Chapter 4
Efficient Market Hypothesis and Price Anomalies

4.1. Introduction

The previous two chapters have provided both theoretical and empirical analysis of the liquidity phenomenon. This chapter focuses on the efficient market hypothesis and price anomalies. We are particularly interested in highlighting the potential role of systematic liquidity risk in explaining the price anomalies following large one-day price changes.

The efficient market hypothesis is based on the random walk theory which states that stock prices change randomly in an unpredictable manner. Thus, no investor can achieve an abnormal return using any past, public or private information. In other words, all this information is already reflected in the stock price. However, several authors find that a momentum strategy in the short run (3-12 months) or a contrarian strategy in the long run (3-5 years) can beat the market. Specifically, DeBondt and Thaler (1985) argue that buying previous loser stocks and selling previous winner stocks yield a significant abnormal return over a three-year period. On the other hand, Jegadeesh and Titman (1993) find that buying winner stocks and selling loser stocks generate a significant abnormal return over 3-12 months. DeBondt and Thaler (1985) and Jegadeesh and Titman (1993) set the foundations of two opposite lines of research that attack the efficient market hypothesis. This chapter examines in detail these two lines of research.

The remainder of the chapter is split into six sections. Section 4.2 defines the efficient market hypothesis. Section 4.3 reviews the literature on stock price anomalies. Section 4.4 discusses the potential sources of these anomalies. Section 4.5 documents the international evidence of the price reversal and momentum. Section 4.6 discusses the observed price anomalies in the UK market. Section 4.7 summarises and concludes the chapter.

4.2. Efficient market hypothesis

Fama (1970) is the first to formalise the efficient market hypothesis. It is based on the fact that stock price should fully reflect all the available information. Thus, the stock price will subsume any new information that comes to the market immediately, rationally and in the right direction and size of that information. He describes the efficient market in terms of a fair game model which indicates that the expected return of a security is a function of its risk. Indeed, under the fair game model the stock price P_t follow a martingale stochastic process which satisfies the following condition:

$$E[P_{t+1} / P_t, P_{t-1}, ...] = P_t$$

Or, equivalently,

$$E[P_{t+1} - P_t / P_t, P_{t-1}, ...] = 0$$

Thus, the martingale hypothesis states that tomorrow's price is expected to be equal to today's price, given the asset's entire price history. In other words, the asset's expected price change is zero when conditioned on the asset's price history; hence its price is just as possibly to rise as it is to fall.

One key trait of the efficient market hypothesis is the random walk model. According to this model, in an efficient market, the stock price may not be equal to the true value of the available information but it deviates from that value in a random manner. Possibly, the simplest version of the random walk hypothesis is the independently and identically distributed (IID) increments case in which the dynamics of P_t are given by the following equation:

$$P_t = \mu + P_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim IID(0, \sigma^2)$$

Where μ is the expected price change or drift, and $IID(0, \sigma^2)$ denotes that ε_t is independently and identically distributed with mean 0 and variance σ^2. The independence of the increments (ε_t) indicates that the random walk is also a fair game, but in a much stronger sense than the martingale: Independence indicates that not only those increments are uncorrelated, but that any nonlinear functions of the increments are also uncorrelated.

Fama (1970) defines three levels of informational market efficiency depending on the type of the information reflected in the stock price. The weak form of efficiency conveys that stock prices reflect all historical information such as historical trading volume and rate of return. The semi-strong form of efficiency indicates that stock prices reflect all historical and publicly available information such as earning announcements. The strong form of efficiency assumes that all the past, publically available and private information is reflected in the stock price.[1]

[1] There are many studies that test the three levels of efficiency and a lot find significant anomalies. The studies of the weak form mainly use autocorrelation tests and the run test to examine if returns can be predicted using their historical values. Examples of studies of the weak form are Grieb and Reyes (1999) and Buguk and Brorsen (2003). The semi-strong form tests focus on whether the announcements of certain events are subsumed efficiently in stock prices. Rose and Selody (1984) and Bacon and McMillan (2007) are two examples of studies of the semi-strong form of efficiency. There is a broad acknowledgement that stock markets are inefficient in the strong form. However,

4.3. Price anomalies

The efficient market hypothesis has been challenged by various price anomalies. Price reversal and momentum are major anomalies researched since the 1980s. The price reversal is consistent with the overreaction hypothesis which states that investors overreact to new information, while the momentum is compatible with the underreaction hypothesis that assumes that investors underreact to new information. We review the studies that have examined both phenomena in the short and long run. Further, we discuss the different explanations suggested in this area.

4.3.1. Long-term price reversal

DeBondt and Thaler (1985) are the first to bring the overreaction hypothesis from the psychological sciences to the field of stock market efficiency and market anomalies. They argue that since investors overreact to unexpected events, price reversals happen in the long run (up to 5 years) as the market corrects itself. DeBondt and Thaler (1985) study NYSE stocks over the period January 1962-December 1982. They have constructed two types of portfolios, winner and loser portfolios. The winner portfolio includes stocks that had experienced positive excess returns over the period of one, two or five years. The loser portfolio on the other hand consists of stocks that had negative excess returns over the same periods of time. The portfolios are held for three years after the formation process. The analysis of DeBondt and Thaler (1985) provides evidence in favour of the overreaction hypothesis. Specifically, a loser portfolio of 35 stocks generates an excess positive return of 19.6%, 36 months after its formation. The winner portfolio,

there are some studies that investigate the strong form of efficiency, such as Finnerty (1976) and Chowdhury et al. (1993), by examining the trading of insiders with private information.

however, experiences an excess loss of -5% over the same period. Thus, a significant positive excess return of 24.6% can be realised by buying the loser portfolio and selling the winner. These results indicate also that the price reversals of losers are larger than those of winners. Furthermore, DeBondt and Thaler (1985) show that these results are robust to the different models used to calculate excess returns. The most important conclusion of the study is that these abnormal returns happen in January. This indicates that the overall overreaction phenomenon is nothing other than a seasonal effect.

