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# Adaptive Market Efficiency: Review of Recent Empirical Evidence on the Persistence of Stock Market Anomalies

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**ABSTRACT**

The field of Finance has undergone an interesting transformation. In the 1970s, Eugene Fama developed conceptual stages of market efficiency (Fama, 1970), that all information is generally incorporated in stock prices. Robert Shiller shows that stock prices are too volatile to be explained by new information alone (Shiller, 1981). The 1980s and 1990s yield a variety of anomalies, which are systematically predictable security price patterns that are exploitable through investment strategies. This paper discusses some of the most popular anomalies:The day-of-the-week effect(French, 1980; Haugan and Lakonishok, 1988; andReinganum, 1983), the January effect (Roll, 1983), the value effect(Basu, 1977; Stattman, 1980; and Rosenberg, Reid, and Lanstein, 1985), the size effect(Fama and MacBeth, 1973;Banz, 1981; andHawawini and Keim, 1995), and the momentum effect (Jegadeesh and Titman, 1993).
Daniel and Titman (1999) and later Lo (2004) suggest that investors behave in line with the adaptive-efficient market hypothesis that once inefficiency is detected and investors are aware of profitable trading opportunities, anomalies should disappear and subsequently, prices return to their efficient values.
This paper summarizes the aforementioned anomalies, and discusses recent empirical research thereof. Some anomalies (day-of-the-week, January, and size effect) seem to disappear over time, whereas others (value and momentum effects) do not. In this context, the role of adaptive efficiency and transaction cost are discussed. This paper aims to help graduate students and interested readers to gain a better understanding of stock market efficiency and anomalies over time.

## 1. Introduction

Over the past decades, the field of Finance has undergone an interesting evolution. The 1970s were dominated by Eugene Fama'sfamous work on market efficiency (Fama, 1970), that all information is generally incorporated into stock prices, which are therefore not predictable. Consequently, arbitrageurs will not earn profits by exploiting foreseeable security price patterns. In the 1980s however, Robert Shiller shows that stock prices are too volatile to be explained by new information alone (Shiller, 1981).


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Throughout the 1980s and 1990s, many scholars produce a broad variety of stock price anomalies[1]. Anomalies are systematically predictable security price patterns that are exploitable through investment strategies.

Nevertheless, French (1980), Haugan and Lakonishok (1988), Reinganum (1983), and Roll (1983) find calendric security price patterns, Ball (1978), Basu (1977), Fama and French (1992, 1993) Rosenberg et al. (1985), and Stattman (1980) find that stocks with high book-to-market and price-to-earnings ratio perform above average. Banz (1981), Fama nad MacBeth (1973), and Keim (1983) report that firms with small market capitalization tend to perform particularly well. Jegadeesh and Titman (1993) find that stocks that have performed well in the past year tend to perform well in the subsequent one, and vice versa.

Roll (1983) calls the possibility of time-persistent anomalies absurd, as smart investors acting as arbitrageurs, must detect and exploit mispricing. Consequently those effects should disappear. French (1980) notes that temporary existence of "anomalies" is not an actual violation of the efficient market hypothesis, as investors are unable to anticipate systematic mispricing and fail to generate profits. That is, investors are not aware of arbitrage opportunities prior academic publication, and vast extinction of anomalies prohibits significant economic profit thereafter. Following the same spirit, Daniel and Titman (1999)argue that markets are *adaptively efficient*, if security price patterns disappear subsequently to their discovery.

Lo (2004) provides a similar definition of *adaptive efficiency*, that anomalies can persist, but underlie cyclical variations, which are due to changes in investment styles, trends, and investor behavior.

Limits to arbitrage play a central role in the persistence of mispricing. Shleifer and Vishny (1997) argue that fund managers may avoid highly volatile stocks due to short evaluation periods of their investment performance, which may impede price correction. Jensen (1978) and Malkiel (2003) argue that price deviation from fundamental values that does not exceed trading cost cannot be exploited.

Certain anomalies (day-of-the-week, January, and size effect) seem to become extinct over time, whereas others (value and momentum effects) do not. The following section reviews the aforementioned anomalies in greater detail; part three outlines the concept of adaptive efficiency and summarizes the persistence of the selected anomalies over time. Part four concludes.

