MASTER THESIS

The Efficient Market Hypothesis and its Validity in Today's Markets

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Content

Table of Abbreviations

The following abbreviations are used throughout the text:

AMEX .... The American Exchange.
APT .... The Arbitrage Pricing Theory of Ross (1976).
ATX .... The Austrian Traded Index.
C/P ratio .... Cash flow to price ratio.
CAPM .... The Capital Asset Pricing Model of Sharpe (1964), Lintner (1965) and Mossin (1966).
CRSP .... The Center for Research in Security Prices.
DAX .... The index of 30 large German stocks ("Deutscher Aktienindex" in German).
DM .... The currency of the Federal Republic of Germany prior to its adoption of the Euro in 2002, the German Mark ("Deutsche Mark").
E/P ratio .... Earnings to price ratio.
E.U. .... The European Union.
FMA .... The Austrian Financial Markets Authority ("Finanzmarktaufsicht" in German).
IPO .... Initial Public Offering
NYSE .... The New York Stock Exchange.
S&P 500 .... The Standard & Poor's Index of 500 U.S. Stocks.
SEC .... The U.S. Securities and Exchange Commission.
U.K. .... The United Kingdom of Great Britain and Northern Ireland.
U.S. .... The United States of America.
US$ .... The currency of the United States of America, U.S. Dollars.

Table of Symbols

The following symbols are used throughout the text:[1]

$AR_{j,t}$	Abnormal return of security j at time t.
$AV_{j,t}$	Abnormal traded number of shares of security j at time t.
$corr(a,b)$	The correlation coefficient of variables a and b.
$\operatorname{cov}(a,b)$	The covariance of variables a and b.
D_t	Dividend payment on day t.
E	Expected value operator.
E_m	Expected value operator as seen by the market.
$E[r]$	Expected return on a security.
$E[\tilde{R}_{j,t}]$	The equilibrium expected return in models where this figure is stationary and the long-run average value of $E_m[\tilde{r}_{j,t} \mid \phi^m_{t-1}]$ in models without stationarity of equilibrium expected returns.
$\ln(a)$	The natural logarithm of a.
$p_{j,t}$	Price of the security j at time t (with reinvestment of cash income from period to period).
$p(t)$	Natural log of a stock price at time t.
p_t	Actual stock price at time t.
P_t	Closing price of a stock on day t.
p^*_t	Ex-post rational stock price at time t.
$q(t)$	Random walk component of the stock price at time t.
r	Actual daily return on a stock.
$r_{j,t+1}$	Percentage return of security j from time t to $t+1$.
r_m	Actual daily return on the market portfolio.
R_f	Return on the risk-free asset.
$R_{j,t}$	Actual return of security j at time.

[1] To facilitate the study of basic literature quoted in this thesis, symbols were generally not changed from the notation used in the papers quoted. Nonetheless, where ambiguities would have resulted from this policy, clarifying alterations were made so each symbol has only one, unambiguous meaning.

$R_{m,t}$ .... Actual return of the market portfolio at time t.

R_t .... Stock return on day t.

u_t .... The error of a forecast of p_t for period t.

$V_{j,t}$ .... Traded number of shares of security j at time t.

$V_{m,t}$ .... Traded market number of shares at time t.

$\mathrm{var}(a)$ .... The variance of variable a.

$x_{j,t+1}$ .... Excess market value of security j at time $t+1$.

X_j .... Information set containing a sequence of security returns.

$z(t)$ .... Stationary component of the stock price at time t.

α .... Abnormal daily return on a stock.

α_j .... Market model excess return of security j.

β_j .... Beta-factor of security/portfolio j, where

$$\beta_j = \frac{\mathrm{cov}(R_j, R_m)}{\mathrm{var}(R_m)}.$$

β_j^{MM} .... Market model beta-factor of security/portfolio j.

$\varepsilon(t)$ .... White noise portion of the stationary component of the stock price at time t.

$\varepsilon_{j,t}$ .... Value of the error term of security/portfolio j at time t, assumed to be distributed as white noise.

$\eta(t)$ .... White noise portion of the random walk component of the stock price at time t.

μ .... Expected drift.

ρ_t .... The required return on an asset over period t.

ϕ .... Factor signifying the decay rate of the stationary component of the stock price with ϕ close to but less than 1.

ϕ_{t-1}^m .... The set of information employed by the market to determine security prices at time $t-1$.

Φ_t, ϕ_t .... Information set which is to be fully reflected in the security's price at time t.

~ .... Indication of a random variable.

1. Introduction

The efficient market hypothesis is one of the most important paradigms in modern finance and was largely accepted to hold by the early 1970s. In 1978, Michael Jensen declared his belief that “there is no other proposition in economics which has more solid empirical evidence supporting it.”[2]

Market efficiency since then has become the basis of numerous financial models and forms the foundation of the investment strategies of many individuals and corporations. Because of the efficient market hypothesis, technical analysts have become the target of widespread criticism and passive management has seen a boom in recent years.

Despite these impressive credentials, several cracks have appeared in the efficient market edifice over recent years. More powerful statistical techniques, the advent of affordable computing and the fact that cheap data storage lead to an explosion in the amount of data available to researchers have handed the academic community more sophisticated tools for empirical studies. While modern financial research was able to discount many previous reports of market inefficiency on grounds of new statistical insights, some anomalies were confirmed and today form part of a growing body of literature at odds with the efficient market hypothesis.

It is the intention of this thesis to explain the reasoning behind and the implications of the efficient market hypothesis and give a short overview of the literature and research documenting its validity – or lack thereof – in the world’s financial markets.

Chapter 2 gives a definition of market efficiency and offers a short history of its development from the first formulation to the present day. Since models of market processes form the foundation of research into market efficiency, the most important such models are introduced in chapter 3. Chapter 4 presents different methodologies to allow the testing of the efficient market theory using empirical data. Chapter 5 gives an overview of the results of such empirical testing reported in the literature.

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2 Jensen (1978), p. 95.

2. What is the Efficient Market Hypothesis?[3]

In 1953 Maurice Kendall published a study[4] in which he found that stock price movements followed no discernible pattern, that is, they exhibited no serial correlation. Prices were as likely to go up as they were to go down on any given day, irrespective of their movements in the past. These results lead to the question of what, exactly, influenced stock prices. Past performance obviously did not. In fact, had this been the case, investors could have made money easily. Simply building a model to calculate the probable next price movement would have enabled market participants to gain large profits without (or with reduced) risk. On the other hand, if everybody could have done so, stocks that were about to rise would have risen instantly, because large numbers of investors would have wanted to buy them, while those holding the stock would not have wanted to sell. This mechanism suggests that the market "prices in" the performance data that is already available about a stock.

2.1. Definition of Market Efficiency

The concept of efficiency adopted for this thesis is one regarding the incorporation of information into security prices.

Generalizing from the results of the above paragraph leads to the proposition that any available information which could influence a company's stock performance should already be reflected in said company's stock price. In an efficient market, therefore, security prices should equal the security's investment value, where investment value is the discounted value of the security's future cash flows as estimated by knowledgeable and capable analysts.[5]

Under this definition, the one thing that can still influence stock prices is new information. When new information about a company becomes available, the above process makes stock prices move immediately to reflect the new situation.[6] Naturally, this new information needs to be unpredictable; otherwise

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3 Cp. Bodie/Kane/Marcus (2002), pp. 340-43.

4 Cp. Kendall (1953).

5 Cp. Sharpe/Alexander (1990), pp. 79.

6 Since trading is a non-continuous process which involves discrete instances of price setting, the exact meaning of "immediately" can be clearly specified. That is, the first trade in a security after new information about that security has been made public should already take

the prediction about the new information (which is itself a piece of information) would already have caused share prices to change.

These considerations suffice to formulate the efficient market hypothesis. In its original postulation, it stated that "an efficient market is one in which stock prices fully reflect available information."[7] Later texts have weakened this definition to allow for prices to be sufficiently different from full-information prices for investors to become informed.[8]

A good description of market efficiency and the underlying mechanics is the one by Cootner (1964):

> "If any substantial group of buyers thought prices were too low, their buying would force up the prices. The reverse would be true for sellers. Except for appreciation due to earnings retention, the conditional expectation of tomorrow's price, given today's price, is today's price.
>
> In such a world, the only price changes that would occur are those that result from new information. Since there is no reason to expect that information to be non-random in appearance, the period-to-period price changes of a stock should be random movements, statistically independent of one another."

In a perfect market, these criteria are obviously fulfilled. In such a market transactions and information are costless, implying that market participants have full information and can react to news without incurring costs. Nevertheless, while perfect markets are a sufficient assumption for market efficiency, they are not a necessary condition.[9]

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place at the new, informationally correct price. While this interpretation of market efficiency is the one most generally used in the literature, it is not the only one available. May (1991), for example, requires of efficient markets that they anticipate information. He states that markets can be considered efficient if the price correction process induced by a piece of new information is completed before that information becomes known. He does not, however, elaborate on how this adjustment process is to come about. (Cp. May (1991), p. 314. [In German])

7 Cp. Ross/Westerfield/Jaffe (2002), p. 341.

8 Cp. Grossman (1976) and Grossman/Stiglitz (1980).

9 Cp. Fischer (2003), p. 48 [in German].

2.1.1. The Three Forms of Market Efficiency[10]

In economic and financial theory a distinction is made between three forms of market efficiency. The basis of this separation is what is meant by the term "all available information". Each stronger form of efficiency incorporates all weaker forms of efficiency.

In *weak-form efficient* markets stock prices reflect market trading data and information derived from it. Examples of market trading data are past prices, volume or short interest.[11] This data is generally easily available and, according to this theory, should therefore be reflected in current prices. If weak-form efficiency holds, stock prices should be composed only of three components – the last period's price, the expected return on the stock and a random error term which has an expected value of zero. This random error is due to new, unexpected information released in the period observed. Their relationship can be expressed as follows:[12]

$$P_t = P_{t-1} + E[r] + \varepsilon_{t-1} \quad (1)$$

where P_t is the stock price in period i, $E[r]$ is the expected return on the stock and ε_{t-1} is the random error term for period $t-1$, with $E[\varepsilon_t] = 0 \; \forall \, t$ and $corr(\varepsilon_{t-1}, r) = 0 \; \forall \, t$.

Weak-form efficiency is a prerequisite for many asset pricing models (CAPM, APT) and for option valuation models following the Black/Scholes and Cox/Ross/Rubinstein methods.[13]

Semistrong-form efficient markets reflect all publicly available information influencing the company's value in stock prices immediately. Above and

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[10] Adapted from Bodie/Kane/Marcus (2002), pp. 342-343 and Ross/Westerfield/Jaffe (2002), pp 343-347. See also Fama (1970).

[11] Many authors limit the information set under weak-form efficiency to past prices. While the choice between these two definitions is important for some applications, it is inconsequential for this thesis.

[12] $E[r]$ in this expression is the absolute return on the security. If interpreted as the percentage return, the formula reads $P_t = P_{t-1} \cdot (1 + E[r]) + \varepsilon_{t-1}$.

[13] Cp. Pichler (1993), p. 118. [In German]

beyond the requirements of weak-form efficiency, in this model data about the firm's products, operations, balance sheet, patents, etc. is priced in.

Strong-form efficiency postulates that stock prices reflect all relevant information, including information which is only known to company insiders. This definition implies that these insiders, who are privy to information before it becomes known to the rest of the market, also cannot earn any excess profits. In theory, if these individuals tried to trade on their information, the market would recognize the attempt and prices would adjust before the trade could go through. In practice, the insider trading rules of the SEC and similar regulatory bodies aim at preventing insiders from profiting from their superior knowledge by prohibiting insider trading for said individuals, their relatives and anybody who is supplied with their information. In the academic community there are also proponents of the view that, if insider information is not available to investors, strong-form efficiency can be considered to hold regardless of whether the availability of insider information would lead to excess returns.[14]

Strong-form efficiency, naturally, is the most contested of the three models. For it to hold, weak and semistrong-form efficiency have to hold first.

2.1.2. Limits of Efficiency

As was already stated in section 2.1 of this text, strict interpretation of market efficiency implies that an efficient market is one in which stock prices fully reflect all available information.[15] As was also indicated above, weaker interpretations have been proposed since this first formulation.

A somewhat more practical interpretation and in fact the one adopted by a fair part of the academic community is that in an efficient market stock prices reflect all available information to a degree that prevents investors from earning excess returns net of transaction costs. The exact composition of the transaction costs considered varies from author to author. Most members of the academic community agree that the minimum trading commissions that floor traders on major exchanges must pay should define a minimal tolerance band around strict-sense efficient prices. Prices that come to lie within that

[14] Cp. Fama (1970), pp. 409-10. See also section 2.1.3 below.

[15] Cp. Ross/Westerfield/Jaffe (2002), p. 341.

bandwidth, according to this interpretation, would still be considered efficient even if different from strictly correct prices.

Grossman and Stiglitz[16] go even further and argue that with costly information, for a market to come close to efficiency some arbitrageurs must be able to earn excess profits. They show that only if for some investors arbitrage is profitable, they will, through their actions, keep prices close to their theoretically ideal value for the rest of the market. Should on the other hand no investor be able to earn abnormal profits which pay for the costly procurement and analysis of information, no investment in information will take place. This implies that the assumption of costless information, as present in much of the theoretical literature, is a necessary condition for prices to fully reflect all available information. Since costless information is unrealistic in practice, so are fully efficient capital markets. The question, therefore, should not be whether a given market is efficient but rather to what degree efficiency holds.