In contrast, Chopra et al. (1992) argue that although the overreaction effect is higher during January, it is a phenomenon distinct from tax-loss selling effect. Specifically, they find a strong overreaction in the NYSE over the period 1926-1986. They report that losers outperform winners by 5-10% yearly, five years subsequent to the portfolio formation date. Furthermore, they exemplify that although the overreaction effect is superior for small firms, its evidence is robust to size effect and time-varying betas.

Brown and Harlow (1988) examine the same issue and reach a different conclusion. They find that over January 1946-December 1983, NYSE stocks show asymmetric reaction to extreme positive and negative price shocks. Hence, stocks react efficiently to positive price shocks in both the short and long run. Conversely, they overreact to negative price shocks in the short run and underreact in the long run.[1]

[1] Brown and Harlow (1988) define the short run as one month following the shock, whereas the long run extends 2-36 months subsequent to the shock.

4.3.2. Short-term price reversal

While DeBondt and Thaler (1985) examine the price reversal in the long run, other studies find significant reversals in the short run as well. Howe (1986) finds evidence supporting the overreaction hypothesis using weekly returns of AMEX and NYSE stocks. In particular, he examines the stocks whose returns rise or fall more than 50% in one week 1963-1981. Howe (1986) reports that losers (winners) achieve returns of 13.8% (-13%) over ten weeks subsequent to the large decline (increase).

Consistently, Lehman (1990) argues that markets are inefficient in the short run. He examines all NYSE and AMEX stocks over the period July 1962-December 1986. Lehman (1990) documents that the portfolios that had experienced a bad/good performance over a one week time horizon display an opposite pattern in the week that follows. Thus, both winner and loser portfolios exhibit significant price reversals. These reversals continue to be significant even after controlling for bid-ask spread and plausible transaction cost.

Bremer and Sweeney (1991) examine the behaviour of a stock's return in the days following a large one-day price decline of -10%. Their sample consists of all the stocks listed in the Fortune 500 in the period 1962-1986. They find substantial price reversals after negative price shocks. Particularly, Bremer and Sweeney (1991) document that a significant positive abnormal return of 1.773% can be realised on the day after a -10% price decline and it accumulates to 2.215% on the second day after the price shock. The authors define the abnormal return as the stock's daily return in excess of its average return over the sample period. They show that the

documented price reversal is distinct from any other anomaly. Thus, it is not a January effect, a Monday effect, a weekend effect or a turn of the year effect. It is robust to different trigger values, sub-periods and subsamples.

4.3.3. Short-term momentum

In contrast to the price reversal studies, some studies find significant return continuation in the short run. Schnusenberg and Madura (2001) examine the short-term price reaction of six US stock market indexes. Following DeBondt and Thaler (1985), they define winners/losers as the days on which an index displays abnormally high/low returns. Schnusenberg and Madura (2001) investigate the price reaction of the winners and losers over a sixty-day interval. They find evidence in favour of the underreaction hypothesis over a one-day interval for both winners and losers. However, their findings support the uncertain information hypothesis over the sixty-day interval. Thus, winners do underreact while losers overreact over that interval. These results are found to be consistent over the six indices.

Lasfer et al. (2003) examine the same issue for the market indices of 39 stock exchanges around the world. Their study extends from 1989 to 1998. Lasfer et al. (2003) use a methodology based on calculating the cumulative abnormal returns for these indices after large price shocks rather than constructing winner and loser portfolios. The main results indicate that for both the developed and the emerging markets, investors show underreaction following positive and negative price shocks. That is, abnormal returns can be achieved up to 10 days following the shock. However, Lasfer et al. (2003) report that some of these abnormal returns decreased in the late-1990s. Furthermore, they document that the amount of the momentum

profits is larger for emerging and less liquid markets. Additionally, the authors show that these abnormal returns are robust to seasonal month/year effects.

Consistently, Spyrou et al. (2007) investigate the short run investor reaction to extreme price shocks in four FTSE indices in the LSE over the period 1989-2004. They argue that each index can be considered as a value weighted portfolio of stocks which represent a certain size segment of the market. Spyrou et al. (2007) find that large capitalisation stock portfolios react efficiently to extreme shocks. However, small and medium show significant underreaction to both positive and negative shocks. Thus, abnormal returns can be achieved while investing in these stocks for many days after the shock. Moreover, Spyrou et al. (2007) find abnormal returns even after adjusting for Fama and French (1993) factors and considering bid-ask biases and global financial crises.

In line with the previous studies, Mazouz et al. (2009) investigate the short-run stock price reaction to a large one-day price shock. The major difference between this study and the others is that it focuses on the individual stock behaviour rather than the market index behaviour. Their sample consisted of 424 stocks of the LSE over the period January 1992-December 2003. The main objective of this study is to find whether the momentum or contrarian abnormal returns are due to the limited ability of the CAPM to explain the cross-section of stock returns. Using similar methodology to Lasfer et al. (2003), Mazouz et al. (2009) report significant abnormal returns following positive price shocks at all trigger values and negative price shocks of 5% or more. These abnormal profits do not significantly differ across three competing models, which are the CAPM, the Fama and French (1993)

three-factor model and the Carhart (1997) four-factor model. Moreover, a significant one-day positive abnormal profit of 1% can be achieved after a positive shock of 5% or more under all three models. Similarly, a negative abnormal return of -.43% under the CAPM and -.34% under the other two models can be earned after a negative shock of -5% or less. Thus, these results support the underreaction hypothesis and are robust to different sub-periods.