[1] See Schwert (2003)and Malkiel (2003)for a good review of anomalies and market efficiency.


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## 2. Selected Anomalies

This section summarizes literature reporting calendar, size, value, and momentum effects.

### 2.1. Calendar Effects

During the 1980, many seasonal patterns in stock price movements were discovered. French (1980) finds unusually negative stock returns on Mondays and after holidays[2] for the 500 largest firms listed at the NYSE between 1953 and 1977. He suggests that firms might use trading breaks as a buffer or information "cool down" in order to avoid sharp declines in stock prices after releasing negative news. Similarly, H.Hong, Lim, and Stein (2000) suggest that bad news is typically released slowly. French (1980) further points out that the discovered effect is not a serious violation of the efficient market hypothesis, as investors are not able to anticipate the mispricing and therefore are not given a real opportunity to apply investment strategies.

In a similar fashion, Haugan and Lakonishok (1988) find abnormally high stock returns in January, predominantly for small firms. Reinganum (1983) points out that early January returns are particularly high for small firms whose stocks declined in December. Analogously, Roll (1983) finds high January returns for small firms and provides a possible explanation for the January effect. That is, firms might realize capital loss before the end of the fiscal year in order to report lower taxable income.[3]

Thaler (1987) notes that the tax-loss-selling hypothesis is legitimate, as other scholars[4] find similar effects in countries that end the fiscal year in months different from December, but fails to explain the effect entirely.

Reinganum (1983) finds high early January returns for securities that did not experience declines in December and suggests that the January effect cannot exclusively be explained with the tax-loss-selling hypothesis.

### 2.2. Size Effect

Fama and MacBeth (1973)and Banz(1981) find higher risk-adjusted returns for firms with smaller market capitalization in the United States.Hawawini and Keim (1995) find evidence for a size effect in European markets and in Japan. Malkiel (2003) reviews empirical findings of the size effect, that smaller firms yield higher returns without increasing the stocks' betas(Fama and French, 1993; Keim, 1983). Fama and French (1993) however, argue that from 1963 to 1990, the beta-return relationship was flat and not positive, as proposed by CAPM (Merton, 1973) and thus may not be an appropriate measure for risk.

Basu (1983) suggests that both, the E/P and the size effect might rather be due to un-captured risk, and not actual market inefficiencies. In fact, Fama and French (1993)

[2] Similarly, Ariel (1990) finds high returns before holidays.

[3] Lakonishok and Smidt (1988) find similar patterns at the end oft the month.

[4] For Canada: Berges, McConnell, and Schlarbaum (1984), for Japan: Kato and Schallheim (1985).Jegadeesh (1991) reports mean reversion in Januaries in the United States and the United Kingdom.


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suggest that firm size on its own might be a superior measure of risk. Malkiel (2003) adds that throughout the 1990s, at least for most markets, large cap stocks earned higher returns. That might be due to higher liquidity of large cap stocks, which is more attractive to portfolio managers. Similarly, Roll (1981) notes that small stocks are traded less frequently, which results in downward biased risk estimates.

### 2.3. Value Effect

The concept of value investing is simple. As early as 1934, Benjamin Graham describes the principle of buying "cheap" stocks; those securities that have high intrinsic value (Graham, 2009). For instance, stocks with high low earnings-to-price ratio, book-to-market ratio can be considered value stocks. Basu (1977) finds positive abnormal returns for stocks with high earnings-price ratios relative to CAPM.

Reinganum (1981) suggests that when controlling for firm size, earnings-to-price ratio effects tend to disappear. Stattman (1980) and Rosenberg, Reid, and Lanstein (1985)find that stocks with high book-to-market equity ratios have high average returns which are not captured through high betas. Fama and French (1992, 1993) argue in a similar fashion that a stock's beta does not explain the cross sectional variation of average stock returns. Ball (1978) argues that abnormal returns, such as the earnings-price effect, are due to poor risk measures of the CAPM, not due to market violations.