2.1.3. Questions Left Unaddressed

In real-world markets the term “all available information” from the above definition must include insider information, which obviously is available to some individuals. Current evidence indicates that the theoretical ideal for such a market, strong-form market efficiency, is too strict a concept to correctly describe reality.

With that in mind, Schwartz[17] asks whether markets are more efficient when a particular bit of information is known to no market participant or when it is known to some. In the first case, he argues, there is an equal distribution of information and gaining excess profits due to that bit of information is impossible for all investors. In the second case, markets have broader, more complete information, but offer excess profits for investors privy to it.

This consideration is similar to what might be asked regarding rules which forbid insider trades. Such regulation is in place in most western capital markets. One might wonder whether markets should be considered more efficient if investors who hold information which was not yet made public are

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[16] Cp. Grossman/Stiglitz (1980), p 393.

[17] Cp. Schwartz (1970), p. 423.

allowed to trade – thus bringing prices closer to their "real" value – or if they are not.

2.2. A Short History of the Efficient Market Hypothesis[18]

Bachelier (1900) laid the theoretical groundwork for the efficient market hypothesis, which was postulated half a century later by Maurice Kendall (1953). Kendall found that stock prices evolved randomly and that his data offered no way to predict price movements. While the explanation for this phenomenon, the efficient market hypothesis, initially seemed counterintuitive to the academic community, scholars quickly embraced the theory and began to document its validity in real-world markets by studying empirical data.

These early studies got a strong methodological boost from the formulation of the capital asset pricing model of Sharpe (1964), Lintner (1965) and Mossin (1966). The CAPM allowed researchers to price securities in efficient markets and spawned a large number of studies based on this and subsequent asset pricing models. Most such studies found evidence consistent with the hypothesis and by the early 1970s, markets were largely considered to be efficient in the semistrong form, as defined by Fama (1970).

By the early 1980s, however, doubts appeared about this earlier stance. Several effects which are described later in this text, like serial correlation and the turn-of-the-year effect, were observed in practice. In his 1978 article, Jensen already hinted at these rising doubts regarding the efficiency of capital markets when he said:

> "…we seem to be entering a stage where widely scattered and as yet incohesive evidence is arising which seems to be inconsistent with the theory."[19]

Over the course of the 1990s and the first years of the new millennium, several anomalies saw intensive scrutiny which solidified their existence and persistence until they could no longer be explained away by even the staunchest of supporters of the efficient market theory. Among these anomalies are the turn-of-the-year effect (and the related time of the month effect, day-of-the-week effect and time-of-the-day effect) and the trend of stock prices to

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18 Cp. Ziemba (1994), pp. 200-201.

19 Cp. Jensen (1978), p. 95.

exhibit short-term momentum and long-term reversal. The last decade brought many new insights regarding especially the latter phenomenon and to the present day the reason for its existence has not been satisfactorily established.

3. Explanatory Models of Market Behaviour

Tests of market efficiency rely on one or more asset pricing models for the derivation of their conclusions. Each empirical study analyzing an aspect of market efficiency, therefore, is a joint test of market efficiency and the asset pricing model used.[20] This chapter gives an overview of the models most commonly employed in the academic literature covering the topic.

3.1. Expected Return Efficient Market Models

Expected return efficient market models are by far the most common frameworks used in market efficiency studies. The following section gives an overview of the most important such models in the literature but does not claim completeness.

3.1.1. The Fair Game Model[21]

Fama (1970) lists three models describing the characteristics inherent to an efficient market – the fair game, random walk and martingale/submartingale models. What they have in common is their reliance on expected returns for the description of market efficiency. Putting this common characteristic into mathematical notation yields the following equation:

$$E\left[\tilde{p}_{j,t+1} \middle| \Phi_t\right] = \left(1 + E\left[\tilde{r}_{j,t+1} \middle| \Phi_t\right]\right) \cdot p_{j,t} \qquad (2)$$

where

E .... Expected value operator.

$p_{j,t}$ .... Price of the security j at time t (with reinvestment of cash income from period to period).

$r_{j,t+1}$ .... Percentage return of security j from time t to $t+1$.

Φ_t .... Information set which is to be fully reflected in the security's price at time t.

~ .... Indication of a random variable.

20 Cp. Fama (1991), p. 1575-1576.

21 Cp. Fama (1970), p. 384-387. For a discussion of Fama's models, see LeRoy (1976) and Fama (1976).

The value of $E\left[\tilde{r}_{j,t+1}|\Phi_t\right]$ is determined by the particular expected return model employed. Equation (2) only states that the information set Φ_t is fully reflected in $E\left[\tilde{p}_{j,t+1}\right]$, the price in one period as expected at time t.

This above definition leads to viewing expected return efficient market models as “fair game” models. The rationale of fair game efficient market models is that no trading system based solely on the information set Φ_t can have expected returns exceeding equilibrium expected returns. This rule can be stated as follows:

$$x_{j,t+1} = p_{j,t+1} - E\left[\tilde{p}_{j,t+1}|\Phi_t\right] \tag{3}$$

and

$$E\left[\tilde{x}_{j,t+1}|\Phi_t\right] = 0 \tag{4}$$

where

$x_{j,t+1}$ .... Excess market value of security j at time $t+1$.

This formulation defines the sequence $\{x_{j,t}\}$ as a fair game with respect to the information set sequence $\{\Phi_t\}$. As will be shown in chapter 4, this formulation has several testable implications for empirical experiments on market efficiency.

3.1.2. The Submartingale Model[22]

The submartingale model is a special case of the fair game efficient market model and the martingale model. Adding to (2) the assumption that

$$E\left[\tilde{p}_{j,t+1}|\Phi_t\right] \geq p_{j,t} \quad \forall\, t, \Phi_t \tag{5}$$

says that the price sequence $\{p_{j,t}\}$ follows a submartingale[23] with respect to the information sequence $\{\Phi_t\}$. Since expected returns conditional on the information in Φ_t are always positive in this model, no trading strategy involving only one security and a cash holding can outperform a simple buy-

22 Adapted from Fama (1970), p. 386.

23 If (5) holds as an equation, the stochastic process follows a martingale.

and-hold strategy.[24] The same cannot be said of the fair game efficient market model, where securities may well have negative expected returns. This is especially true of securities which offer a negative correlation with the market, thus compensating their low or negative returns by providing a reduction of total risk when added to a well-diversified portfolio.[25]

Due to this difference, the submartingale model provides venues for testing other than those supported by the more general fair game model described above.

3.1.3. The Random Walk Model[26]

Another special case of the "fair game" efficient market model, the random walk model requires that successive price changes be independent and identically distributed. Formally, these conditions can be expressed as follows:

$$f\left(r_{j,t+1} \middle| \Phi_t\right) = f\left(r_{j,t+1}\right) \qquad (6)$$

In addition to (6), f must be the same for all t.

The random walk model does not imply that past prices contain no information about future return distributions. On the contrary, if the random walk hypothesis is confirmed, past prices constitute the best information for forecasts. What the model does imply is that the past price sequence cannot be used to obtain information about future price sequences.[27]

The random walk model thus adds conditions to the more general fair game model which naturally makes it less likely to pass tests for market efficiency.

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24 In Jensen (1987), p. 97, Jensen defines this model as follows: $E\left[p_{j,t+1} \middle| \Phi_t\right] = p_{j,t} \cdot \left(1 + \rho_t\right)$, where ρ_t is the required return on the asset for period t and $E\left[p_{j,t+1} \middle| \Phi_t\right]$ is the expected end of period price conditional on information set Φ_t. This notation shows clearly that the amount a security's price in one period is expected to exceed the prior period's price is exactly the return required on that asset.

25 Information taken from a lecture in Corporate Finance by o.Univ.-Prof. Dr. Peter Steiner, Institute for Banking and Finance, Karl-Franzens Universität Graz, held on November 11, 2003, in Graz.

26 Adapted from Fama (1970), pp. 386-387.

27 Cp. Uhlir (1979), p. 38.

3.1.4. The Capital Asset Pricing Model[28]

The capital asset pricing model (CAPM) was formulated by William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966) and has had a turbulent history since its inception. Although it does not fully withstand empirical tests, it is still in widespread use in the investment community because of the insights it offers and because its accuracy suffices for many applications.

The CAPM is based on the assumption that investors hold diversified portfolios. If so, the variance of a security is not an appropriate measure of its riskiness, as investors are more concerned with the security's contribution to their portfolios' variances. As a measure of this contribution, the model uses the security's covariance with a value-weighted portfolio of all securities in the market, standardized over this market portfolio's variance.

Apart from an investment in securities, the CAPM also offers the possibility of a long or short position in a risk-free asset. These assumptions lead to the following equation:[29]

$$E\lfloor R_{j,t} \rfloor = R_f + \beta_j \cdot E\lfloor R_{m,t} - R_f \rfloor$$

where

E .... Expected value operator.

R_f .... Return on the risk-free asset.

$R_{j,t}$ .... Actual return of security j at time t.

$R_{m,t}$ .... Actual return of the market portfolio at time t.

β_j .... Beta-factor of security/portfolio j, where

$$\beta_j = \frac{\operatorname{cov}(R_j, R_m)}{\operatorname{var}(R_m)}.$$ [30]

Put into words, the expected return on a security can be split up into the return on the risk-free asset and the excess return over the risk-free rate of the market portfolio times the security's standardized covariance with that market

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28 Cp. Bodie/Kane/Marcus (2002), p. 259 and pp. 263-274.

29 The assumptions listed here are naturally simplified. In addition to those mentioned, the CAPM also relies on the assumptions of rational investors, perfect markets, identical holding periods, zero taxes and transaction costs and homogeneous expectations.

30 For most applications beta is assumed to be stable over time despite empirical findings to the contrary. The same is true of the risk-free rate.

portfolio. Thus, beta is a factor expressing the sensitivity of the security's returns to movements in the excess returns over the risk-free rate of the market portfolio.

In market efficiency tests, the CAPM often serves as a yardstick for the measurement of security returns in excess of their risk-adjusted expected returns. Nonetheless, the CAPM is far from being a perfect description of real-world markets. For a discussion of some of the CAPM's shortcomings, see Seyhun (1986), Ferguson and Shockley (2003) and section 5.2.3 of this thesis.

3.1.5. The Market Model[31, 32]

The market model is a single-factor model derived from the larger group of k-factor models and bears a certain resemblance to the CAPM. It states that:

$$R_{j,t} = \alpha_j + \beta_j^{MM} \cdot R_{m,t} + \varepsilon_{j,t}$$

where

$R_{j,t}$ .... Actual return of security j at time t.

α_j .... Market model excess return of security j.

β_j^{MM} .... Market model beta-factor of security/portfolio j.[33, 34]

$R_{m,t}$ .... Actual return of the market portfolio at time t.

$\varepsilon_{j,t}$ .... Value of the error term of security/portfolio j at time t, assumed to be distributed as white noise.

The term α_j in this model denotes the expected excess return of security j over the expected return on the market portfolio, which can be written as $\alpha_j = E[R_{j,t}] - \beta_j^{MM} \cdot R_{m,t}$. The market model parameters are usually calculated by regressing the return of a security on the return of the market portfolio,

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31 The terms market model and index model are used interchangeably in the literature.

32 Cp. Bodie/Kane/Marcus (2002), pp. 292-298 and Ross/Westerfield/Jaffe (2002), pp. 288-291.

33 While this notation differs from other finance texts, its serves to underline the distinction between the CAPM beta and the market model beta coefficients in this text.

34 Similar to the risk-free rate and beta in the CAPM, alpha and beta of the market model are for most applications assumed to be stable over time.

showing that the resemblance of market model and capital asset pricing model is superficial.[35]

3.2. Variance Efficient Market Models

Beside the more common expected return efficient market models several other types of models have been formulated to attempt to describe market efficiency and derive testable implications. One reason for this different approach is the wish to capture market inefficiencies outside the return-expected return relationship.

Some of these alternative models describe market efficiency in terms of securities' return variances. Schwartz[36] argues that if consistent inter-stock volatility differences persist and volatility for a stock remains stable over time, traders might be able to formulate profitable trading strategies from historical price series. Irrespective of the direction of price changes of a stock, such a trading strategy could for example involve buying and/or selling of straddles, strips, straps or strangles to profit from differences in expected return volatility.[37]

One example of a study trying to determine the validity of the efficient market hypothesis that employs a variance-based test approach is Shiller (1981). In his paper, Shiller starts out by denoting the efficient market model as:

$$p_t = E\left[p_t^* \middle| \Phi_t\right]$$ [38]

where

E .... Expected value operator.

Φ_t .... Information set which is to be fully reflected in the security's price at time t.

p_t^* .... Ex-post rational stock price at time t.

p_t .... Actual stock price at time t.

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35 Seyhun discusses differences in the application of the market model and the CAPM for certain market efficiency studies in Seyhun (1986), pp. 193-194.

36 Cp. Schwartz (1970), p. 423.

37 For a concise introduction to option strategies see Hull (2002), pp. 202-215.

38 Shiller uses the notation $p_t = E\left[p_t^*\right]$ but goes on to explain that he defines $E\left[p_t^*\right]$ to be the mathematical expectation for p_t^* "conditional on all information available at time t" (Shiller (1981), p. 422). To simplify the understanding of this passage, his equation was therefore adapted to the notation previously used in this thesis to describe similar models.