4.3.4. Medium-term momentum

Jegadeesh and Titman (1993) are the first to examine the momentum trading strategies or what they have called the relative strength trading strategies. Their methodology depends on constructing portfolios based on the past cumulative returns of the stocks and evaluating the performance of these portfolios for a certain period of time. In particular, the relative strength strategy is based on buying the stocks which had a good performance in the past and selling the ones which had performed badly in the same period of time. Jegadeesh and Titman (1993) conduct their analysis on NYSE and AMEX stocks over the period 1965-1989. They consider 16 momentum strategies resulting from the intersections of selecting stocks based on their past performance over one to four quarters of the year and holding them for the next one to four quarters. The analysis shows that each momentum strategy generates significant positive returns over 3 to 12 months. However, these profits disappear in the following two years. One example is that the portfolio constructed on the basis of the past six months' returns earns a cumulative positive return of 9.5% over the next 12 months. Nevertheless, this return diminishes to less than its half over the following 24 months. Interestingly, a decomposition analysis of these momentum profits shows that neither systematic risk nor the delayed price

reaction to information about a common factor[1] can be considered as potential sources of these profits. The evidence is more consistent with delayed price reaction to firm-specific information's being a good explanation of these profits. Thus, Jegadeesh and Titman (1993) argue that investors underreact to firm-specific information in the short run and overreact in the long run.

Jegadeesh and Titman (2001) replicate their study of the year 1993 for nine additional years. Thus, they incorporate the period 1990-1998 in their original study. Jegadeesh and Titman (2001) submit robust evidence that momentum profits continue to exist in the 1990s at about the same magnitude as in the earlier period. They argue that this new evidence confirms that the findings of their original study are not the product of data snooping. On the other hand, Jegadeesh and Titman (2001) document that the price reversals happening 13 to 60 months after the formation period are sample-dependent. Accordingly, the existence of these reversals depends on the sample period, sample composition and the way returns are adjusted to risk.

4.4. Alternative explanations of price anomalies

Researchers have suggested many competing explanations for the documented price anomalies. Zarowin (1990) argue that overreaction is nothing other than a manifestation of the size anomaly. Other researchers demonstrate that markets are efficient and the documented price anomalies exist as a result of failure to adjust for time-varying risk: Chan (1988), Ball and Kothari (1989), Berk et al. (1999), Wu (2002), Wang (2003) and Li et al. (2008). A number of studies find that price

[1] This factor has been suggested by Lo and Mackinaly (1990)

anomalies are attributable to microstructure effects, thus if transaction costs are taken into consideration these anomalies will disappear (see, for example, Atkins and Dyi, 1990; Cox and Peterson, 1994; Li et al., 2008). Moskowitz and Grinblatt (1999) argue that industry momentum can explain the individual stock momentum. Several studies ascribe the documented price anomalies to methodological problems such as data snooping and survivorship bias (see, among others, Ince and Porter, (2006); Andrikopoulos et al., 2007). Finally, some researchers go for a psychological explanation of the issue. A detailed description of the alternative explanations follows.

4.4.1. Size effect

Zarowin (1990) reexamines the DeBondt and Thaler (1985) findings with respect to the overreaction hypothesis but after controlling the size effect. He applies two tests in order to investigate whether the outperformance of losers over winners is due to the overreaction hypothesis or the size effect. In the first test, Zarowin (1990) matches winner and loser portfolios with the same size. He observes no significant difference in returns except for January. In the second test, Zarowin (1990) conducts the same analysis on periods when winners are smaller than losers and vice versa. The results show that when winners are smaller they outperform losers, while when losers are smaller they outperform winners. Furthermore, Zarowin (1990) repeats the analysis after adjusting for risk and seasonality effect. He finds that the loser-winner effect exists in all months and even after the risk adjustments. The main conclusion of Zarowin's (1990) analysis is that the loser-winner effect documented by DeBondt and Thaler (1985) is not due to the overreaction hypothesis. Alternatively, it is definitely a size-related anomaly.

Many authors adopts Zarowin's (1990) claim to explain price anomalies. Clare and Thomas (1995) attribute the documented overreaction phenomenon in the UK market over the period 1955-1990 to the size effect. Andrikopoulos et al. (2009) argue that there is a weak evidence of overreaction in UK market over the period 1987-2007. They find that this evidence almost disappear when they adjust for size whereas any unexplained anomalies are related to market cycles.

4.4.2. Risk explanation

Brown et al. (1988) develop the uncertain information hypothesis which states that both favourable and unfavourable events are followed by significant positive returns. Thus, rational risk-averse investors underreact to the good news and overreact to the bad. Brown et al. (1988) explain these reactions by assuming that in both cases of good and bad news, the investor will face uncertainty and as a consequence higher risks and expect higher returns. They test their hypothesis by examining the behaviour of the CRSP equally weighted index and the behaviour of the 200 largest companies in the S&P 500 over July 1962-December 1985. The time interval examined extends from 1 to 60 days prior to and after the event date. Brown et al. (1988) find evidence in favour of their hypothesis at the market-wide level and individual stock level.

Chan (1988) argues that the estimation of abnormal return is sensitive to the model and the estimation method used. He documents that the betas of winners and losers portfolios are changing over time. Using NYSE stocks, he finds weak evidence of price reversal over a three-year test period. More specifically, Chan (1988) argues

that if returns are adjusted for time-varying risk, no significant abnormal returns will be found.