Bauman, Conover, and Miller (1999) investigate 21 international stock markets and report that value stocks tend to outperform growth stocks. Growth stocks commonly have low book-to-market ratios, as investors anticipate high future growth in dividend payments on earnings. Bauman et al. (1999) suggest that investors tend to overreact to past growth rates and project them into the future, causing overvaluation of growth stocks.

### 2.4. Momentum Effect

Momentum strategies have long been investigated. In contrast to DeBondt and Thaler's (1985, 1987) overreaction hypothesis, stocks that performed well in the past 1-12 months tend to perform well in the subsequent period (Chan, Jegadeesh, and Lakonishok, 1996; Jegadeesh and Titman, 1993).In contrast, stocks that have performed particularly poor over the past three to twelve months tend to perform poor in the respective subsequent time period.

Jegadeesh and Titman (1993) and (Chan et al., 1996) argue that returns of the strategy are not due to systematic risk, but rather delayed investor reaction to firm-specific information. Subsequently, prices will adjust gradually, and investors who apply this strategy will strategy will move stock prices above their fundamental value, causing a delayed overreaction in the spirit of DeBondt and Thaler (1985, 1987).

## 3. Adaptive Efficiency

Lo (2004) develops an adaptive efficient market hypothesis that postulates the coexistence of efficient markets and temporary deviations due to behavioral biases. He uses first-order autocorrelation coefficients for monthly S&P 500 returns as a measure for


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market efficiency and finds that the degree of market efficiency follows cyclical variations. As a result, he suggests that market conditions are constantly changing, thus follow an evolution where market participants[5] compete for resources, uncover arbitrage opportunities, exploit them, and adjust their risk perception[6].

In a more simple version of adaptive efficiency, Daniel and Titman (1999) test whether their profitable trading strategy, which buys (sells) high (low) book-to-market/high (low) momentum portfolios, disappears over time. They find continual returns of their trading strategy, which, consistently with Lo's (2004) interpretation of adaptive efficiency, follows cyclical variations. Similarly, Barberis and Shleifer (2003) develop a model of style-investing, that due to raise and decline of the popularity of investment styles, the profitability thereof varies over time. They argue that investors categorize securities into asset classes, such as value stocks, momentum stocks, large-cap stocks, et cetera, which are then used in the portfolio allocation process. This causes securities of the same category to be under- or overvalued simultaneously, resulting in time-varying profitability of investment styles. Thus, profitability of styles can disappear, but also reoccur if an investment style is not exploited due to prior arbitrage.

Miller (1999) states that besides other anomalies, momentum should disappear over time, as all abnormal profit follows economic principles. Agents who are aware of such profits will compete to exploit them, which eventually causes their disappearance. Daniel and Titman (1999) argue that this is only possible if a substantial number of investors are aware of mispricing. Furthermore, if rational investors are aware of systematic mispricing, but overestimate the efficiency of the market as self-regulatory, they might fail to apply exploiting strategies causing the anomaly to persist. The following sections summarize recent empirical evidence on the persistence of the discussed anomalies.

### 3.1. Calendar Effects

Roll (1983) calls the January effect “absurd”, as investors necessarily must anticipate this effect in order to earn arbitrage profits and therefore it should disappear over time. Thaler (1987) suggests, similarly to Malkiel (2003) and Jensen (1978), that transaction costs limit possibilities to exploit these anomalies. Malkiel (2003) also suggest that transaction costs challenge exploitation of other seasonal patterns, such as

[5]Lo (2004) further argues that investors do not behave identically over their career. For instance, risk perception and risk appetite might vary. Menkhoff, Schmidt, and Brozynski (2006) provide supportive evidence: They find in a series of experimental studies, that more experienced investors tend to be less overconfident, are less prone to herding behavior, and more risk averse than their less experienced colleagues.

[6] According to Lo (2004), the population of market participants is not homogeneous over time. He mentions that at least some investors might exit the market after bearish periods; others will adjust their risk perception. Thus, investors who never experienced genuinely bearish markets might have a different risk perception. Veronesi (1999) suggests that investors react to contrary information stronger in good times and less in bad times and argues that investors incorporate information into stock prices context-dependent.


