THE EFFICIENT MARKET HYPOTHESIS: A CRITICAL REVIEW OF LITERATURE AND METHODOLOGY

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Abstract. *The development of the capital markets is changing the relevance and empirical validity of the efficient market hypothesis. The dynamism of capital markets determines the need for efficiency research. The authors analyse the development and the current status of the efficient market hypothesis with an emphasis on the Baltic stock market. Investors often fail to earn an excess profit, but yet stock market anomalies are observed and market prices often deviate from their intrinsic value. The article presents an analysis of the concept of efficient market. Also, the market efficiency evolution is reviewed and its current status is analysed. This paper presents also an examination of stock market efficiency in the Baltic countries. Finally, the research methods are reviewed and the methodology of testing the weak-form efficiency in a developing market is suggested.*

Key words: *market efficiency, random walk, stock returns, investor rationality, Baltic stock market*

Introduction

The efficient market hypothesis (EMH) has been under academic and professional consideration for many years. Its wide research has been driven by multiple reasons. First of all, a risk-weighted return is expected to be higher in inefficient markets. Therefore, research in the field of stock market efficiency is important for both private and institutional investors. Comprehensive understanding of market efficiency is also crucial for corporate executives whose decisions and actions determine perceived value of companies. The EMH may also be used to model the development of the stock market being important for stock market operators and supervisors. Finally, the EMH is an underlying assumption in multiple financial models. In recent years, the academic and professional focus has shifted to the behavioural finance theory, yet it does not eliminate the usefulness of the EMH.

The aim of this article is to review the status of the EMH with the emphasis on the Baltic stock market. The issue of global research on stock market efficiency has been addressed by quite a number of scholars. The very first ideas and findings in the field date back to the 19th century. Those ideas were later gradually developed and gained

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popularity until they reached a peak in the eighties. However, the Baltic stock market and its efficiency have a much shorter history. The market lacks a comprehensive research as a lot of previous works were built on misleading assumptions.

The efficient market concept

An efficient market theory is still an important part of modern finance. Its empirical evidence is ambiguous, but the concept itself is sound.

The EMH may be applied to capital markets. The present capital market efficiency is primarily associated with the cost efficiency, while other markets are often analysed from the perspective of the allocation efficiency (Blume, Durlauf, 2008). In general, an efficient stock market is a market where stock prices reflect fundamental information about companies. In such a case, the market value of the company changes in a way very similar to that of the intrinsic value of a company. These changes are not consistent with the value and do not restrain from trading financial assets. The differences in investor awareness and uneven transaction costs prevent fundamental changes in value to be completely and immediately reflected in market prices (Goedhart, Koller, Wessels, 2010). However, if markets are efficient, changes in asset prices cannot be reflected in algorithms, while excess return is gained as a success rather than an outcome of a correct prediction. Allen, Brealey and Myers (2011) defined a market as efficient when it was not possible to earn a return higher than the market return. In other words, the value of shares reflects the fair value of the company and is equal to the future cash flows discounted by an alternative cost of capital. Eakins and Mishkin (2012) argued that an efficient market was a market where asset prices fully reflected all information available. Generally, the essence of an efficient market is built on two pillars: 1) in efficient markets, available information is already incorporated in stock prices; 2) in efficient markets, investors cannot earn a risk-weighted excess return.

Considering the information reflected in market prices, market efficiency is usually broken down into three levels. Weak, semi-strong, and strong forms of market efficiency are distinguished. In weakly-efficient stock markets, the current stock price reflects all information related to the stock price changes in the past. Such information includes data on previous prices, trading volume, etc. Based on the above-mentioned information, it becomes then impossible to make excess profit in a stock market. Thus, if the market is weakly, efficient, technical analysis yields no excess return. In semi-strongly efficient markets, current stock prices reflect not only information about historical prices but also all current publicly available information, e. g., announcements of acquisitions, dividend pay-outs, changes in accounting policy, etc. Finally, in strongly efficient markets, current stock prices reflect all possible information which does not necessarily have to be public. This form of market efficiency implies that it is impossible to earn excess profit while

trading on insider information which seems to be unlikely (Malkiel, 2011). On the other hand, some authors see the strong form of market efficiency as possible since insider trading is not legal (Schwert, 2003). Many empirical studies have confirmed the weak form of market efficiency in different capital markets. In addition, this form of market efficiency is among assumptions in the valuation of stocks and options (Palan, 2004). In turn, the results of the semi-strong market efficiency studies vary considerably, while the strong form of market efficiency has not been broadly investigated, and the obtained results indicate market inefficiencies (Mishkin, Eakins, 2012).