Consistently, Ball and Kothari (1989) detect a significant negative serial correlation in market-adjusted stock returns over a five-year period. They argue that this negative serial correlation is due to time-varying expected returns which in turn are attributable to the time-varying relative risks. In fact, Ball and Kothari (1989) examine the contrarian strategy of DeBondt and Thaler (1985, 1987), however allowing the expected returns to vary over time and find insignificant abnormal returns over the five-year period. Thus, the evidence of Ball and Kothari (1989) supports the efficient market hypothesis and excludes any market mispricing. The study sample consists of all the stocks on the CRSP which have monthly data for 10 years minimum over the period 1930-1981.

Conrad and Kaul (1998) analyse a variety of trading strategies of NYSE and AMEX stocks over the entire period 1926-1989 and through its sub-periods. More specifically, they study 120 trading strategies with different holding periods ranging from one week to three years. Out of the 120 strategies, Conrad and Kaul (1998) find 55 strategies with significant profits. These 55 strategies consist of 30 momentum and 25 contrarian. The general conclusion that the authors reach is that, usually, the momentum strategies generate positive and significant profits in the medium run (3-12 months). However, the contrarian strategies seem to do so in the long run (up to three years). In an attempt to examine the sources of these profits, Conrad and Kaul (1998) conduct a decomposition analysis which shows that for all strategies the profits are generated by two components. These are the time series

predictability in stock returns and the cross-sectional variation in the mean returns of these stocks. However, Jegadeesh (2002) reexamines the results of Conrad and Kaul (1998) after controlling for sample biases and bootstrap experiments. He finds that cross-sectional differences in expected returns explain very few, if any, momentum profits. In line with the previous studies, Berk et al. (1999) develop a dynamic theoretical model of time-varying systematic risk and conditional expected returns. The model explains the contrarian profits in the short run and the momentum profits at longer horizons.

Wu (2002) uses all the NYSE and AMEX stocks in the period July 1963-December 1995 to construct two extreme momentum portfolios (best short-term winners and worst short-term losers) and two extreme reversal portfolios (best long-term winners and worst long-term losers). He argues that a conditional version of the Fama and French (1993) three-factor model relaxed on linearity assumption and imposed on cross-sectional restrictions can capture the abnormal returns resulting from short-term momentum and long-term reversal.

Repeatedly, Wang (2003) argues that the major part of the momentum profits is due to time-varying risk. He documents that dynamic conditional versions of asset pricing models that allow for time-varying betas and risk premiums do a better job in explaining pricing errors, such as anomalies, than the unconditional static ones. In particular, Wang (2003) finds that a non-parametric conditional version of the Fama and French (1993) three-factor model performs best when challenged by the momentum anomaly. Using NYSE, he reports that winners have 1% monthly

conditional expected returns over the losers. Thus, this difference can account for the major proportion of momentum profits.

Chordia and Shivakumar (2002) suggest common macroeconomic factors as a source of momentum profits in NYSE and AMEX stocks. Particularly, they find that the cross-sectional differences in conditionally expected return predicted by these macroeconomic factors can account for the documented momentum profits. Chordia and Shivakuma (2002) explain their results by arguing that common macroeconomic factors can predict the time-varying expected returns which in turn explain the momentum profits. The macroeconomic factors examined are dividend yield on the market[1], default spread, yield on three month treasury bills and term structure spread.

Recently, using a sample of 6155 companies from the LSE, Li et al. (2008) suggest a new factor that can fully account for the profits of momentum strategies. This factor is the time-varying unsystematic risk modelled by GJR-GARCH (1, 1)-M which accounts for the asymmetric volatility of winners and losers to good and bad news and also for the conditional risk premium. Li et al. (2008) argue that over the period 1975-2001, the three factors of Fama and French (1993) plus the conditional standard deviation term in the mean equation of return can fully explain the momentum profits.

[1]The dividend yield on the market is defined as the total dividend payments accruing to the CRSP value-weighted index over the previous 12 months divided by the current level of the index.

However, some studies suggest that time-varying risk cannot fully explain the documented anomalies. Karolyi and Kho (2004) use bootstrap tests to evaluate the ability of return generating models that allow for time-varying expected returns, factor risks and a range of cross-sectional/time series error structures to generate momentum profits. In particular, they look at simple random walk models and the Fama and French three-factor model, with and without conditioning information variables and allowing for autocorrelated, cross-correlated and conditionally heteroskedastic errors. Moreover, they use different sampling techniques in bootstrap simulations. Karolyi and Kho (2004) find that none of the examined models can fully explain the profits of a six-month momentum strategy of NYSE, AMEX and NASDAQ stocks over the period 1964-2000. Nevertheless, accounting for time-varying expected returns with market-wide and macroeconomic instrumental variables can explain 75–80% of the momentum profits.

Consistently, Lewellen and Nagel (2006) document that neither the unconditional nor the conditional CAPM can explain the momentum profits. They use a different methodology to test the explanatory power of the conditional CAPM. Their test is based on direct estimates of conditional alphas and betas from short-window regressions rather than the specification of conditional information. The test shows that the time variations in betas and equity premium are not large enough to explain the unconditional pricing errors. The empirical evidence assumes six-month momentum strategy of NYSE and AMEX stocks over the period July 1964-June 2001.

Some researchers suggest totally different explanations of the price anomalies in the risk context. Lo and Mackinlay (1990) argue that only a small proportion of the contrarian profits of buying losers and selling winners are due to the overreaction hypothesis. Alternatively, the positive cross-auto covariance across stocks is the main factor that explains the major proportion of these profits. In other words, Lo and Mackinlay (1990) document that, it is the overtime positive cross-autocorrelation between stocks and its lead-lag structure rather than the negative autocorrelation in individual stock returns that explain the price reversals. They give an example of two stocks A and B comprising the market. They argue that if the two stocks are positively cross-autocorrelated, then a high return on A today implies a high return on B tomorrow. Therefore, a contrarian strategy of selling A and buying B will yield a positive return. Lo and Mackinlay (1990) support their argument by an empirical evidence of a sample of NYSE and AMEX stocks over the period June 1962-December 1987.