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the holiday effect (Ariel, 1990) or the end-of-the-month effect (Lakonishok and Smidt, 1988).

Some seasonal patterns tend to disappear over time. Agrawal and Tandon (1994) find that the day-of-the-week effect and the turn-of-the-month effect disappear in the 1980s. Schwert (2003) suggests a significantly lower turn-of-the-year effect after its discovery but persistence thereafter, and disappearance of the weekend effect after initial reporting of its existence. Alt, Fortin, and Weinberger (2011) provide more recent evidence that the effect vanished in the 1990s and 200s in the United States, the United Kingdom, and Germany.

Thus, calendar effects seem to disappear over time, as investors began to exploit the pattern subsequent its discovery. In the spirit of Daniel and Titman (1999), the extinction of calendar effects appear to be anappropriate case of adaptive efficiency.

### 3.2. Size Effect

Schwert (2003) suggests that the size effect largely disappeared after first publication of respective papers that discovered it and suggests that this might be due to exploitation by investment strategies. In line with this argument, Van Dijk (2011) provides a summary of empirical evidence that the size effect essentiallyvanishes during the 1980s.

Malkiel (2003) remarks the *survivorship bias*as a possible explanation of the phenomenon, as most current databases disregard capturing small firms that went bankrupt in the past, and therefore are biased towards more successful small firms that have not failed over time.

In addition, Schwert (1983) suggests that transaction costs are relatively higher for smaller firms, which diminishes profitability of strategies exploiting the effect. Stoll and Whaley (1983) and Schultz (1983)suggest that high transaction costs for small capitalization firms challenge profitability of strategies exploiting the size effect. Schultz (1983) shows, however, that transaction costs alone cannot justify high returns of small firms, as average returns exceed transaction costs for one-year portfolio holding periods significantly.

Similarly with the calendar effects, the size effect anomaly appears to behave adaptively efficient, as it disappears subsequent its discovery.

### 3.3. Value Effect

Asness, Moskowitz, and Pedersen (2013)and Fama and French (2012)find strong supporting evidence of the persistence of abnormal value returns over time. Asness et al. (2013)not only report persistent value effects in security prices, but also in various asset classes, including individual stocks in the United States, the United Kingdom, Europe, and Japan, country equity index funds, government bonds, currencies, and commodity futures[7].

[7] Within the test period (1972-2011), value strategies produce average annual abnormal return of 3.7% in the United States, 4.5% in the United Kingdom, 4.8% on European


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Novy-Marx (2013) finds that controlling for profitability immensely increases the profitability of value strategies and introduces an alternative: The profitability strategy. Value strategies aim to long inexpensive and short expensive securities. In a similar spirit, profitability strategies long securities of productive and short securities of firms with unproductive assets.Novy-Marx (2013) reports that a combined value-profitability strategy increases profitability and reduces portfolio volatility. Thus, the value anomaly seems not to disappear over time and thus not follow the spirit of adaptive efficiency (Daniel and Titman, 1999).

### 3.4. Momentum Effect

Chabot, Ghysels, and Jagannathan (2009) test if momentum profits disappear over time. They argue that it is plausible that momentum exists, as investors do not systematically exploit mispricing due to lack of awareness thereof. They report however, that momentum returns are in fact *higher* subsequent to the rise of momentum literature in the early 1990s. Similarly, among others, Asness et al. (2013), Daniel and Moskowitz (2013), Fama and French (2012), H. Hong et al. (2000), H. Hong and Stein (1999), Lee and Swaminathan (2000), and Moskowitz, Ooi, and Pedersen (2012) produce strong evidence of momentum in various asset classes subsequent to the publication of popular momentum literature. This suggests that the classical mechanism, that arbitrageurs diminish the mispricing and cause the effect to extinct, does not yet apply in the case of momentum and the effect does not underlie principles of adaptive efficiency.