This notation shows that p_t is the optimal forecast of p_t^*, given the available information Φ_t, at time t. Shiller then argues that for every optimal forecast, the forecast error u_t must be uncorrelated with the forecast. Since the variance of the sum of two uncorrelated variables is the sum of their variances, $\operatorname{var}(p_t^*) = \operatorname{var}(u_t) + \operatorname{var}(p_t)$ holds. Due to the fact that variance can never be negative, the following inequality must then be true:

$$\operatorname{var}(p_t) \leq \operatorname{var}(p_t^*) \tag{7}$$

Employing data from 1871 to 1979 from the Standard and Poor's Composite Stock Price Index for p_t and the discounted value of the actual subsequent real dividends paid by the stocks in the above index for p_t^*, Shiller finds that (7) is violated substantially. His reported variance of p_t exceeds the variance of p_t^* by a factor of 31, i.e. the standard deviation of p_t exceeds the standard deviation of p_t^* by a factor of 5.6.

Shiller's paper is a good example of possible variance efficient market model tests, but should not be taken as evidence rejecting the efficient market hypothesis. As Marsh and Merton (1986) show, different assumptions regarding the stochastic process for dividends lead to a test which rejects the efficient market hypothesis if $\operatorname{var}(p_t) \geq \operatorname{var}(p_t^*)$ - the opposite condition of that derived by Shiller. Marsh and Merton argue that, while both testing methodologies are mathematically correct, they differ in their assumptions regarding the dividend model and, taken together, would always reject market efficiency.[39] They take this as evidence that Shiller's test is a rejection of his finite-variance stationary stochastic dividend process with deterministic trend, conveying no information regarding market efficiency and quote several related studies rejecting stationarity of the stochastic process describing dividends.

[39] Their argumentation is, however, not correct in the mathematical sense, for if $\operatorname{var}(p_t) = \operatorname{var}(p_t^*)$ neither test would reject market efficiency. Nonetheless, qualitatively their arguments are sound, since the above equation is obviously too stringent to hold in any real-world market.

3.3. Behavioural Models

Behavioural models were developed based on research by psychologists predicting irrational investor behaviour. Their common characteristic is that they do not rely on the assumption that all investors behave rationally.

One example of such a model is Black (1986). Contrary to a market where investors only revise their expectations based on new information, Black introduces noise as a factor causing reactions of investors. He argues that market participants sometimes trade on noise as if it were information. Furthermore, he makes the case that noise trading is necessary for liquid markets because, for two individuals to trade, they need to have different expectations about the good in question. Such different expectations in turn can only arise from noise.[40] Under that interpretation, one investor must make a mistake.[41] In a market with information traders and noise traders, noise traders as a group will therefore on average lose money while information traders reap excess profits over the market return.

Shleifer and Summers (1990) similarly divide market participants into arbitrageurs on the one side and other investors or “noise traders” on the other side. Their noise traders sometimes follow trading strategies “based on pseudo-signals, noise and popular models.”[42] The authors argue that, while some of these activities cancel each other out, many of them are correlated and lead to aggregate demand shifts. They quote studies which show that subjects in psychological experiments tend to be overconfident, extrapolate past time series and overreact on new information.

One key insight of their paper is that noise traders will not generally lose money. Since on average noise traders take on more risk, they are rewarded in a market where higher risks earn higher returns and therefore are not likely to disappear as a group.

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[40] Since in Black’s model the term information is synonymous with verifiable information, differing valuations of a stock by investors can only be caused by noise.

[41] The efficient market hypothesis suggests quite another explanation for the willingness of investors to trade. If prices are correct, investors are indifferent between holding a cash amount equal to the asset price (which they can reinvest at any time) and holding the asset itself. The reasons for trading, then, lie outside their expectations regarding the stock’s performance and could be found, for example, in their different cash flow requirements for consumption or wishes to rebalance a portfolio after market swings.

In a market where such noise traders exist, security prices move in response to both fundamentals and investor sentiment and are therefore more volatile than in a market with only rational market participants. Another implication is that returns in such a market are mean-reverting; a characteristic that was shown to exist in capital markets by Fama and French (1988) and Poterba and Summers (1988) and is consistent with the trend reversal effect reported in section 5.4.1.

In addition to the above effects, arbitrageurs in a market with noise traders begin to resemble the latter. Arbitrage in such a market requires picking stocks and taking positions to take advantage of noise trader mood swings. Shleifer and Summers argue that if noise traders tend to chase trends, arbitrageurs would buy stocks starting to rise (thus stimulating the interest of other investors) and try to sell near the top – a strategy that very much resembles that of noise traders. The short-term positive serial correlation and long-term mean reversion these mechanics predict would explain findings like those mentioned in the above paragraph, as well as crashes like that of October 1987.[43]

Fama (1997) quotes several studies which assume that investors believe that stocks follow trends in the short term while reverting to their mean in the long term. These studies go on to explain long-term under-reaction or over-reaction to information by using appropriate behavioural models describing market mechanics. Fama's own analyses find that regardless of the sign of abnormal returns before an information event, positive and negative abnormal returns after the event are approximately equally likely.

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[42] Cp. Shleifer/Summers (1990), p. 23.

[43] Empirical findings are consistent with short-term momentum and long-term mean reversion, a result that is examined more thoroughly in section 5.4.

4. Testing for Market Efficiency

Testing for market efficiency is made difficult by the fact that there is no obvious methodological approach. Fama describes this problem with the following words:

> "The definitional statement that in an efficient market prices "fully reflect" available information is so general that it has no empirically testable implications. To make the model testable, the process of price formation must be specified in more detail. In essence we must define somewhat more exactly what is meant by the term "fully reflect"."[44]

Most of the tests available today are based on the assumption that market efficiency is measurable by observing and analyzing expected and actual returns or their variance. These tests therefore not only test the efficient market theory but simultaneously also this underlying assumption - that expected returns or return variance can be used to test for market efficiency. Once this assumption is accepted, however, it becomes apparent that it provides an easy way of testing the efficient market hypothesis. In efficient markets, no trading system based only on the information these markets are believed to "fully reflect" can create returns in excess of equilibrium expected returns.[45] If, therefore, a trading system is observed consistently creating returns in excess of equilibrium expected returns in a given market, efficiency can be rejected for the information set that trading system is based on.

4.1. Tests for Weak-Form Efficiency

Studies testing for weak-form market efficiency must rely solely on past trading data. Most papers formulate a trading rule based on past security prices which they then test to see whether its application can earn risk-adjusted profits in excess of the market return.

One such trading strategy featuring widely in the literature is the filter rule.[46] It involves buying stocks following a price increase of at least y% and selling stocks and going short after prices have fallen by at least y% from a subsequent

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[44] Cp. Fama (1970), p. 384.

[45] Cp. Fama (1970), p. 385. It can also be shown that such markets are efficient with regard to any subset of the set of information they are considered to fully reflect. For a proof of that statement cp. Fama (1970), pp. 391-392.

high. The investor stays in the short position until prices again increase at least y% from a subsequent low, after which the short position is covered and the stock bought again. In a market which is inefficient in that its stock prices exhibit positive serial correlation, such a strategy could allow investors to earn abnormal profits.

4.2. Tests for Semistrong-Form Efficiency

4.2.1. Event Studies

One frequently employed test for semistrong-form efficiency is the so-called event analysis or event study. These tests usually study an event window of three or five days around news announcements regarding certain stocks. If news announcements convey new information to the market or if they remove uncertainty regarding rumours in circulation prior to the announcement, shares of the company affected by the news will exhibit abnormal returns.[47]

This abnormal return on a stock (α) on any given day is in some tests being calculated by subtracting the market return on a broad-based index portfolio[48] on that day (r_m) from the stock's actual return (r):[49]

$$\alpha = r - r_m$$

By calculating the abnormal returns on stocks for the days leading up to and following news announcements, conclusions can be drawn regarding the speed of price adjustment and the question whether information is leaked before announcements. If, for example, a company announces a dividend omission at date t, there should be an abnormal return at that date, but the return on the following trading day $t+1$ should not exhibit abnormal returns.[50] If there are statistically significant abnormal returns at dates other than t, information about the dividend omission could have been leaked before the actual announcement day or the market observed could indeed be inefficient to the

46 Cp. Fama (1970), pp. 394-395.

47 Cp. Fischer (2003), p. 48.

48 Instead of the market return, some studies deduct from the stock's actual return an expected return derived from an asset pricing model like the CAPM or the market model.

49 Adapted from Bodie/Kane/Marcus (2002), pp. 351-53.

50 Since many companies announce their news after the market closes, date t for them should be taken to mean the trading day following the announcement.

extent that the incorporation of new information into prices takes longer than one day.

4.2.1.1. Fama, Fisher, Jensen and Roll's 1969 Test[51]

One example of a technique of the type described above is the test Fama, Fisher, Jensen and Roll reported in 1969. They study the reaction of stock returns in the months surrounding stock splits of a ratio of at least 1.25:1, of stocks listed on the NYSE from January 1927 through December 1959.

Fama et. al. find that the securities in their sample on average exhibit significantly positive abnormal returns in the 29 months prior to the split. The authors interpret this phenomenon to show that, as economic common sense indicates, the decision to split is made by management after substantial increases in a company's earnings relative to the market.[52] Since 71.1 percent of all split securities were later shown to offer higher percentage dividend increases than the market in the year after the split, investors correctly interpreted the fact that a stock splits as increasing the probability of a larger-than-average dividend increase.

After the split, the authors found that excess returns[53] are randomly distributed about zero. This is in fact a good indication that markets are efficient. Fama et. al. argue that investors interpret a split as a signal suggesting above-average returns in the future and say that the lack of any excess returns after the split shows that this information is correctly reflected in security prices within the month of the split.

The paper then goes on to investigate the effect of dividend announcements after the split has occurred. To do so, the authors separate stocks which go on to increase dividends at a rate above that of the market from those increasing dividends less than the market does on average. While overall residuals are not significantly different from zero, these two groups viewed isolated of each

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[51] Cp. Fama/Fisher/Jensen/Roll (1969).

[52] Ross et. al. (in Ross/Westerfield/Jaffe (2002), pp. 326-27) for example argue that companies decide to split their stock in order to entice more small investors to buy. Naturally, this is only necessary if the price of individual shares is considered high – which is more likely to be the case after companies have reported large earnings relative to the market and are believed to continue to do so in the future.

[53] Meaning both positive and negative residuals derived from a regression of security returns on the return of the market.

other do show significant deviations from the mean. Stocks that go on to announce dividend increases surpassing those of the market show small positive residuals, while stocks "disappointing" investors by increasing dividends less than the market, show stronger negative excess returns. Finally, one year after the split occurred, residuals reverted to a value similar to that of five months before the split, which Fama et. al. believe can be considered the earliest time reliable information concerning a possible split is likely to have reached the market.

The authors interpret these results as proof that dividend announcements subsequent (or simultaneous) to the split announcement are reflected in prices just as economic theory would predict.

The study holds valuable information regarding the absorption of information about stock splits and subsequent dividend announcement into stock prices and lends support to semistrong-form market efficiency. Due to its use of months as the smallest period of observation it can, however, not make a definitive statement regarding the actual speed of incorporation of information into security prices.

Nonetheless, there is nothing to confirm that, as Schwartz[54] claims, the period of positive average residuals leading up to a split is a sign for market efficiency. Only had the split been announced 29 months in advance of the actual split date would the positive residuals during that period suggest an inefficient market. In fact, these residuals only reflect the increasingly positive economic outlook for the firm, which is not an indication of, but the reason for the later split.

4.2.2. Mutual Fund Studies

Mutual fund performance studies compare the record of various mutual funds with the performance of market indices. If semistrong-form efficiency holds, mutual fund managers, after adjusting for the riskiness of their funds, should not be able to, on average, earn higher returns than a passive portfolio.[55] These

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54 Cp. Schwartz (1970), p. 422.

55 This statement relies on the assumption that mutual fund managers do not have access to insider information. If, as some researchers believe, mutual fund managers do have such access, the studies described above test for strong-form efficiency rather than semistrong-form efficiency. Rejecting efficiency under such a model would therefore only contradict

studies rely on the fact that, while some fund managers significantly outperform the market over past periods, investors will not know which of them will do so in the future. Therefore, investors can only earn excess profits over the market return if either mutual funds as a whole on average outperform the market or if past criteria, for example excess returns over extended periods of time, can be used to forecast which funds will go on to outperform the market in the future.

One good example of an early mutual fund market efficiency study is Jensen (1968).

4.3. Tests for Strong-form Efficiency[56]

There are generally two types of strong-form efficiency tests to be found in the literature. Both try to determine if market participants with privileged information can earn abnormal profits.

The first group directly investigates stock price movements after trades by company insiders or searches for abnormal returns prior to news announcements. A general caveat of this technique is that information with the same direction of impact on the stock price as a subsequent news announcement (but unrelated to the news announcement) can at times become available in the period leading up to the announcement date. Conditional on the exact methodology of analysis employed, the price movement following the surfacing of such (publicly available) information can be mistaken for insider trading.