Sadka (2006) suggests liquidity risk as a plausible explanation of momentum profits. He decomposes liquidity risk in NYSE stocks into two components: permanent (variable) and transitory (fixed). The permanent component is related to the change in stock price associated with information asymmetry. The transitory component is related to the change in stock price associated with inventory and order processing costs. For 1983–2001, Sadka (2006) documents that momentum profits can be viewed as a compensation for the unexpected systematic (market-wide) variations of the variable component rather than the fixed component of liquidity. In other words, the unexpected variations in the aggregate ratio of informed traders to noise traders can explain the momentum profits.

4.4.3. Industry effects

Moskowitz and Grinblatt (1999) suggest industry momentum as a source of the individual stock momentum. They argue that the herding behaviour between investors towards a certain industry could cause price pressures, which in turn could create return continuation. Moskowitz and Grinblatt (1999) study NYSE, AMEX and NASDAQ stocks over 1963-1995. They find that once returns are adjusted for industry effects, momentum profits for individual stocks become mostly insignificant. Moreover, industry portfolios display significant momentum at the intermediate horizon of 6 to 12 months and significant price reversal in the long run. The profits of industry momentum continue to be significant even after controlling for size, book to market equity, individual stock momentum, cross-sectional dispersion in mean returns and potential microstructure influences. Additionally, these industry momentum profits are robust to various specifications and methodologies.

Grundy and Martin (2001) find contrasting results. They document that a short-term momentum strategy yields stable significant profits on NYSE and AMEX stocks over the sub-periods of the 1926-1995 era. Grundy and Martin (2001) demonstrate that none of the three dynamic Fama and French (1996) risks, the industry effects or the cross-sectional variability in stocks' average returns can explain these momentum profits. Thus the main conclusion of the study is that these profits are due to a momentum in the stock-specific components of returns. Consistently, Chordia and Shivakumar (2002) document that industry momentum cannot fully explain individual stock momentum in NYSE and AMEX stocks.

4.4.4. Psychological explanation

Some researchers use a psychological explanation of the documented price anomalies. Daniel et al. (1998) develop a theory that explains both the underreaction and the overreaction from a psychological perspective. They argue that the so-called overconfidence and biased self-attribution phenomena produce a return continuation over the short run and a price reversal in the long run. The overconfidence involves the overestimation of investors of their own beliefs and abilities. The biased self-attribution implies that investor confidence increases largely if public information comes consistent to his/her private information while it falls modestly if public information contradicts it. The Daniel et al. (1998) theory indicates that investors overweigh private information signals while they underweigh public information ones. Thus, when an investor receives a private signal, he/she tends to overweigh that signal, resulting in a return continuation in the short run. However, as soon as public information is disseminated in the market, stock price will gradually be corrected towards its full information value, resulting in a price reversal in the long run.

Barberis et al. (1998) use different psychological concepts to explain the same phenomena. They develop a parsimonious model of investor attitude consistent with the empirical evidence of price reaction. The model incorporates two important psychological concepts: conservatism and representativeness. Barberis et al. (1998, p. 309) define conservatism as "the slow updating of models in the face of new evidence". They argue that because investors are conservative, they tend to keep their own beliefs and react slowly to new information, causing an underreaction. Thus, the latter is a direct manifestation of the investor conservatism. On the other

hand, Barberis et al. (1998) document that the overreaction phenomenon is a product of the investor representativeness heuristic. They define representativeness as "the tendency of experimental subjects to view events as typical or representative of some specific class and to ignore the laws of probability in the process" (p. 308). Barberis et al. (1998) argue that investors may conclude that the past history of a firm is representative of its future performance. Thus, investors believe that a certain trend exists. When it comes to reality, if the history of the firm does not repeat itself then those investors will be disappointed and a price reversal will occur.

Hong and Stein (1999) develop a unified behavioural model that explains both the undereaction and overreaction phenomena. The model is based on the interaction between two types of boundedly rational investors, news watchers and momentum traders. The news watchers are only able to process public information, while momentum traders can do simple forecasts of prices based on past performance. One important assumption of the model is the gradual diffusion of private information across the investing public. Under these assumptions, news watchers will underreact to private information, momentum traders will take advantage of this underreaction with a simple arbitrage strategy creating a return continuation that will eventually end with an overreaction in the long run.

Hong et al. (2000) test the gradual information diffusion model of Hong and Stein (1999). Indeed, they investigate whether stocks with slower information diffusion display higher momentum profits. They use firm size and analyst coverage as proxies of the rate of information flow. The main hypothesis of the study is that small firms and firms with low analyst coverage exhibit slower information

diffusion and consequently more pronounced momentum. Using NYSE, AMEX and NASDAQ stocks, Hong et al. (2000) provide evidence in favour of their hypothesis over 1980-1996. The evidence is much stronger for losers than winners. As a robustness check, Hong et al. (2000) show that the analyst coverage is not a proxy of transaction cost when the latter is measured by turnover rate or the existence of listed options for the stock.

4.4.5. Microstructure effects

A number of studies suggest that when returns are adjusted for microstructure effects, abnormal profits disappear. Atkins and Dyi (1990) argue that markets are efficient when transaction cost is taken into consideration. They study all the stocks listed on the NYSE for the period 1975-1984. Atkins and Dyi (1990) analyse the price reaction after a large one-day price change. They find a significant overreaction up to 10 days following the event day. However, the magnitude of the resulting overreaction profits is small compared with the bid-ask spread.