## 4. Conclusion

The basic assumption of capital markets being efficient is subject to much criticism. Many scholars attempt to reject the hypothesis that asset prices follow a random walk and claim partial price predictability. As a result, various trading strategies were developed to demonstrate patterns in asset prices. French (1980) finds systematically negative stock returns on Mondays. Haugan and Lakonishok (1988), Reinganum (1983) and Roll (1983) find high returns in Januaries; Ariel (1990) finds patterns in stock prices after holidays and at the end of a month. Basu (1977) finds positive abnormal return for firms with a high earning-price ratio, and Rosenberg et al. (1985) find positive abnormal return for stocks of firms with high book-to-market value relative to CAPM. These findings raise various questions: Are these anomalies in fact violations of the efficient capital market hypotheses, statistical artifacts, or due to data snooping? If the violations are indeed real, will they persist over time?

Some scholars almost petulantly argue that systematic mispricing cannot persist over time, as it violates basic economic assumptions: i) Agents are fully rational; and ii) Agents maximize utility. Kahneman and Thaler (2006) suggest that neither is true. Agents do not always behave fully rational; neither do they always maximize utility in an economical sense. Among many others, Johnson and Tversky (1983), Kahneman and Frederick (2002), Kahneman, Knetsch, and Thaler (1986, 1991), Kahneman, Slovic, and

stocks, 12% in Japan, and 4.8% on global stocks. Country indices yield 6% value profits, currencies 3.3%, and Commodities 6.3%.


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Tversky (1982), Kahneman and Thaler (2006), Kahneman and Tversky (1974, 1979), Kahneman (2011), and Tversky and Kahneman (1992, 1974) have shown that individuals – either individually or collectively – not always behave rationally, particularly in risky situations, and thus might influence market outcomes.

Roll (1983) calls the possibility of persistent mispricing absurd, as they should immediately be arbitraged away by rational investors. Schwert (2003) finds that indeed, many anomalies tend to disappear over time, particularly after their discovery and publication in academic literature. French (1980) argues that if mispricing exists for the reason that arbitrageurs are unaware of those (e.g., before publication), markets can hardly be called inefficient, as nobody is able to exploit mispricing and earn profit.

Despite the notion of lack of awareness, many other factors might prevent asset prices to return to their fundamental values. Shleifer and Vishny (1997) argue that some investors might avoid stocks with high volatility, Barberis and Thaler (2003) and Jensen (1978) suggest that transaction cost can diminish the profitability of exploiting strategies, especially if those are transaction intensive.

Shleifer (2003) notes that noise trader risk might prevent rational agents from correcting prices. That is, too many investors with false beliefs might push security prices further away from their fundamental value. Chordia et al. (2008) argue that inefficient markets are difficult to correct if liquidity is low. Jones and Lamont (2002) and Stambaugh, Yu, and Yuan (2012) note that short-selling constraints hinder price correction.

Given the possibility of profitable exploitation, anomalies should disappear over time and then markets are at least *adaptively efficient* (Daniel and Titman, 1999; Lo, 2004). Schwert (2003) tests this hypothesis, and finds that most anomalies tend to disappear or at least decrease in magnitude after their discovery. Interestingly, momentum returns did not diminish after their first discovery in the early 1990s[8]. Some models have been developed to understand this phenomenon. Barberis et al. (1998) and Daniel et al. (1998) suggest behavioral biases to be responsible for this phenomenon, while H. Hong and Stein (1999) propose a model of delayed information diffusion. However, the literature lacks of strong evidence that would justify a single superior model.

Simultaneously, many convincing approaches have been undertaken to explain stock price anomalies with intertemporal variations of risk[9]. Are stock market anomalies an illusion after all, an artifact due to inappropriate measurement of risk?

The debate, if capital markets are efficient and all prices are incorporated into stock prices in the sense of the efficient capital markets hypotheses is ongoing. Why do some anomalies disappear over time, while others don't? Why do markets at least sometimes fail to correct themselves? The debate seems to yield much ground for future research in the field of Finance to shed light on these questions.

[8] See, for example: Moskowitz, Ooi, and Pedersen (2012) or Daniel and Moskowitz (2013)

[9] See, for example: Bergbrant and Kelly (2013) and Maio and Santa-Clara (2011, 2012, 2013)


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