The second group is formed by studies which analyze the investment performance of money managers, relying on the assumption that these individuals sometimes have access to private information. This assumption is more likely to hold in European stock markets than in the U.S., since European institutional portfolios are frequently managed by banks, which have privileged access to information about companies through their banking relationships with their clients.

strong-form efficiency but offer no information on whether semistrong-form efficiency would be an appropriate description of the market.

[56] Cp. Hawawini (1984), pp. 49-50.

5. Evidence of Market Efficiency

5.1. Market Anomalies

5.1.1. Serial Correlation[57]

The most obvious way to test for weak-form market efficiency is to look for serial correlation in stock returns. Opinions on the short-term correlation of stock returns are divided between proponents of the efficient market hypothesis and researchers who claim to find a positive or negative relationship between past and present stock returns. Kendall (1953) and Roberts (1959) suggest that no patterns exist in stock prices, while both Lo and MacKinlay (1964) and Conrad and Kaul (1988) find positive serial autocorrelation between the weekly returns of NYSE stocks. The return correlations they report, however, are not necessarily large enough to offer trading opportunities.

Jegadeesh and Titman (1993) looked at intermediate-term serial correlation (3- to 12-month holding periods) and found that stocks do exhibit positive serial correlation. They suggest that the portfolios offering the best performance in the past outperform other stocks with enough reliability to offer trading opportunities.

Over longer horizons, Fama and French (1988) and Poterba and Summers (1988) find substantial negative serial correlation. However, due to the lower number of observations possible over longer horizons, the statistical solidity of these studies is not as uncontested as that of the studies in the previous two paragraphs. Furthermore, Bodie, Kane and Marcus argue that these results need not necessarily indicate mean reversion, but could result simply from changes in the risk premium expected by investors. In fact, most variables seemingly predicting stock market returns should be examined regarding their relation to the risk premium. Bodie et. al. claim that in many cases the variables which are subject of study predict risk premium instead of stock market returns.[58] Naturally, in markets where risk premiums are highly correlated with stock

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[57] Cp. Bodie/Kane/Marcus (2002), pp. 357-359 and p. 363.

[58] Cp. Ross/Westerfield/Jaffe (2002), pp. 358-59.

market returns, these variables seem to predict the latter, when in fact they are measures of the former.[59]

Recent studies assert that short-term positive serial correlation is followed by long-term negative serial correlation, an effect which is discussed more thoroughly in section 5.4 of this thesis.

5.1.2. Return Seasonality[60]

Many studies document patterns of seasonality in stock returns. Seasonality can be found in intraday returns, weekly returns, monthly returns and annual returns. Since most seasonals do not exceed the average bid-ask spreads of stocks, Fama (1991) alleges that this phenomenon may be caused by seasonals in the probabilities that measured prices are at ask or bid, due to seasonals in investors' trading patterns.

The two best-documented patterns of seasonality are described in the following sections 5.1.2.1 and 5.1.2.2.

5.1.2.1. The Day-of-the-Week Effect[61]

Keim and Stambaugh (1984) document the weekend effect described by several previous papers.[62] They observe the daily returns from the value-weighted Standard and Poor's Composite Stock Price Index in the period from 1928 through 1982, covering a larger timespan than previous studies.

Their study reports significantly negative average returns on Monday and large positive average returns on Saturday. The hypothesis of equal means across days of the week could be rejected at what they term "any reasonable significance level"[63] in the total period and in the subperiods of 1928 through 1952 and 1953 through 1982. They rejected the same hypothesis at the 5 percent significance level for nine out of the eleven five-year subperiods. Keim and Stambaugh also investigated the 1928 through 1952 subperiod, for

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59 See also section 5.4.3.4 for a similar argument.

60 Cp. Fama (1991), p. 1586-1589.

61 In the literature also sometimes referred to as the "Weekend Effect".

62 Among them are Cross (1973), French (1980) and Gibbons/Hess (1981).

63 Cp. Keim/Stambaugh (1984), p. 824.

large parts of which the NYSE was open on Saturdays, and find that, in general terms, returns tended to be higher on the last trading day of the week. In a similar test, French (1980) determines that negative average returns may generally be expected on days preceded by days of closed markets.[64] He furthermore shows that for the period from 1953 through 1977, which he tested for the weekend effect, investors could not have earned abnormal profits net of transaction costs exploiting this effect.

Keim and Stambaugh investigate the existence of a size effect related to the day-of-the-week effect and find that, not only do average returns tend to increase as the week progresses, but they do so more quickly the smaller the firms observed. They find that Friday returns are significantly correlated with size. Furthermore, they conduct tests to determine whether the cause for the day-of-the-week effect can be found in measurement errors or a bid-ask spread bias, both of which hypotheses they have to reject.

Rogalski (1984) finds additional evidence pointing to a relation between the weekend effect and the January effect. He states that the weekend effect is on average positive in January and negative for the rest of the year.

Gibbons and Hess (1981) report a strong day-of-the-week effect for U.S. treasury bills which is qualitatively the same as the one they find for stocks. They test possible explanations for their results but find none which proves an adequate explanation.

5.1.2.2. The Turn-of-the-Year Effect[65]

The turn-of-the-year effect describes the phenomenon that returns in January are on average significantly higher than over the rest of the year. Many scholars also show that small companies consistently outperform large ones in early January. One researcher studying this effect is Ziemba, who finds an average return difference between the smallest and largest deciles of stocks in early January of 6 to 10 percent.[66]

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64 Cp. French (1980), pp. 63, 68.

65 In the literature also referred to as the “January Effect”, the “Size Effect” and the „Small-Firm-in-January Effect“.

66 Cp. Ziemba (1988), p. 717.

Keim (1983) shows that over the period from 1963 to 1979 small firms outperformed large ones in January every year. To reach this conclusion, he divided the firms listed on the NYSE and AMEX into ten groups sorted by market value of common equity. Correcting for biases in beta estimates due to trading frequency differences, Keim then calculated the average abnormal return for each month and each decile. Apart from the finding that small firms yield abnormal returns compared to their larger counterparts, even after adjusting for differences in risk, the study shows that abnormal returns are considerably higher in January than in any other month.

Within the month of January, Keim shows that 10.5 (26.3) percent of the size effect for an average year occurs on the first trading day (on the first five trading days). Over the whole year, almost fifty percent of the size effect is due to the outperformance of larger stocks by smaller stocks in January. A subsequent study[67] found that part of the size effect reported by Keim was caused by a bias due to differences in bid-ask spreads between small and large stocks. Adjusting for this bias, all of the size effect, on average, was found to be due to the month of January.

This effect is believed by many authors to result from investors wanting to realize losses on their investments for tax purposes.[68] According to his argumentation, investors sell stocks which have lost value over the year in December to realize a tax shield from investment losses. In January these investors then reinvest their money in the stock market. Some researchers believe that small stocks are most affected, since they are the most volatile and therefore have the highest probability of having made large losses.[69] Offering another possible explanation, Ritter shows that individual investors on average hold higher proportions of small stocks in their portfolios than do institutions.[70]

Contradicting the tax-loss-selling hypothesis, Keim[71] finds that the January effect was larger in the 1930s than in any subsequent period despite the fact

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67 Blume/Stambaugh (1983), p. 403.

68 This tax-loss-selling hypothesis is only one possible explanation for the turn-of-the year effect. For a concise overview over other explanations, see Ritter (1988), pp. 703-05.

69 Cp. Bodie/Kane/Marcus (2002), pp. 360-61.

70 Cp. Ritter (1988), pp. 705-06.

71 Cp. Keim (1982) as quoted in Keim (1983), p. 30.

that in the years prior to World War II the U.S. personal income tax rates were relatively low and would therefore suggest a less significant January effect.

As stated in section 5.1.2.1 above, Rogalski (1984) finds that the weekend effect is on average positive in January and negative for the rest of the year.

Ritter and Chopra (1989) find that the January effect cannot be attributed to a January seasonal in the market's risk-return relation but is induced by the small-firm pattern in January. For their analysis, they form four value-weighted portfolios of NYSE securities ranked by their beta factors calculated from the CRSP monthly returns over a four year period. In an alternative portfolio formation, stocks are grouped into quintiles ranked by market value. Ritter and Chopra then analyze the tax-loss selling hypothesis and reach the conclusion that the correlation between beta and tax-loss selling status in their data does not support this explanation for the turn-of-the-year effect. They also give evidence rejecting a risk-mismeasurement hypothesis which stipulates that the turn-of-the-year effect is caused by an underestimation of small stocks' betas in January, due to their (the betas') being higher in that month than from February to December. The one possible explanation they find support for is the portfolio rebalancing hypothesis. According to that theory, money managers sell possibly embarrassing stocks in December and reacquire more speculative securities, including small, high-beta firms, in January.

5.1.3. Stock Price Reaction to Index Inclusion

Studies testing for market efficiency by investigating the reaction of stocks' prices on inclusion of these stocks into a market index rely on the assumption that the inclusion of a stock into an index brings no new information into the market. If the assumption holds and stock prices still react to the index inclusion, this reaction can be argued to be caused by large-scale purchases of the stock by index funds. The price effect is therefore a liquidity effect, or rather, a lack-of-liquidity effect, which should not be present in efficient markets.

Shleifer (1986) conducted a study following the idea of the above paragraph, analyzing the reaction of stock prices upon inclusion of stocks into the S&P 500 over the period from 1966 to 1983. He finds that in the period from

1976 to 1983, over 95 percent of individual observations have positive abnormal returns on the announcement date[72], with an average abnormal return over all observations of 2.79 percent.[73] The study shows that an inclusion into the S&P 500 is new and relevant information which is not anticipated by the market. Furthermore, the abnormal returns on the announcement date persist for a minimum of 10 to 20 trading days. A longer persistence can neither be confirmed nor ruled out.

5.1.4. Neglected-Firm Effect and Liquidity Effect[74]

Amihud and Mendelson (1986, 1991) postulate and later show that investors demand a premium over the expected rate of return for stocks with low liquidity. Because small stocks are generally less liquid than Blue Chips, the liquidity effect might account for some of their abnormally high risk-adjusted returns. This result is further supported by Pratt (1989), who finds that closely held stocks in some cases trade at discounts of more than 30 percent. Chordia, Roll and Subrahmanyam (2000) suggest that market and industrywide liquidity is systematic and affects quoted spreads, quoted depth and effective spreads of all stocks. They then go on to suggest an alternative model for stock valuation which takes liquidity into account.

Ross et. al. also talk about the cost of liquidity for the company (in terms of a higher cost of capital due to a higher expected return on the firm's equity position) and equate liquidity with part the cost of trading securities.[75] This cost is composed of brokerage fees, the bid-ask spread and market-impact costs. While the first two of these components are probably obvious to the informed reader, the last offers an interesting connection to the issue of information asymmetry – a core question of the efficient market hypothesis.

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[72] Changes in the index composition are announced after trading closes on weekdays, usually Wednesdays. The term “announcement date” as used in this section therefore means the trading day following the announcement day.

[73] In the period prior to 1976 the results from the period after 1976 could not be confirmed. One possible reason for this shortcoming is that information regarding the announcement date is of a lower quality before 1976. Another possible explanation is the lower proportion of the S&P 500 held by index funds in the early years. An inquiry into these hypotheses found tentative support for the latter reasoning. For more details, see Shleifer (1986), p. 584.

[74] Adapted from Bodie/Kane/Marcus (2002), pp. 279-284 and p. 361.

[75] Cp. Ross/Westerfield/Jaffe (2002), pp. 325-327.

According to the authors, the specialist generating the quotes for a given stock fears being "picked off" by investors with superior information. If such an investor has information that the market does not yet reflect, he will - if, for example, he expects stocks to fall - sell large amounts of the stock, possibly leaving the specialist with a great number of shares which he can later sell only at a lower price. To protect himself, the specialist widens the bid-ask spread, increasing the cost of trading (and reducing the stock's liquidity) for all investors. Ross et. al. therefore see a positive relationship between bid-ask spreads and the ratio of informed to uninformed investors. This leads to the conclusion that better public information (due to more analysts following the stock or more public announcements by the company) would narrow the gap between informed and uninformed investors and reduce trading costs. Obviously, this argumentation is incompatible with the strong-form of the efficient market hypothesis, which requires stock prices to immediately adjust as soon as any investor tries to trade on a piece of new information.[76]

5.2. Insider Information[77]

The evidence on insider trading shows that insiders can predict and profit from abnormal future stock price changes. Moreover, different classes of insiders have different quality information. Specifically, insiders who would be expected to have better knowledge regarding the overall affairs of the firm (i.e. chairmen of the boards of directors and officer-directors) predictably hold higher quality insider information. Research findings also suggest that insiders can discern the differences in the value of their information and adjust the volume of their trades accordingly. Evidence on the profitability of transactions by normal investors following insider trades is ambiguous.

5.2.1. Legislative Treatment of Insiders

The act of obtaining and using insider information depends strongly on the legislative system capital markets are based in. The following section gives a brief overview of insider legislation in the United States of America and the European Union. A basic understanding of the differing legal frameworks

[76] For an empirical study confirming this effect, see Hong/Lim/Stein (2000).