The efficient market hypothesis is closely related to other financial models and assumptions. First of all, absolute or partial rationality of market participants is essential for its efficiency. It is often agreed that not all market participants are rational, resulting in part of trades being not based on a rational analysis. On the other hand, the trades of irrational investors are random, which should not influence the stock price. For instance, if a share price is positively affected by a random purchase, it will adversely be negatively affected by a random sale, because the probability of random purchase and random sale is the same (Shleifer, 2000). In terms of trading methods, investors can be grouped into informed investors and noise traders. Informed investors rely on fundamental analysis while noise traders do not consider all available information when trading. Goedhart, Koller and Wessels (2010) divided investors into intrinsic value investors, traders, and mechanical investors. The intrinsic value investors ground their trading decisions on a fundamental analysis, while traders use technical analysis, and mechanical traders exercise trades according to rules (e. g., index replication). The study conducted by Goedhart, Koller and Wessels (2010) showed that it was the intrinsic value investors who had a major impact on stock prices as their trades were concentrated and large. Thus, even though the existence of irrational investors is generally recognized, their influence on stock prices is often considered to be negligible (not in behavioural finance, though). This conclusion is closely related to the arbitrage theory which assumes irrational investors creating risk-free profit opportunities for others. Sophisticated investors spot these opportunities and eliminate irrational prices by trading mispriced securities. The EMH is also closely linked with the capital asset pricing model (CAPM) and securities substitution theory. The CAPM is often employed to measure the risk in testing the efficient market hypothesis.

Evolution of the EMH

The idea of market efficiency initially appeared in the 19th century. It reached its academic maturity in the eighties, however, since then its popularity and empirical validity has declined.

Similar thoughts to the random walk theory were first expressed in the 17th–18th centuries. Howe, the very first ideas of random walk came from other fields than finance: mathematics, botany, physics, logic (Sewell, 2011). In turn, the economic terms of the efficient market theory were found at the end of the 19th century. According to De Moor, Van den Bossche and Verheyden (2013), the founder of the efficient market theory was G. Gibson. In 1889, he published a book on London, Paris and New York stock exchanges, arguing that stock prices reflect the views of the smartest market participants. Gibson saw stock valuation as a voting process in which the participants vote on in which direction the stock price will change. Smartest participants would eventually gain more votes for their correct guesses which would allow them to accumulate more funds (De Moor, Van den Bossche, Verheyden, 2013). Another pioneer in the efficient market theory was a French mathematician L. Bachelier who published "Speculation theory" in 1900 where he argued that the expected return of an investment is always equal to zero (Sewell, 2011).

In the first half of the 20th century, a number of significant works attempted to demonstrate the randomness of stock prices. In 1905, K. Pearson became the first to use the concept of "random walk", but he used it in the context of botany, not finance. In 1925, F. MacCauley compared the stock market to the coin-tossing game. A little later, in 1933, the U.S. economist A. Cowles, after having analysed trade statistics of professional investors, concluded that professional investors were unable to predict future prices and earn excess profit. Cowles came to the same conclusion again in 1944, having analysed the U.S. stock market data. However, the works published right after the Great Depression were significantly influenced by the prevailing distrust in financial analysts and financial markets in general. At that time, the economic theory developed rapidly and was heavily influenced by the work of J. M. Keynes. While Keynes intended primarily to explain the developments in the real economy, he also provided some insight about the financial market and asset prices. In 1923, Keynes argued that the gain of investors is not associated with the better ability to predict the future but is a consequence of higher risks taken. On the other hand, in 1936, in "The General Theory of Employment, Interest and Money", Keynes argued that trades in stock market are driven by "wild instincts" rather than rational considerations. This assumption, in turn, may fit better in behavioural finance rather than in the efficient market theory.

After World War II, the number of studies supporting the EMH increased. In 1953, M. G. Kendall analysed a time series of 22 stocks and concluded that stock returns were random. This result came as a surprise to many economists at that time (Dimson, Mussavian, 2000). Later, one after another H. Roberts (1959), A. Larson (1960), and S. Alexander (1961) confirmed the EMH (Sewell, 2011). On the other hand, similar results were not always statistically significant; moreover, there were opposite results reported

by other researchers. In 1964, S. Alexander concluded that the S&P index does not follow the random walk, while W. Steiger concluded that stock prices are predictable. Thus, in the post-war period, the number of studies on the EMH increased, but not all of them affirmed the hypothesis. In addition, over that period, the EMH remained in the shadow of the rational expectations theory and the CAPM.