Consistently, Cox and Peterson (1994) examine stock returns' behaviour after a one-day price decline of 10% or more. They sample all NYSE, AMEX and NMs stocks over January 1963-June 1991. They find significant price reversals up to three days following the decline. However, these reversals diminish over time and disappear entirely after October 1987. More importantly, Cox and Peterson (1994) report that bid-ask spread bounce and market liquidity explain price reversals. Thus, after controlling for spread bonuses, there are no reversals. Similarly, given the gradual improvement in market liquidity, price reversals have disappeared over time. At a longer term, subsequent to three days after the decline and extending to 20 days,

stocks seem to have negative abnormal returns. This finding is inconsistent with the overreaction hypothesis documented by other authors.

Park (1995) argues that the studies which have used closing transaction prices suffer from a sample selection bias due to bid-ask bounce. He examines the behaviour of NASDAQ stock prices after a large one-day price change, using the average of the bid- and ask- prices. Park (1995) finds that avoiding the bid-ask bonus eliminates the price reversal in day +1. However, the price reversal persists in the days following day +1. More importantly, Park (1995) documents that the profits from a contrarian strategy do not cover the transaction price movement between the bid- and ask-prices.

The studies that examine momentum rather than contrarian strategies also find that transaction cost can explain the abnormal returns. Lesmond et al. (2004) argue that the profits of momentum strategies do not exceed the trading costs of momentum portfolios. Indeed, they sort stocks according to size, turnover and transaction cost and find that the portfolios which yield significant momentum profits consist of small and illiquid stocks with high trading costs. The analysis of Lesmond et al. (2004) focuses on a six-month holding momentum portfolio for the CRSP stocks over the period January 1980-December 1998.

Ali and Trombley (2006) argue that short sale constraints explain the momentum profits of NYSE, AMEX and NASDAQ stocks. In fact, they document a positive relationship between the magnitude of momentum profits and short sale constraints

over the period 1984-2001. Additionally, they demonstrate that loser stocks rather than winner stocks do impel these results.

Lately, Li et al. (2008) document that once actual transaction costs are taken into consideration, momentum profits disappear. They study momentum in the UK market over a 20-year period, December 1985-December 2005. Specifically, Li et al. (2008) find that when commissions, short selling costs and stamp duties are added, the average round-trip transaction cost based on the quoted spread rises to 3.77% for winners and 6.71% for losers. Trading losers is found to be more expensive than trading winners. The reason behind the latter result is that it cost more to sell losers with low market capitalisation and low trading volume. Li et al. (2008) define a new low-cost momentum strategy that yields significant profits. It is based on shortlisting from all winner and loser stocks those with the lowest total transaction costs.

In contrast, some studies find significant momentum profits even after controlling for transaction cost. Korajczyk and Sadka (2004) investigate whether trading costs including quoted spread, effective spread and price impact costs can explain momentum profits. Their sample consists of all the US stocks with monthly data over the period 1967-1999 in the CRSP. The main finding of the study is that although trading costs can reduce the profits of momentum strategies, that cannot fully explain these profits.

Consistently, Hanna and Ready (2005) look into the stocks in the Russell 3000 index over the period 1979-2001. They argue that momentum portfolios have high monthly turnover exceeding 40% and thus high transaction costs. However, the

momentum strategies designed to reduce turnover by maintaining positions for six months yield significant positive returns after transaction costs.

4.4.6. Methodological bias

Several studies attribute the documented price anomalies to methodological problems such as data snooping and survivorship bias. Conrad and Kaul (1993) argue that the long-term contrarian strategies of DeBondt and Thaler (1985) suffer from a methodological drawback which could spuriously inflate their profitability. They examine a sample of NYSE firms over the 1926 to 1988 period. They show that measurement errors in observed prices due to bid-ask errors, non-synchronous trading, and/or price discreteness, lead to substantial spurious returns to the long-term zero-investment contrarian strategies because single-period returns are upwardly biased (see Blume and Stambaugh (1983)). By cumulating short-term returns over long periods, these strategies cumulate not only the "true" short-term returns but also the upward bias in each of the single-period returns.

Consistently, Ball et al. (1995) question the empirical findings of DeBondt and Thaler (1985, 1987), Chan (1988), Ball and Kothari (1989), Chopra et al. (1992) and Jones (1993). They argue that their contrarian portfolios suffer from measurement problems in their raw and abnormal returns. One major problem is that most of the contrarian profits are generated by low-priced loser stocks which display skewed return distributions and are highly sensitive to mispricing and microstructure effects. The low prices have a tendency to group in a very few years following bear markets. Consequently, the DeBondt and Thaler (1985, 1987) research design is entwined with problems in specifying expected returns for low-priced stocks in particular

market settings. Another problem is that allowing for time-varying beta limits the evidence of significant price reversals.

On the other hand, Ince and Porter (2006) argue that the documented momentum effect is due to the problems of using Thomson Datastream (TDS). They compare individual equity return data from TDS for the US equity market to the source most frequently used by academics, the Center for Research in Security Prices (CRSP) for the period 1975-2002. Their comparison reveals several problems with using TDS data for research regarding issues of coverage, classification, and data integrity. Specifically, they find that naive use of TDS data can have a large impact on economic inferences, particularly earlier in the period of coverage and among smaller stocks. Ince and Porter (2006) argue that winners and losers will be concentrated in smaller stocks since small stocks tend to have higher variance; therefore data problems with calculating returns of small stocks will likely show up in momentum portfolio returns.