[77] Cp. Seyhun (1986), pp. 210-211.

applicable to the two market areas mentioned above is necessary for a discussion of their repercussions on market efficiency. Nonetheless, the information given here should not be considered exhaustive.[78]

5.2.1.1. U.S. Insider Legislation[79]

The U.S. lack a clear definition of what constitutes insider trading. Nonetheless, trading based on insider information is prohibited. Insider information is characterized by the two elements of being material[80] and non-public.

A person obtaining insider information has two choices. He can either "disclose or abstain", that is, disclose the information before trading on it or abstain from trading altogether. The dissemination of the information outside an official disclosure is prohibited. Furthermore, misappropriation of information entrusted to an employee and its use to obtain a personal benefit is punishable as fraud. A person receiving a tip from an insider[81] can be convicted if he was aware of the insider's breaking of the law and obtained a personal benefit from the information.

Finally, U.S. employers are liable for insider violations by their employees and face penalties of up to 1 Million US$.

Taken together, U.S. insider legislation and the power wielded by the overseeing authority, the SEC, form the global standard. Despite sometimes complex and even contradictory regulations, U.S. laws offer the best protection for investors worldwide.

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[78] Especially section 5.2.1.2 (E.U. Insider Legislation) is incomplete, since E.U. regulations are only one part of the legal framework in the European Union, the second part of which is made up of national legislation of the member states. A discussion of individual member states' insider regulations, however, is beyond the scope of this thesis. The interested reader may find a more thorough discussion of the U.S. and E.U. insider legislation in Leinich (1992) [In German].

[79] Cp. Leinich (1992), pp. 16-59. [In German]

[80] "An omitted fact is material if there is a substantial likelihood that a reasonable shareholder would consider it important in deciding how to act." Cp. Leinich (1992), p. 48. [In German]

[81] Officers, directors, and owners of 10 percent or more of any equity class of securities in the U.S. are defined as insiders by the Securities and Exchange Act of 1934. Cp. Seyhun (1986), fn. 1.

5.2.1.2. E.U. Insider Legislation[82]

Under E.U. legislation, insiders are company officers, directors, beneficial owners of more than 10 percent of the company's equity and individuals with access to insider information through their line of work. This definition encompasses both members of the managing- and the supervisory boards. Insider status also applies to any individual obtaining information which, directly or indirectly, can only stem from one of the aforementioned people.

For information to qualify as insider information it must concern one or more issuers of securities, be non-public, precise, and of a nature such that in the case of its publication it would have considerable influence on the price of the security concerned.

E.U. regulations forbid the trade based on, and the dissemination of, insider information. Giving advice concerning the trading of securities based on insider information is also prohibited.

These rules form a lower bound on insider regulation inside the European Union; national legislators are free to decide on stricter laws. Similarly, enforcement measures are left under the discretion of the member countries but must provide sufficient incentive for the regulations to be adhered to.

5.2.2. Evidence from U.S. Markets

Several authors have documented that earning abnormal profits from insider trading is possible. Pratt and DeVere (1968) and Jaffe (1974) for example show that stock prices tend to increase after insider purchases and fall after insider sales.

In Lorie and Niederhoffer (1968), the authors investigate insider trading in U.S. markets from January 1950 through December 1960. In the U.S., insiders are required by the SEC to announce transactions in the common stock and convertible securities of their respective companies, which the Commission then publishes in the "Official Summary of Insider Trading[83]". Due to the

[82] Cp. Leinich (1992), pp. 60-90. [In German]

[83] U.S. Securities and Exchange Commission, "Official Summary of Security Transactions and Holdings", Government Printing Office, Washington D.C.

delay until insiders advise the SEC of their transactions and the additional delay until their publication, the earliest investors can be confident of finding out about insider trading would be six days after the end of the month the transaction took place in. Lorie and Niederhoffer find that insiders buy at a price lower than that at this latter date in 75 percent of all cases. In other tests they find that an intensive accumulation of a stock by insiders is a good indicator of outperformance over the following six months. They also report that insiders buy (sell) more often preceding large price increases (decreases) and that the probability of an insider purchase followed by a purchase is three times as large as that of an insider purchase followed by a sale.

Jaffe (1974) tests for strong-form efficiency by searching for abnormally large (small) average CAPM-derived residuals following insider purchases (sales). His initial sample comprises the largest 200 securities in the CRSP database over the period from 1962 to 1968. Using three different criteria for selecting insider trading subsamples, Jaffe conducts an equal number of methodically distinct tests. In all three analyses, he finds evidence consistent with strong-form market inefficiency, one of which persists after transaction costs. Furthermore, he finds that markets react only sluggishly to the publication of the "Official Summary of Insider Trading". For this reason, the information contained therein can be used to earn abnormal profits after transaction costs, a result inconsistent with even semistrong-form efficiency.

In contrast to these findings, Seyhun (1986) shows that investors cannot profit from following the transactions of insiders because transaction costs outweigh the possible abnormal returns. His deliberations show clear support for semistrong-form market efficiency, while he has to reject the strong form of the hypothesis.

He begins his study by arguing that market-makers adjust the bid-ask spread proportional to the volume of insider trades they are faced with to avoid excessive losses caused by adverse selection. This adjustment of spreads ensures that the market-maker recovers in trades with uninformed investors what he loses in trades with informed investors. The argumentation here follows the same lines as that of Ross et. al. regarding the neglected-firm effect described in section 5.1.4 above. Seyhun finds evidence consistent with his hypothesis. Stocks subject to frequent insider trades – usually small stocks – exhibit larger bid-ask spreads than stocks with less frequent trading by such "informed investors".

Using data from 769 firms for the period from 1975 to 1981 and estimating abnormal returns based on the market model, he also shows that abnormal returns to insiders are smaller than reported in previous studies. The reason for this difference lies in the earlier studies' use of the CAPM, which tends to introduce an upward bias into abnormal returns. This bias depends on the sample's size of the small-firm effect and the distribution of insider purchases and sales, respectively, in the small-firm and large-firm segment.[84] For Seyhun's sample, abnormal returns for the 300 days following an insider trading day increase from 3.1 percent to 4.3 percent when he uses residuals calculated using the CAPM instead of the market model.

Seyhun also shows that the dollar volume of insider trades is directly proportional to the ex-post quality of insider information. While these results are significant at the 1 percent level, he reports that the dollar volume of trading increases less than linearly with the value of insider information. Furthermore, splitting the three effects, Seyhun finds that the types of insiders, dollar volume of trading and firm size are separate determinants of insiders' abnormal profits.

5.2.3. Evidence from International Markets

In Austria, the FMA[85] requires board members of domestic joint-stock companies to publish their transactions in the Wiener Zeitung. Since the FMA, after news about a stock are published, analyzes every transaction that is in suspicion of having been made by an insider and since in 2003 a successful case of insider litigation found widespread media attention, insider trading in

[84] CAPM derived residual returns for small firms are generally positive, while the model usually yields negative residuals for large firms. If insiders on average have more sales than purchases among small firms, the CAPM will induce an upward bias in insider returns. The reverse is true for large firms. Seyhun finds that the purchases-to-sales ratio among insiders in his sample has a value of approximately 2 for small firms and 0.6 for large firms.

[85] The "Finanzmarktaufsicht" or FMA is the body charged with ensuring the correct functioning of the Austrian financial markets.

Austria “should offer no valuable clues for other investors to follow”, according to a spokesman of the authority.[86]

Regarding international findings, Hawawini (1984) quotes several papers documenting mutual fund performance outside U.S. markets. These studies find evidence consistent with strong-form efficiency for the French, Spanish and U.K. funds.

5.3. Mutual Fund Performance

5.3.1. Methodology of Mutual Fund Studies[87]

Mutual fund efficient market tests rely on the fact that in an efficient market, money managers, after adjusting for risk, cannot consistently realize higher returns than the average return on the market. Mutual fund studies are usually considered to be tests of the semistrong-form efficient market hypothesis. In contrast, some papers assume that money managers have access to insider information and therefore claim to test for strong-form efficiency.

The following brief example shows how the performance of mutual funds is measured in the academic literature. Using the CAPM, the risk-return relationship can be stated as follows:

$$\frac{R_{j,t} - R_f}{\beta_j} = R_{m,t} - R_f \qquad (8)$$

where

$R_{j,t}$ .... Return on security/portfolio j at time t.

R_f .... Return on the risk-free asset.

$R_{m,t}$ .... Return on the market portfolio at time t.

β_j .... Beta-factor of security/portfolio j, where $\beta_j = \frac{\mathrm{cov}(R_j, R_m)}{\mathrm{var}(R_m)}$.[88]

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[86] Information taken from a presentation by Mag. Klein, FMA, held on November 28, 2003, in Vienna.

[87] Adapted from Hawawini (1984), pp. 50-52.

[88] As the lack of the index t in this notation indicates, β_j is considered to be constant over time.

A mutual fund can be considered to have outperformed the market if the left-hand side of equation (8) is greater than the right-hand side. This left-hand side is the Treynor ratio[89], a risk-adjusted measure of an asset's excess performance over the risk-free rate while the right-hand side is the market's excess return over the risk-free rate. Naturally, even though the CAPM is one of the models used most frequently to determine abnormal returns and measure outperformance, it is not the only one. The market model, random walk model, martingale/submartingale model, Fama three-factor model and arbitrage pricing theory are other examples of frequently used frameworks.

5.3.2. Evidence of Mutual Fund Performance[90]

Shortly after the formulation of the capital asset pricing model, Jensen (1968) found inferior performance of mutual funds after expenses, while Henriksson (1984) and Chang and Lewellen (1984) reported that fund managers have enough private information to offset their expenses. Hendricks, Patel and Zeckhauser (1993) and Goetzmann and Ibbotson (1994) argue that mutual funds' past returns predict future returns.

Elton, Gruber, Das and Hlavka (1993) point out some errors in Ippolito's 1989 study[91] and demonstrate the importance of using benchmarks mirroring the asset types of the portfolio to be tested. They also show that for the period from 1945 to 1984 mutual fund managers underperformed passive portfolios, that funds with higher fees and turnover did worse than funds with lower fees and turnover and that fund managers did not adjust their expenses in line with their performance (i.e. charging higher fees to reflect higher performance and lower fees during times of low performance). Moreover, they found no evidence that funds charging a load fee performed sufficiently better than no-load funds to compensate for the amount charged.

In his 1995 article[92], Malkiel employed a new dataset which prevented survivorship bias by including in the analysis funds which had not existed over

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89 Cp. Treynor (1965).

90 Adapted from Malkiel (1995).

91 Cp. Ippolito (1989).

92 Cp. Malkiel (1995), p. 571.

the whole research period. He documented an underperformance of the market by actively managed funds both including and excluding reported expenses (except load fees). Furthermore, Malkiel showed some persistence of mutual fund performance over the 1970s, only to find it disappear during the 1980s. He concluded that passive management continues to outperform active management and that markets remain “remarkably efficient”.

As mentioned in section 5.2.3, Hawawini (1984) quotes several papers documenting strong-form efficient markets in France, Spain and the U.K. after conducting mutual fund studies in these and other countries.

5.4. Short-Term Momentum and Long-Term Reversal

The momentum and reversal effect structurally belongs under section 5.1.1 (“Serial Correlation”), but has earned a separate section due to its dominance of the literature on market efficiency over the last two decades. A large proportion of the studies since the 1990s aim at discussing the phenomenon described in the below paragraphs. While the reasons for this effect are still being researched, even the strongest doubters have by now been convinced of its existence.

5.4.1. Evidence for Trend Reversal

In the mid-1980s, different scholars began to find evidence for a tendency of stock returns to exhibit negative serial correlation over periods from 13 to 60 months. Despite its initially doubtful reception, the academic community has since confirmed this effect, which has grown to command more and more attention in the market efficiency literature over recent years. It is interesting to see that, while quite robust in studies of earlier periods, Jegadeesh and Titman (2001a) find that the evidence for return reversal is substantially weaker over the years from 1982 to 1998. Theoretically, this result could indicate that the reversal effect was caused by data snooping or that investors’ reaction to its publication has initiated its waning.

Regardless of its unclear future, the following paragraphs quote two studies representative of the early literature on the topic.

5.4.1.1. De Bondt and Thaler's 1985 Paper

De Bondt and Thaler (1985) postulate a model wherein investors systematically overreact. This assumption leads to two hypotheses. First, extreme stock price movements in one direction will be followed by movements in the opposite direction. Second, the larger the first movement, the larger the corrective swing. The authors study monthly return data from the NYSE and classify stocks as winners or losers by comparing their portfolio formation period return with the return of an equally-weighted market portfolio. In a next step, they calculate excess returns for three-year periods for both a winner and a loser portfolio.

Taking into account the large influence of the choice of return residuals on the results of long-term studies, they employ three different return residuals – market adjusted excess returns, residuals derived from the market model and excess returns predicted by the capital asset pricing model. They present their findings based upon market adjusted excess returns after discovering that the choice of return residuals does not affect their study's results.

Over the period of their study, winner portfolios on average earn 5 percent less than the market over a three-year period, while loser portfolios outperform the market by a margin of 19.6 percent over the same interval. Notwithstanding the authors' assertion that their results are "qualitatively different from the January effect"[93], it is interesting to note that their loser portfolios earn more than 90 percent of their excess returns in that month.

Referring to the De Bondt and Thaler paper, Fama and French (1996) argue that the long-term return reversals found therein can be explained away by a multifactor asset pricing model.[94] Since stocks having low (high) long-term past returns are on average smaller (larger) and have a higher (lower) book-to-market-equity ratio, Fama and French's three factor model correctly predicts their higher subsequent returns.

