615.49	655.24	597.45	557.08	512.47	516.14	565.59	540.99	17.63
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	87.40	91.67	93.57	93.93	93.38	92.94	92.37	92.42	93.04	92.74	28.24
GRS test statistic	0.921										
GRS (*p*-value)	0.514										

	Low	2	3	4	5	6	7	8	9	High	WML^r
Panel B: Reversal portfolios - Momentum annual returns											
MKT	0.99	0.94	0.92	0.89	0.88	0.90	0.90	0.92	0.98	1.09	0.10
SMB	0.97	0.75	0.65	0.54	0.46	0.43	0.40	0.43	0.47	0.61	-0.36
HML	0.32	0.38	0.42	0.43	0.43	0.42	0.38	0.34	0.29	0.09	-0.24
WML^m(0)	-0.02	-0.01	-0.01	-0.00	-0.00	-0.00	0.00	-0.00	-0.00	-0.01	0.00
WML^m(-1)	0.01	0.00	0.00	-0.00	0.00	0.00	-0.00	0.00	0.00	0.00	-0.01
WML^m(-2)	-0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
WML^m(-3)	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	-0.00	-0.00
WML^m(-4)	0.01	0.01	0.00	0.00	-0.00	-0.01	-0.00	-0.01	-0.00	-0.01	-0.01
INTERCEPT	0.46	0.31	0.22	0.09	0.09	0.05	0.10	0.09	-0.00	0.14	-0.65
t (MKT)	37.57	43.36	54.30	47.95	42.33	41.37	44.29	48.16	48.77	46.36	3.46
t (SMB)	12.71	10.30	10.17	8.71	6.61	5.57	5.21	5.67	5.88	7.22	-6.10
t (HML)	4.48	7.57	9.68	10.21	9.11	8.40	6.98	6.25	4.97	1.48	-3.50
t(WML^m(0))	-2.15	-2.13	-2.13	-1.08	-0.82	-0.54	0.07	-0.06	-0.53	-2.09	0.04
t(WML^m(-1))	1.18	0.86	0.85	-0.07	0.37	0.42	-0.59	0.21	0.13	0.70	-1.62
t(WML^m(-2))	-0.14	0.25	0.55	1.45	1.87	2.35	1.19	1.17	0.85	0.22	0.22
t(WML^m(-3))	0.63	0.41	0.90	1.34	1.98	2.08	1.13	0.62	0.74	-0.37	-0.64
t(WML^m(-4))	1.21	1.26	0.82	0.36	-0.86	-1.34	-0.72	-1.24	-0.92	-1.68	-2.14
t (INTERCEPT)	2.37	2.27	2.19	0.99	0.97	0.40	0.70	0.67	-0.02	1.03	-3.56
F-test	328.15	528.21	691.88	721.77	630.13	590.62	496.32	521.69	571.84	590.46	19.11
Prob(F-test)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$\mathrm{Adj}-\mathrm{R}^2(\%)$	87.73	92.02	93.79	94.03	93.22	92.80	91.54	91.92	92.58	92.80	28.36
GRS test statistic	1.60										
GRS (p-value)	0.105										