Finally, Andrikopoulos et al. (2007) argue that the two mainly used databases in UK research, TDS and London Share Price Database (LSPD), suffer from problems such as survivorship, content and accuracy bias. In fact, they compare these two databases to a new UK equity database (UKED) which they have constructed by a careful selection of publically available accounting and financial data for UK listed securities. Andrikopoulos et al. (2007) find a survivorship bias that is mostly concentrated in foreign stocks listed in UK and small stocks included in the dead stock file of TDS. They argue that such a bias can lead to problems in the measurement of the profitability for all investment strategies that use accounting

data for classification purposes. Thus, a potential overestimation or underestimation of the returns of these strategies can result from the survivorship bias. On the other hand, they find important problems of coverage in accounting items and issues of data integrity in the estimation of securities' returns of LSPD.

4.5. International evidence on price anomalies

The evidence of price reversal and momentum is not country-specific but is a worldwide phenomenon. Many studies examine both price anomalies in different markets from the US one. Alonso and Rubio (1990) present evidence supporting the overreaction hypothesis from the Spanish capital market. Particularly, they report that, over a twelve-month test period, losers outperform winners by 24.5%. Their study covers the period 1967-1984. Alonso and Rubio (1990) demonstrate that the overreaction in the Spanish market is an independent phenomenon and it exists even after controlling for size and seasonality effects.

Da Costa (1994) provides other evidence in favour of the overreaction hypothesis from the Brazilian stock market over the period 1970-1989. He documents significant price reversals of winner and loser portfolios over one year and two years after the portfolio formation. He also illustrates a higher magnitude of overreaction in the Brazilian stock market than in the US market. Additionally, he argues that the overreaction effect is robust to the time-varying risk as measured by CAPM beta.

Gunaratne and Yonesawa (1997) examine the overreaction hypothesis in Tokyo Stock Exchange over 1955-1990. They find that, based on the last four years' performance, past losers outperform past winners by 11% annually. These results

are robust to the risk adjustments. Gunaratne and Yonesawa (1997) also point out that the documented overreaction is an independent phenomenon not generated by seasonal effects.

Qiang and Ping (2007) investigate momentum and contrarian strategies using winner and loser portfolios in China's stock market. They assume different strategies with different holding periods starting from 3 up to 36 months. Qiang and Ping (2007) find no momentum profits over the period 1994-2004. However, contrarian strategies are found to yield profits over the 18-36 month holding periods.

Drew et al. (2007) examine the intermediate-horizon momentum strategies in the Australian Stock Exchange. They find large momentum effects over the period June 1988-May 2002. Moreover, momentum profits are found to reverse in a slower manner if compared to the US. Hence, while momentum reverses after one year on average in the US, the reversal takes three to four years in the Australian market. Drew et al. (2007) use Lee and Swaminathan's (2000) approach to analyse the momentum-volume relationship. In agreement with Lee and Swaminathan's (2000) study, they find more pronounced momentum effects among high volume stocks when momentum portfolios are based on past three and six month returns. However, for portfolios based on past 9 and 12-month returns, the findings are opposite, that is, momentum premium is higher for low-volume firms.

Some studies focus on a multi-country setting. Rouwenhorst (1998a) examines medium-term momentum strategies within and across 12 European markets. His individual stock-based analysis covers 2190 stocks over the period 1987-1995.

Rouwenhorst (1998a) finds that in all the 12 countries, significant momentum profits can be achieved for up to one year. Moreover, at the international level, a well diversified winner portfolio outperforms a loser portfolio by 1% a month. Rouwenhorst (1998a) argues that the size factor cannot explain these momentum profits, however a common international factor may drive them.

As a part of his analysis to the factors that generate the cross-sectional differences in expected returns in emerging markets, Rouwenhorst (1998b) documents that past winners outperform past losers in 17 out of 20 emerging markets, using a 6-month momentum strategy. One additional result of the study is that stocks with high beta, small market cap, high past medium-term return or high book-to-market ratio have higher average turnover than stocks with low beta, large market cap, poor past performance or low book-to-market ratio.

Chan et al. (2000) investigate momentum strategies executed on market indices of 23 countries around the world. They long winner countries and short loser countries over five holding periods of 1, 2, 4, 12 and 26 weeks. Chan et al. (2000) find that the momentum strategies yield significant profits, especially for the holding periods of 1 and 2 weeks. Furthermore, they document that neither non-synchronous trading nor risk beta can fully explain the momentum profits. One important result is that the indices which experienced a high trading volume display higher momentum profits.

Finally, Griffin et al. (2003) examine momentum strategies in 40 countries around the world. These strategies include buying winners and selling losers over different holding periods ranging from 1 to 12 months. The main objective of the study is to

explore any relationship between momentum profits and macroeconomic risk. Highly significant momentum profits are found in most of the countries studied. Asian markets show weaker evidence of momentum than European and African. Consistently, momentum strategies are less profitable in emerging markets compared to developed markets. One more important result of the study is that no relationship exists between momentum profits and the macroeconomic factors proposed by Chen et al. (1986). Thus, macroeconomic risk cannot account for the profits of momentum strategies.

4.6. UK evidence on price anomalies

Since this thesis focuses on the LSE, we choose to review the UK evidence of price anomalies in a separate section. Power et al. (1991) investigate the overreaction hypothesis in the UK market over the period 1973-1987. They find that both losers and winners exhibit significant price reversals continuing to five years after the portfolio formation. Indeed, Power et al. (1991) argue that the return regularities coincide with changes in the growth rates and profitability ratios of the winner and loser stocks. Moreover, they document that the contrarian profits exist even after controlling for changes in market risk. Therefore, they go for the psychological explanation to defend their results.

Clare and Thomas (1995) ascribe the overreaction phenomenon in the UK market to the size effect. They investigate 1000 randomly chosen stocks over the period 1955-1990 and find that losers significantly outperform winners by 1.7% annually over a testing period of two years. However, the most important conclusion of the study is

that the overreaction is nothing other than a size-related phenomenon. Thus, losers tend to be small firms that outperform other large ones.