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[93] Cp. De Bondt/Thaler (1985), p. 800.

[94] Cp. Fama/French (1996), p. 56.

5.4.1.2. Fama and French's 1988 Paper[95]

In a paper subsequent to De Bondt and Thaler (1985), Fama and French also offer evidence of a mean reversion effect in stock returns over periods of 3 to 5 years. They argue that this effect could be caused by either irrational investor behaviour or by rational pricing in an efficient market where equilibrium expected returns vary over time.

In the latter model, shocks to expected returns, which can be viewed as the discount rates used by investors, can generate shocks to current prices in the opposite direction. Similarly, returns can exhibit negative autocorrelation when expected returns possess positive autocorrelation. Testing this theory, Fama and French formulate a model with a return generating process made up of a random walk and a stationary component as follows:[96]

$$p(t) = \underbrace{q(t-1) + \mu + \eta(t)}_{q(t)} + \underbrace{\phi \cdot z(t-1) + \varepsilon(t)}_{z(t)}$$

where

$p(t)$ .... Natural log of a stock price at time t.

$q(t)$ .... Random walk component of the stock price at time t.

μ .... Expected drift.

$\eta(t)$ .... White noise portion of the random walk component of the stock price at time t.

$z(t)$ .... Stationary component of the stock price at time t.

ϕ .... Factor signifying the decay rate of the stationary component of the stock price with ϕ close to but less than 1.

$\varepsilon(t)$ .... White noise portion of the stationary component of the stock price at time t.

Using this model, they find that between 30 and 45 percent of the variances of 3 to 5 year returns for portfolios formed according to industry are due to the variation in expected returns over time, generated by the slowly decaying

95 Cp. Fama/French (1988).

96 The reader may notice that the notation used marks a departure from the customary norm of depicting stochastic processes with capital letters. Nonetheless, the notation in this text follows that of Fama and French (1988), pp. 248-251. (See also fn. 1)

stationary price component $z(t)$. Furthermore, their results suggest that the stationary component is relatively more important for small-stock portfolios. Owing to the difficulty of analyzing stock return behaviour over longer periods, the Fama and French results sometimes suffer from low statistical power, a fact that reduces their trustworthiness.

5.4.2. Evidence for Momentum

Following the last paragraphs, a section on trend continuation may seem surprising. The explanation for this apparent contradiction lies in the different time horizon the two effects can be observed over. In the 1990s, studies finding return momentum over short horizons created a stir with the authors reporting return reversal. Subsequent studies confirmed these new results and determined that the borderline between holding periods exhibiting the momentum effect and reversal effect is to be found around 12 months. Portfolios held for up to one year exhibit momentum, while for holding periods exceeding that duration, reversal effects can be observed.

5.4.2.1. Jegadeesh and Titman's 1993 Paper[97]

By the early 1990s, papers had appeared documenting the profitability of short-term contrarian strategies with portfolio formation and holding periods of only days or weeks.[98] Arguing that such strategies are transaction intensive and could be profitable due to a lack of liquidity or short-term price pressures, Jegadeesh and Titman decided to analyze similar strategies for periods of between 3 and 12 months. For their test, they select stocks based on their returns over the previous 1 to 4 quarters and then hold them for the following 1 to 4 quarters. The 16 strategies derived from this methodology are complemented by 16 similar strategies where one week is skipped between selection and holding period to avoid effects due to bid-ask spread, price pressure and lagged reaction effects. As the source of their data they employ the entries in the CRSP database for the period of 1965 to 1989.

Each month, they rank stocks based on their returns over the portfolio formation period, forming ten equally-weighted decile portfolios. Next, they

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97 Cp. Jegadeesh/Titman (1993).

98 Cp. Jegadeesh (1990) and Lehmann (1990) as quoted in Jegadeesh/Titman (1993).

calculate returns on a zero-cost, top-decile minus bottom-decile portfolio over all holding periods. Their study finds that for the 32 strategies described above, all zero-cost portfolios yield positive returns; only one of them not statistically significant. The strategy of calculating returns over 12 months and then holding the entered position for 3 months returns the highest abnormal profit of 1.31 percent per month for the contiguous periods and 1.49 percent when a week is skipped between portfolio formation and holding periods.

Trying to derive reasons for this momentum effect, Jegadeesh and Titman report that they find both the top-decile or winner portfolio and the bottom-decile or loser portfolio to have higher-than-average betas, with the zero-cost portfolio having a negative beta. This evidence is related to the results of a size analysis, where they find that the loser portfolio is on average composed of smaller stocks than the winner portfolio, with both being overweighted in small stocks compared to the market average. Nonetheless, by repeating return calculations on size- and beta-based subsamples of their data, the authors find that, while somewhat related to the factors of size and beta, the momentum effect seems to be caused by serial correlation in the idiosyncratic part of returns and is not limited to specific subsamples of stocks. In an interesting subsequent calculation, they show that investors could have earned a risk-adjusted return of 9.29 percent annually, net of transaction costs, over the period observed. Searching for a seasonal component of returns they furthermore find that the relative strength strategy loses an average of 7 percent each January and that expected returns vary over the other months. Extending their period of analysis beyond the original 12 months, Jegadeesh and Titman find clear evidence for mean reversion. The return reversal effect in the two years following the first year after portfolio formation is strong enough to eat away half of the first year’s profits.

Analyzing the 1990 to 1998 period in a subsequent paper[99], Jegadeesh and Titman confirm their 1993 results.

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[99] Jegadeesh/Titman (2001a).

5.4.2.2. Chan, Jegadeesh and Lakonishok's 1996 Paper[100]

Chan, Jegadeesh and Lakonishok analyze all U.S. primary stocks listed on the NYSE, AMEX and Nasdaq stock exchanges which are covered by the CRSP and COMPUSTAT files from 1977 to 1993. They aim at finding momentum in stock returns and investigate whether analyst forecasts are systematically biased. For their paper they conduct several tests, each month forming ten equally-weighted decile portfolios from stocks ranked based on various measures of past returns and earnings news. With this method, they build upon the approach first employed in Jegadeesh and Titman (1993).

In their first test, they find evidence of price momentum for portfolios of stocks ranked by their compounded returns over a six-month period. The authors report that buying the top portfolio and selling the bottom portfolio yields an average annual return of 15.4 percent.[101] Interestingly, analysts are found to be overly optimistic in their forecasts and only gradually correct their reported views regarding loser portfolios; an effect which could be due to psychological factors or caused by incentives rewarding favourable estimates.

Ranking stocks by a measure of standardized unexpected earnings, the second test finds the arbitrage portfolio to yield 6.8 percent over six months. The authors argue that the markets do not fully reflect the information contained in unexpected earnings. Much of the abnormal returns occur at earnings announcement dates subsequent to the portfolio formation period because the markets are again surprised when their incorrect view of the stocks' returns is further corrected. Analyst forecasts are again found to be corrected only gradually, especially in the case of large negative earnings surprises.

In a subsequent multivariate analysis, Chan et. al. find that the strategies of ranking by prior return and ranking by past earnings surprises expose an underreaction to different pieces of information and do not subsume each other. Jegadeesh and Titman (2001) quote papers reporting that analyst forecast revisions add yet more predictive power to possible momentum strategies.

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[100] Cp. Chan/Jegadeesh/Lakonishok (1996).

[101] Chan et. al. call this strategy “buying the arbitrage portfolio” while in Jegadeesh/Titman (1993) it is referred to as “buying the zero-cost portfolio”. The terms are interchangeable.

Chan et. al. furthermore find evidence that markets are faster in correcting underreaction to earnings surprises than underreaction to past returns. They suspect that this effect is caused by the fact that earnings momentum strategies are based on the performance of near-term income, while prior returns reveal considerably larger revisions in market expectations of future prospects.

5.4.2.3. Other Evidence

Rouwenhorst (1998) conducts a momentum study of stock market returns in twelve European countries[102] over the period of 1978 to 1995, proving that the short-term momentum effect is not limited to U.S. markets. He uses selection and holding strategies similar to that of Jegadeesh and Titman (1993) with ranking and holding periods of 3, 6, 9 and 12 months. Under each combination of ranking and holding periods, winner portfolios outperform loser portfolios by about 1 percent per month, results significant at the 5 percent level. On average, winner and loser portfolios are smaller than the mean of the sample, with the portfolio of losers again being smaller than that of the winners. Furthermore, the momentum effect is not significantly reduced when controlling for country momentum. Similarly, while the continuation effect is stronger for smaller firms, it is present in all size categories. Since size and country are correlated, Rouwenhorst also controls for country-and-size effects and again finds that the momentum effect persists over all country-and-size portfolios. Additionally, the study finds a trend reversal after approximately one year, in line with studies similar to those quoted in section 5.4.1. Comparing a U.S. and a European momentum strategy shows that momentum returns are positively correlated across markets and suggests that the European strategy offers excess returns independent of a common component with the U.S.

5.4.3. Possible Explanations for the Momentum and Reversal Effects

The most commonly quoted reason for the momentum effect in the earlier studies is the markets' possible underreaction or overreaction to information. With the finding of evidence suggesting that stock price momentum might be

[102] The sample countries are: Austria (60 firms), Belgium (127), Denmark (60), France (427), Germany (228), Italy (223), The Netherlands (101), Norway (71), Spain (111), Sweden (134), Switzerland (154) and the United Kingdom (494).

accompanied by a later reversal effect, hypotheses evolved to take account of this fact and several more complex explanations have since then been offered and analyzed for validity. Four groupings of such “advanced explanations” are introduced below.

5.4.3.1. Unrepresentative Data

Fama and French[103] note that results similar to those of Chan et. al., as quoted above, defy explanation by their three-factor model. One possible reason they mention is that the short-term return continuation anomaly could be caused by data snooping. While they quote several studies which reach conclusions similar to their own, but over differing periods of time, they ask for international analyses to complement the U.S. results. This request can be considered fulfilled by the Rouwenhorst study[104] quoted above, which gives evidence opposing the hypothesis that the momentum and reversal effects could be caused by unrepresentative data. Evidence rejecting the data snooping explanation is also given by Jegadeesh and Titman (2001a), who use data over the period from 1990 to 1998 and find confirmation of the earlier studies' results in this out-of-sample test.

5.4.3.2. Irrational Investors

Another possible explanation voiced by Fama and French (1996) is that asset pricing is irrational and investors underreact to short-term past information while overreacting to long-term past information.[105] This explanation is expanded on by Jegadeesh and Titman (2001), who mark a distinction between the hypothesis of a possible underreaction followed by an overreaction and a hypothesis wherein investors overreact after a delay, possibly caused by positive feedback trading.

Psychological research suggests that investors tend to interpret successful investments as proof of their own abilities, while they have a propensity to discount negative developments of their holdings as bad luck. Up markets therefore cause these irrational investors to overestimate their stock-picking

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[103] Cp. Fama/French (1996), pp. 81.

[104] Rouwenhorst (1998).

[105] Cp. Fama/French (1996), pp. 81-82.

abilities and to overreact to further positive news.[106] Cooper, Gutierrez and Hameed (2004) prove that from January 1929 to December 1995 momentum profits on the NYSE and AMEX were indeed considerably larger following up markets than down markets,[107] which lends support to behavioural explanations for the momentum-and-reversal effect.

Haugen (1995) stipulates an opposing explanation. He suggests that short-term momentum and long-term reversal could be explained by short-term, lagged overreactions, which in the long-term lead to reversion when the market realizes its error.

Lakonishok, Shleifer and Vishny (1995) find market behaviour consistent with investors overreacting to information contained in stocks' earnings to price (E/P) and cash flow to price (C/P) ratios. Their results suggest that glamour stocks, i.e. stocks with low E/P and C/P ratios, underperform value stocks, which have relatively high E/P and C/P ratios over five-year periods after portfolio formation. They also find that value stocks are no more risky than glamour stocks. As possible reasons for this perceived phenomenon of persistent irrationality, Lakonishok et. al. quote money managers' preference for stocks which have a good track record and are therefore easier to justify to sponsors and investors who focus on short-term profits.

Hong, Lim and Stein (2000) offer no similar explanations, but show that small stocks and stocks covered by few analysts exhibit significantly more momentum than larger or better-covered stocks. In addition, they find that low-coverage stocks react more slowly to bad news than to good news. They explain this phenomenon by pointing out that the management of companies with good news will try to "push the news out the door themselves" whereas companies with bad news have little incentive to advertise them.[108]

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106 This statement relies on the assumption that most investors are long in the stock market. If the majority of investors were short in stocks, the reverse would be true.

107 While CAPM-adjusted momentum profits following markets up from a date three years earlier are a robust 1.12 percent during the first six months of the subsequent holding period, momentum profits following down markets are 0.01 percent and statistically insignificant. Similar results were obtained for different holding periods and momentum return-generating models

108 Cp. Hong/Lim/Stein (2000), pp. 267-268.

5.4.3.3. Missing Risk Factor

The third possible reason cited by Fama and French (1996) is that a fourth risk factor missing from their model could allow the formation of a similar framework which would, in addition to all other phenomena covered by their three-factor model, also explain the short-term return continuation.[109] Moskowitz and Grinblatt (1999) offer one such factor which could possibly fit Fama and French's description. They compare the effect of industry return momentum to that of short-term return continuation and find that industry momentum makes up part of the short-term return momentum reported in the literature.

Putting the Moskowitz and Grinblatt results into perspective, Jegadeesh and Titman (2001) quote several conflicting studies on this issue. Nonetheless, they too point out that in a world where taking risks is rewarded, high-risk stocks yield more than low-risk securities and that a missing risk factor is one possible explanation for the momentum effects documented in recent literature.

Chan and Chen (1991) suggest that this missing risk factor could be associated with the relative economic performance of firms. In a market conforming to an efficient equilibrium asset pricing model, such a factor of distress costs would be compensated by superior returns.

5.4.3.4. Non-Stationarity of Expected Returns

Jegadeesh and Titman (2001) argue that if the variation of risk premiums for bearing certain risks is serially correlated, momentum strategies will offer abnormal returns. This possible explanation follows a similar venue as the one of Fama and French (1988) presented in section 5.4.1 above.

Fama (1976a) presents this possible explanation in a particularly illustrative diagram, which is reproduced in Figure 1 below. He suggests a world where the equilibrium market expected return[110] on a security j at time t,

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[109] Cp. Fama/French (1996), pp. 82.

[110] This equilibrium expected return equals the risk-free rate of return plus the expected risk premium of the security.

$E_m\left[\tilde{R}_{j,t} \middle| \phi_{t-1}^m\right]$[111] wanders around $E\left[\tilde{R}_{j,t}\right]$, which is the long-run average value of $E_m\left[\tilde{R}_{j,t} \middle| \phi_{t-1}^m\right]$. In such a world's efficient markets, the equilibrium return expected by the market is the true expected return ($E_m\left[\tilde{R}_{j,t} \middle| \phi_{t-1}^m\right] = E\left[\tilde{R}_{j,t} \middle| \phi_{t-1}\right]$). The deviation of actual returns from expected returns conditional on all available information, $\tilde{R}_{j,t} - E\left[\tilde{R}_{j,t} \middle| \phi_{t-1}\right]$, is unpredictable from past deviations. Nonetheless, the deviation of observed returns from the unconditional expectation, $\tilde{R}_{j,t} - E\left[\tilde{R}_{j,t}\right]$, exhibits serial correlation with recent past deviations. If tests of market efficiency calculate autocorrelations using an assumed constant average return (implying a model where the statement $E_m\left[\tilde{R}_{jt} \middle| \phi_{t-1}^m\right] = E\left[\tilde{R}_{jt}\right]$ holds true), they would falsely reject the efficient market hypothesis.

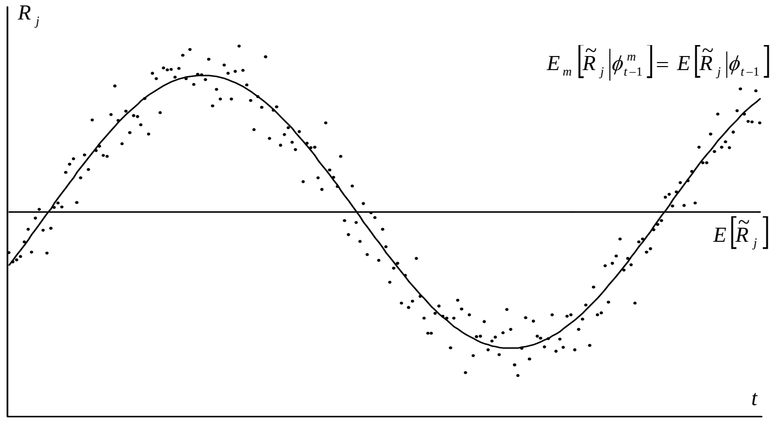

Figure 1
Hypothetical behaviour of returns in an efficient market where equilibrium expected returns wander substantially through time[112]

In contrast, Jegadeesh and Titman (2001a) find evidence speaking for a behavioural explanation for the momentum and reversal effects and against the explanation of non-stationarity in expected returns.

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[111] The expression ϕ_{t-1}^m signifies the set of information employed by the market to determine security prices at time $t-1$, while ϕ_{t-1} is the total set of information available at time $t-1$.

[112] Reproduced from Fama (1976a), p. 149.

5.5. Evidence from the Austrian Market

The first study on the efficiency of the Austrian stock market was Uhlir (1979). He tested for serial correlation of returns by comparing the number of observed runs in return signs[113] to the expected number of runs under independence of returns. His study's major results were that the stocks on the Austrian market exhibited significant first order correlation and significant dependence in price changes over very short intervals. While he rejected the random walk hypothesis over daily return intervals, he could not do so over biweekly or monthly periods.

Since this first study the Austrian stock market has gone through a number of evolutionary steps and more recent tests prove more favourable. Pichler (1993a) tests the Austrian stock market for a size effect and a day-of-the-week effect. Aussenegg and Grünbichler (1999) research the existence of a size and IPO effect in Austria. The two most recent papers by Mestel, Gurgul and Schleicher investigate the reaction of stock prices and trading volume, employing modern event study methodology. Due to their novelty value for the Austrian stock market and since they offer the most up-to-date verdict available on Austrian stock market efficiency, these studies are presented in some detail below.

5.5.1. Pichler's 1993 Test

Pichler (1993a) lists some of the problems in connection with tests of efficiency on the Austrian market. He uses log returns[114] of a sample of Austrian stocks over the period from January 1986 to December 1990 to analyze the size effect and day-of-the-week effect. Pichler finds no size effect for portfolios formed by market capitalization but cannot reject a size effect if grouping is done by segments of the stock market. Regarding the day-of-the-week effect, he finds statistically significant positive abnormal returns on Mondays. He traces this effect to the settlement procedure at the Vienna

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[113] Such a run is any uninterrupted series of either negative returns, positive returns or zero returns.

[114] The log stock returns employed are $R_t = \ln\left(\frac{P_t + D_t}{P_{t-1}}\right)$, where R_t is the return on day t, $\ln$ is the natural logarithm, P_t is the closing price on day t, and D_t is the dividend payment on the same day. See Pichler (1993a), p. 196.

exchange. Transactions at the Austrian stock market are settled on the second Monday following each calendar week. Due to this pattern, Monday returns (the returns from the closing price on the preceding Friday to the closing price on Monday) are not only made up of the stock returns on that day but contain also a return at the risk-free rate for the time until settlement. Since for Mondays this time span is one period longer than that for all other days, Pichler shows that Monday returns should, and indeed do exceed other days' returns by five times the daily return on a risk-free asset.[115]

5.5.2. Aussenegg and Grünbichler's 1999 Study

Aussenegg and Grünbichler (1999) use data from January 1986 to June 1997 in their study of the size effect in the most liquid segment[116] of the Austrian stock market. They report studies which find negative long-run performance for initial public offerings (IPOs). To separate this effect from the size effect, Aussenegg and Grünbichler separate stocks which were listed on the Vienna exchange through an IPO from other stocks, distinguishing between a group of all stocks and one of all non-IPO stocks. For each of these two groups they then form five equally-weighted size portfolios. In the group containing all stocks, they report no size effect for the whole period but find a positive size effect for the January 1986 to September 1991 subperiod and a significantly negative size effect for the October 1991 to June 1997 subperiod. In the non-IPO group, a positive size effect can be found for the whole period studied. Using the same subperiods, they observe a positive size effect over the earlier subperiod larger than in the group of all stocks and a size effect over the later subperiod which is less negative than in the larger group.

They also investigate a possible connection between the month-of-the-year effect and the size effect, as it is reported from other markets. They find that the size effect is larger in January and March and smaller in December, but significant only for the non-IPO group.

115 Pichler also shows that, more generally, his findings are true for the first day falling into any new settlement period, regardless of whether that day is a Monday or a different day of the week.

116 The "Amtliche Handel" on the Vienna stock exchange contains Austria's 94 largest stocks in terms of market capitalization. The study comprises 129 stocks, a number that includes companies which were delisted over the observation period.

Aussenegg and Grünbichler interpret their findings as proof that Austrian markets do exhibit a size effect, but that it is outweighed by the strong influence of the negative long-run performance of IPOs. Like in other markets, this size effect is subject to seasonal differences and in the case of Austria is largest in January and March and negative in December.

5.5.3. Mestel and Gurgul's 2003 Test[117]

In 2003, Mestel and Gurgul investigated the reaction of the Austrian stock market on public dividend announcements. The authors chose to employ various linear stochastic time-series models for the estimation of stock market returns, thereby deviating from the more common approach of using linear regressions based on the market model. Their sample consists of 22 companies listed on the Austrian stock market and quoted in the Austrian Traded Index (ATX) between January 1992 and April 2002, although several firms were not quoted for the whole period. The study uses as announcement date the very first date the company's board makes an official statement on dividends; if the information from that first statement is later revised, this revision is considered another announcement. Regarding the interpretation of their results, the authors caution that statements about dividends often coincide with information regarding earnings and that in such cases the stock market reaction caused by either cannot be separated. Another factor to be considered is the small sample size compared to other studies. An analysis that tests for the reaction of 22 stocks over a ten-year period cannot yield data as reliable as similar studies conducted over several decades on an index like the Standard & Poor's 500.

The dividend process in Mestel and Gurgul's paper is defined to be a martingale.[118] Their pre-event window spans fifty days while the event window covers five – the announcement day plus the two days before and after. Abnormal returns are calculated by subtracting the security's actual return from the expected return calculated using an ARIMA model.

Consistent with other studies, the Mestel and Gurgul results "support the hypothesis that the Austrian stock market reacts efficiently on news on

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117 Mestel/Gurgul (2003).

118 For the formal description of a martingale process, see section 3.1.2 and fn. 23.

dividends."[119] The study finds abnormal daily returns (cumulative abnormal returns for the event window) of 0.62% (1.81%) in the case of dividend increases and -1.36% (-2.02%) for dividend decreases. The results are statistically significant at the 1% level (5% level), while for constant dividend announcements the abnormal returns were not significantly different from zero. More importantly, only in one instance (day $t = +2$ after a dividend increase) do they find significant corrections of the initial reaction. All other cases prove consistent with a market which correctly reflects all information in prices on the day of its announcement. The authors confirm these results employing both a sign test and a signed rank test on the same data, which come up with similar results.

As a complementary approach, Mestel and Gurgul conduct an analysis of cross-sectional variance of abnormal returns over both pre-event and event window. The change in variance over this interval supports the choice of the event window, as variance increases over that period. Furthermore, they find that not only stock prices but also the variance of abnormal returns reacts on dividend announcements, with constant or decreasing dividend announcements leading to significantly increased variance.

5.5.4. Gurgul, Mestel, and Schleicher's 2003 Test[120]

In Gurgul, Mestel and Schleicher (2003), the authors employ the same underlying data as the paper by Mestel and Gurgul described above. Their pre-event window in this study spans 30 days, while the event window covers five days like in the above article.

The first notable departure from Mestel and Gurgul (2003) is the authors' reliance on the market model for the derivation of abnormal returns in this paper. These abnormal returns are calculated as follows:

$$AR_{j,t} = R_{j,t} - E\left[R_{j,t} \middle| X_j\right]$$

where

$AR_{j,t}$ .... Abnormal return of security j at time t.

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[119] Mestel/Gurgul (2003), p. 331.

[120] Gurgul/Mestel/Schleicher (2003).

$R_{j,t}$ .... Actual return of security j at time t in the event window.

E .... Expected value operator.

X_j .... Information set, where $X_j = \{R_{j,-32},...,R_{j,-3}\}$.

and

$$R_{j,t} = \alpha_j + \beta_j \cdot R_{m,t} + \varepsilon_{j,t}$$

where

α_j .... Market model excess return of security j.

β_j .... Market model beta-factor of security j, where $\beta_j = \frac{\operatorname{cov}(R_j, R_m)}{\operatorname{var}(R_m)}$.[121]

$R_{m,t}$ .... Actual return of the market portfolio at time t.

$\varepsilon_{j,t}$ .... Value of the error term of security/portfolio j at time t, assumed to be distributed as white noise.

The parameters α_j and β_j for each event are estimated using the Ordinary Least Squares method on the data in the pre-event window.

As in Mestel and Gurgul (2003), the data is then partitioned into three groups, according to whether dividends were announced to increase, decrease or remain constant. Consistent with the above-mentioned study, their results for both abnormal daily returns and cumulative abnormal returns over the event window find statistically significant positive abnormal returns in the group of increased dividend announcements and negative abnormal returns in the group of decreased dividend announcements, with no significant difference from zero for the constant dividend announcements. Once again the authors find that news are reflected in stock prices on the day of their announcement.

After investigating abnormal returns during the event window, the authors go on to analyze the variance of these abnormal returns. Their results mirror those of Mestel and Gurgul (2003) reported above.[122]

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[121] As the lack of the index t in this notation indicates, α_j and β_j are considered to be constant over time.

[122] Cp. section 5.5.3 and Mestel/Gurgul (2003), pp. 328-330.

Finally, Gurgul et. al. explore the reaction of trading volume on dividend announcements, using the same three partitions as above. To calculate the abnormal trading volume, they make use of the following formula:

$$AV_{j,t} = \log\left(\frac{V_{j,t}}{V_{m,t}}\right) - E\left[\log\left(\frac{V_{j,t}}{V_{m,t}}\right) \middle| X_j\right]$$

where

$AV_{j,t}$ .... Abnormal traded number of shares of security j at time t.