Campbell and Limmack (1997) attribute the price reversals in the UK to the seasonality effects. They examine the behaviour of winner and loser portfolios in the UK market over the period January 1979-December 1990. They find significant return continuation over a 12-month period for both winners and losers. However, price reversals are found in the long run of 2-5 years. In an attempt to explain these anomalies, Campbell and Limmack (1997) match portfolios with similar size and find that the overreaction is not a demonstration of the documented size-effect. Though the price reversal anomaly is found to be a seasonal phenomenon that happens mostly in January and April, representing the tax-loss selling hypothesis.

In contrast, Dissanaike (1997) submits robust evidence in favour of the overreaction hypothesis in the UK market. His sample consists of large, well-known and frequently traded companies. In fact, he constructs his own FTSE500 index and uses its constituents. The sample is selected deliberately in order to avoid any bias that could result from bid-ask bonus or infrequent trading. Moreover, examining large companies rules out the possibility that overreaction could be a size-related phenomenon. Dissanaike (1997) constructs winner and loser portfolios with testing periods of up to 4 years. The results support the overreaction hypothesis. Thus, contrarian strategies yield significant profits even after controlling for time-varying risk.

Dissanaike (1999) replicates his study of the year 1997 over the same data set but using a different methodology. He uses Fama and Macbeth (1973) cross-section regressions instead of examining the behaviour of winner and loser portfolios. The explanatory variables in such regressions are the returns four years before the formation date and the dependent variables are those following that date. Dissanaike (1999) argues that this testing approach complements the portfolio approach. However, it has an advantage in that it applies to all the sample firms rather than the extreme losers and winners only. Dissanaike (1999) finds consistent results using the regression tests. Indeed, he finds significant price reversals in the UK market and these reversals continue to exist even after controlling for the time-varying risk.

Recently, Mazouz and Li (2007) find other evidence supporting the overreaction hypothesis in the UK market over the period 1973-2002. They report that losers outperform winners by about 16.4%, using cumulative abnormal returns (CAR) and 18.3%, using buy-and-hold returns (BHR), 36 months after portfolio formation. Furthermore, Mazouz and Li (2007) argue that the overreaction is not a seasonal phenomenon and it exists even after controlling for the size effect and the time-varying nature of risk.

On the other side of the coin, Liu et al. (1999) study medium-term momentum strategies of 4182 UK stocks in January 1977-June 1998. They investigate 16 momentum strategies with holding periods of 3, 6, 9 and 12 months. Their analysis shows significant momentum profits that are robust to sub-periods, seasonal effects and return adjustments. Moreover, Liu et al. (1999) argue that none of size, stock price, book-to-market ratio or cash earnings-to-price ratio can explain these

momentum profits. Thus, they conclude that momentum is an independent phenomenon that confirms the weak form market inefficiency.

Consistently, Ellis and Thomas (2004) examine medium-term return continuation in the UK market. They sample stocks from the FTSE350 over the period 1990-2003. Ellis and Thomas (2004) find that momentum strategies achieve significant profits of about 1.4% per month. Upon analysing the alternative explanations of these profits, Ellis and Thomas (2004) document that neither transaction cost nor holding risk can account for them. Moreover, momentum profits are found to be higher for the stocks that had higher trading volume during the formation period.

4.7. Summary and conclusions

Fama (1970) states that markets are efficient, in the sense that the market price is a fair estimate of the underlying asset value. Thus, any new information is disseminated and reflected in the prices instantly. However, recent research finds that security prices could deviate from their equilibrium values. Two competing hypotheses are put forward against the efficient market hypothesis. These hypotheses are the overreaction hypothesis proposed by DeBondt and Thaler (1985) and the underreaction hypothesis documented by Jegadeesh and Titman (1993). While the overreaction hypothesis indicates price reversals of the past winner and loser stocks over the long run, the underreaction hypothesis implies return continuation for past winners and losers over the short run. Both hypotheses represent return puzzles that extensive research has examined. Some researchers stress psychological and behavioural elements of stock price determination (Barberis et al., 1998; Daniel et al., 1998; Hong and Stein, 1999). Others stick to the efficient market hypothesis and argue that the price anomalies represent pricing errors

resulting from the failure to account for the time-varying nature of risk and return (Chan, 1988; Ball and Kothari, 1989; Wu, 2002; Wang, 2003). Atkins and Dyi (1990), Cox and Peterson (1994) and Li et al. (2008) assert that transaction cost could explain the documented abnormal returns. Zarowin (1990) relates the price reversal anomaly to the size anomaly. Moskowitz and Grinblatt (1999) claim that investors might herd towards a certain industry, causing a return continuation. Regardless of the competing explanations of momentum and price reversal, these two phenomena are found in different financial markets around the world (see, for example, Alonso and Rubio, 1990; Da Costa, 1994; Rouwenhorst, 1998a,b; Griffin, et al., 2003; Qiang and Ping, 2007). Consistently, the UK evidence indicates that momentum and price reversal are independent phenomena that question the efficient market hypothesis (see, among others, Power et al., 1991; Clare and Thomas, 1995; Dissanaike, 1997, 1999; Liu et al., 1999; Ellis and Thomas, 2004).

We have now completed the literature review part of this thesis. The next three chapters present our empirical work. Chapter 5 studies the role of systematic liquidity risk in asset pricing using data from the UK. Chapter 6 links between systematic liquidity risk and price anomalies following large one-day price changes. Finally, Chapter 7 investigates whether short-term price reversal and momentum can be explained by allowing the systematic risk factors to vary over time.