$V_{j,t}$ .... Traded number of shares of security j at time t.

$V_{m,t}$ .... Traded market number of shares at time t.

E .... Expected value operator.

X_j .... Information set, where $X_j = \left\{\log\left(\frac{V_{j,-32}}{V_{m,-32}}\right),\ldots,\log\left(\frac{V_{j,-3}}{V_{m,-3}}\right)\right\}$.

Their results support the hypothesis that dividend announcements convey new and valuable information to the market. Regarding the whole sample, trading volume is significant only on days $t = 0$ and $t = +1$, which suggests that market participants rebalance their portfolios mainly on the day of and the day after the announcement. Their most interesting finding, however, is that for the group of constant dividend announcements a significant abnormal trading volume shows that, even when dividends remain constant, investors revise their portfolios. In conjunction with the fact that stock prices in this group remain constant and variance increases sharply, their results suggest that market participants have heterogeneous beliefs which cancel each other out on average. Taken together the market's reaction again appears unbiased.

5.5.5. Other Evidence

5.6. Evidence from the German Market

Despite their limited number compared to U.S. markets, studies on the German market give a much clearer picture than that which can be drawn of the even less-analyzed and smaller Austrian market. The following studies provide an outline of the state of research and the evidence about market efficiency in Germany.

5.6.1. Uhlir's 1984 Review[123]

Uhlir reports that the German stock market is characterized by limited disclosure practices, the absence of a real competitive market for information and by infrequently traded shares. Regarding empirical research results concerning market efficiency, Germany lags behind other countries with developed capital markets.[124] Nonetheless, prices between German stock exchanges can be described as efficient, since intensive arbitrage leaves no profit opportunities to a strategy of trading between exchanges.

Tests of market efficiency in conjunction with the random walk model on the German stock markets conclude that the assumption of independence of subsequent returns does not hold over short intervals (one to four days). Similar to the situation in Austrian stock markets, it becomes an increasingly valid description when the interval length between observed returns is increased (i.e. weekly returns, monthly returns, etc.).

Uhlir furthermore quotes results which reject stationarity with regard to return variance. He then goes on and evaluates the evidence against weak-form efficiency by comparing trading-rule returns to buy-and-hold returns. While most trading rules yield superior profits gross of transaction costs, once these costs are taken into account the evidence is insufficient to reject weak-form efficiency.

Going one level further in Fama's efficiency hierarchy, Uhlir states that the small number of studies available indicates a moderate degree of semistrong-form efficiency. He cannot quote any studies on strong-form efficiency of the German market.

5.6.2. Krämer and Runde's 1993 Study[125]

Krämer and Runde examine the German equity market for return seasonality, putting a specific emphasis on statistical significance. In their test of the day-of-the-week effect, they employ data of a total of 7506 daily returns (all daily

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[123] Cp. Uhlir (1984).

[124] Research of efficiency on German markets is complicated by the fact that large parts of the shares of publicly traded companies are held by the state.

[125] Cp. Krämer/Runde (1993).

returns from January 1960 through December 1989) and find a significant Monday effect very similar to that reported for the U.S. stock market.[126]

They also test for a holiday effect, analyzing daily DAX returns from April 1960 through March 1990 and find that, over that period, close to a third of the total growth of the DAX companies stemmed from abnormal returns over holidays. This effect is all the more remarkable since mean Sunday returns were negative. Nonetheless, these findings are qualified by the fact that the authors "stumbled" over this effect and formed their hypothesis after having discovered a significant reduction of mean returns when removing holidays for the test of the day-of-the-week effect. This mode of discovery gives rise to the possibility of data snooping, which is in need of confirmation or rejection by subsequent studies.

At the end of their paper, Krämer and Runde caution against the unqualified adoption of research results confirmed by significance tests based on the assumption of finite return variances. They show that if variances are infinite, as proposed by many authors, the values representing limits of significance change. This effect could lead to erroneous belief in the significance of research findings.

5.6.3. Glaser and Weber's 2003 Study

Glaser and Weber (2003) are the first to investigate a relation between momentum profits and turnover for the German stock market. Their data covers the daily and monthly closing prices and daily traded volume of 446 companies listed in the top segment of the Frankfurt stock exchange over the period from June 1988 to July 2001. They form five equally-weighted, monthly rebalanced portfolios by ranking stocks based on returns over a formation period of 3, 6, 9 and 12 months. Independent of this grouping, they form three portfolios by ranking stocks based on the average daily turnover[127] over the

[126] Krämer and Runde specifically quote French (1980), Gibbons/Hess (1988) and Keim/Stambaugh (1984), all of whom find mean Monday returns very similar to the -0.161 percent Krämer and Runde derive for the German market. For more on return seasonality, especially on U.S. markets, see section 5.1.2 of this thesis.

[127] Daily turnover is defined as the number of shares traded on a particular day divided by the number of shares outstanding at the end of that day.

same formation period as before. Finally, they report abnormal returns over holding periods of 3, 6, 9 and 12 months.

Glaser and Weber find statistically significant returns on their momentum portfolio[128] for all strategies except those with 3-month formation period and 3-month holding period, 3/6 and 6/3 periods. They also report that they observed a reverse size effect over the period of their study, i.e. small stocks on average had a lower return than large stocks. Since their portfolios are equally-weighted, this characteristic of their sample period should cause a downward bias in the momentum profits detected.

Consistent with other studies, Glaser and Weber show that turnover is positively correlated with absolute returns, as they find the largest turnover values for extreme winners and extreme losers. Furthermore, high-turnover winners outperform low-turnover winners. They also confirm that some of their momentum profits are explained by adjusting for the factors of size, book value-to-market value and industry. Studying longer holding periods, Glaser and Weber show that the momentum effect largely disappears after 12 months. Finally, they find a turn-of-the-year effect causing January returns to be higher on average than returns during the rest of the year. Momentum strategies are unprofitable in January and large parts of high returns of high-turnover momentum strategies are due to the months of October to December.

5.6.4. Other Evidence

Guy (1977) uses value-weighted, monthly return data for 90 German stocks from January 1960 to December 1970 to analyze the behaviour and efficiency of German stocks. His sample includes the fifty largest companies, according to market capitalization of widely held stock, and forty chosen at random from the remaining population. Guy finds that small stocks on average have higher returns than large stocks, consistent with patterns on other markets.

Contrary to Uhlir's results, he finds strong serial correlation, especially for the 50 large companies, despite using monthly return data. Guy also reports that betas for German companies are relatively stable over time in tests developed

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[128] The "momentum portfolio" is formed by buying the winner portfolio and selling the loser portfolio. The term is interchangeable with the terms "arbitrage portfolio" and "zero-cost portfolio" used in section 5.4.2.

to minimize measurement error and that their behaviour is consistent with the domestic capital asset pricing model.

Frantzmann (1989) uses daily return data on 100 German stocks and three market indices from the period of January 1970 to December 1985 to study efficiency on German equity markets. He finds that mean Friday returns are relatively high, while returns on Monday and Tuesday are, depending on the period observed, either not significantly different from zero or significantly negative. This effect can partially be explained away by adjusting for settlement practices on German equity markets. Frantzmann furthermore observes a turn-of-the-month effect, with significantly positive returns existing only on the two days at the end and the four days at the beginning of the month. He finally tests whether trading strategies can be formulated to profitably exploit the anomalies net of transaction costs. Unable to find such trading strategies, he concludes that German equity markets are weak-form efficient.

An interesting detail of his results is that, over the sample period studied, the return standard deviation of large stocks[129] is approximately 70 percent higher than that of small stocks.

Like Guy, Stehle (1997) finds a significantly positive size effect over the period 1954 to 1990. Small stocks over this period generate mean returns on average 2.27 percent larger than those of large stocks. Adjusting for risk using the CAPM, he even reports a 6 percent size effect. In addition, he shows that 75 percent of this size effect is due to the months of January and February.

5.7. Evidence from Bond Markets

The earlier chapters show an extensive body of literature and research investigating the efficiency of equity markets. The same cannot be said of fixed-income markets, even though in terms of the dollar volume of transactions, they are at least as large as the equity market. Nonetheless, the below paragraphs give an outline of some notable studies conducted on the bond market and provide an overview of their results.

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[129] He classifies stocks as large if their publicly traded equity capital exceeds 2 million DM on December 31, 1985.

Jordan and Jordan (1991) use CRSP data on the Dow Jones Composite Bond Average index for January 1963 to December 1986 to analyze seasonality in daily bond returns. Their test for a day-of-the-week effect finds that equal mean returns by day of the week cannot be rejected. A subsequent test, in contrast, identifies a clear week-of-the-month effect. Returns on the Dow Jones Composite are significantly greater in weeks 1 and 2 than in week 4. This result is consistent with similar studies quoted by the authors, but shows a different pattern than the week-of-the-month effect observed on stock markets.[130] Jordan and Jordan furthermore cannot find a prominent turn-of-the month effect. In a final test, they find that they can reject equal mean returns across months and that the bond index is subject to the January effect.

Section 5.1.2.1 already reported the findings of Gibbons and Hess (1981), who discover a strong day-of-the-week effect for U.S. treasury bills qualitatively equalling their results for stocks. Among possible explanations for their results they test for an influence of settlement periods and a hypothetical systematic measurement error - neither of which proves an adequate explanation.

Frantzmann (1989) analyzes pricing anomalies in German bond markets using a sample of 259 bonds of the German state, railway and postal service. Investigating the period from January 1980 to December 1985, he finds a significant day-of-the-week effect, with Tuesday returns being lower than returns on the other days of the week. Monday returns conversely are higher, an effect which can be explained away when adjusting for the fact that Monday returns include the returns of Saturday and Sunday. The search for a month-of-the-year effect reveals significant differences in return variances across months, but does not suggest a January seasonal. Frantzmann furthermore discovers no evidence for a turn-of-the-month effect. Finally, since he finds no profitable trading strategies exploiting the stronger anomalies on equity markets, similar strategies can be expected to be equally unprofitable on bond markets.

[130] Equity markets have their highest returns in the first week and their lowest in the third week of the month.

6. Summary and Conclusion

As in so many areas other than finance, some questions cannot be answered by an unqualified "yes" or "no". Rather than asking whether markets are efficient, academic research over the past decades has shown that the question should be how efficient they are.[131]

In the 1970s weak-form efficiency was considered to hold by the larger part of the academic community, while this was never so clear of semistrong- or strong-form efficiency. Considering the larger part of the literature available today, markets can be described as not conforming to the strong-form efficient market hypothesis. Furthermore, while over large areas markets appear to come close to the theoretical ideal, a number of anomalies inconsistent with market efficiency in the semistrong or even the weak sense have been confirmed. The most notable among them are the seasonality of stock returns and the momentum and reversal effect. Both have seen a great deal of attention in the academic literature and have withstood attempts to reconcile them with traditional market efficiency. The size criterion also plays an interesting part in the scholarly discussion, in that small firms are more significantly anomalous in the two effects mentioned above, as well as in several other observed phenomena.

A partial explanation of these inconsistencies with market efficiency is that efficiency exists, but with a certain tolerance band formed around efficient prices by transaction costs. Many authors point out that, while markets are not efficient, deviations of prices from values are in most cases too small to be exploited profitably. Moreover, the influence of transaction costs is generally exacerbated in samples with small firms. Maybe the view that markets could be as efficient as transaction costs allow gives some comfort to proponents of the efficient market hypothesis, which is, after all, based on a world without such expenses.

Shleifer and Summers wrote that if the efficient market hypothesis were a publicly traded security, "its price would be enormously volatile."[132] This

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[131] Cp. Bodie/Kane/Marcus (2002), p. 355.

[132] Cp. Shleifer/Summers (1990), p. 19.

observation can easily be backed up by a comparison of its “price” in the late 1970s with today’s quotation.

Over the 1980s and 1990s, many anomalies have been confirmed and a number of behavioural models are currently being proposed, each of which explains one or more of the anomalies encountered. Fama (1997) emphasizes the need to find a model which can replace the efficient market hypothesis. He stresses that, while recent behavioural finance frameworks are capable of describing individual anomalies exceptionally well, they fail at explaining other phenomena and thus offer no new universal paradigm with explanatory power comparable or superior to that of the efficient market hypothesis. He goes on to write:

> “…it is safe to predict that we will soon see a menu of behavioural models that can be mixed and matched to explain specific anomalies. My view is that any new model should be judged … on how it explains the big picture. The question should be: Does the new model produce rejectable predictions that capture the menu of anomalies better than market efficiency? For existing behavioural models, my answer to this question (perhaps predictably) is an emphatic no.”[133]

In the end the word is not yet in on how efficient markets really are. Since this topic remains high on the list of many researchers, however, further results can be expected in the future. The question of the importance of the efficient market hypothesis for finance on the other hand has long been answered. Market efficiency research has had a highly visible impact on real-world practice. Prior to the work on efficiency, investment managers were believed to have access to considerable amounts of private information. The rise of passive investment strategies over the last decades is both a direct refutation of that belief and a clearly visible result of market efficiency research.

This thesis tries to give a basic overview of the material available on the topic of the efficient market hypothesis, to allow the reader to consider new findings against the background of this information.

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[133] Cp. Fama (1997), p. 8.

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