The EMH reached its peak of popularity in the eighties (Shiller, 2003). It was the U.S. economist E. Fama who contributed most and whose works have become classic in the field of market efficiency. In 1965, E. Fama confirmed the randomness of stock prices and for the first time defined the "efficient market" concept. Further, he claimed that the evidence on the EMH was so strong that it could only be neglected by large-scale empirical studies (Fama, 1965). In 1967, H. Roberts first coined the concept "efficient market hypothesis" and divided market efficiency into the strong and the weak forms. In 1970, this division was expanded by Fama who added the semi-strong form of market efficiency. Fama defined an efficient market as the market where information is "fully reflected", and proposed to carry out market efficiency tests in line with the asset pricing tests (Fama, 1970). At that time, the idea of market efficiency was popular among the academics but still little known to professionals. This situation changed in 1973 when B. Malkiel published his book "A Random Walk down Wall Street". According to Shiller (2003), after the appearance of Malkiel's book, fascination with the EMH spread from academics to professionals. However, in 1976, S. Grossman pointed to the market efficiency paradox: the more investors believe in market efficiency, the less efficient market becomes. Grossman claimed that if there is a general consensus that the market is efficient, the participants begin to act passively and cease to collect information, which would lead to inefficiency.

In the last decades of the 20th century, many studies on the EMH concluded inefficiency. In 1980, S. Grossman and J. Stiglitz claimed that markets could not be efficient since the cost of information existed. Return on investment must be therefore higher than the cost of information, otherwise the propensity to invest would disappear. Later, the U.S. economist R. Shiller opposed the EMH with the concept of excess volatility. He concluded that the actual volatility of stock prices had been higher than that calculated on the basis of fundamental information. De Bondt and Thaler (1985) reconfirmed Shiller's hypothesis of excess volatility. According to them, people tend to overreact to company announcements, the result of which is reflected in stock prices. In addition, De Bondt and Thaler (1985) first noticed that in January stock returns were generally higher than in other months, which could not be explained by fundamental information only. In 1986, F. Black was the first author to define "noise traders". Unlike some authors presented above, Black claimed that noise traders could make a considerable influence on market prices. In 1990, the EMH was rejected by B. Lehmann and N. Jegadeesh (Sewell,

2011). Fama (1991) claimed that it was not obvious whether returns seemed predictable due to market inefficiency or whether this was driven by misleading assumptions in asset pricing models. Even though the opposition to the EMH became stronger, a number of studies still proved the validity of the EMH. In 1997, K. Chan concluded that global stock markets were weak-form efficient. In 1998, Fama argued that an overreaction in stock markets was as common as underestimation which therefore did not lead to inefficiency. Criticism reduced the popularity of the EMH, but the idea of market efficiency remained relevant in modern finance.

The modern approach to the EMH

The significance of the EMH in the modern financial theory remains a subject of discussion. Shiller (2013) called the EMH "half-true". The EMH perfectly describes trading conditions in the modern stock market, because the information flow and trade execution are faster than ever. On the other hand, there are certain patterns in stock prices, which the EMH fails to explain.

The traditional argument for the weak-form efficiency is return independence which is usually measured by correlation. Allen, Brealey and Myers (2011) analysed a set of blue-chip companies where the correlation coefficient of return on two consecutive days ranged from -0.03 to 0.03. This led to the conclusion that stock return today will not influence the stock return tomorrow. One could argue that a one-day period is too short to spot the potential dependencies. On the other hand, Allen, Brealey and Myers (2006) showed that the results remained nonetheless unchanged when analysing weekly returns. Serial correlation tests had repeatedly validated the EMH when analysing returns of individual companies as well as equity indices (Parks, Zivot, 2006). Stock market predictability could be tested by applying the trading rules of technical analysis, but these rules often fail to yield a constant excess return (Schleifer, 2000). Parks and Zivot (2006) argued that technical analysis would only be profitable if transaction costs did not exist. Technical analysis is not popular among academics but is still widely applied by professionals (Mishkin, Eakins, 2012). For this reason, one could assume that the methods of technical analysis are not applied at their best when used in academic research.

Another argument for the weak-form efficiency is a timely and accurate stock price adjustment after key announcements (e. g., mergers and acquisitions, divestitures, stock splits). The research of stock price changes after the key announcement is often referred to as "event studies". The results of event studies have many times proved the presence of semi-strong market efficiency. Shleifer (2000) analysed aggregated data on investor reaction to corporate news and concluded that price adjustments were in line with the semi-strong form of market efficiency. Shleifer (2000) claimed that stock price drift began before the actual announcement, showing market anticipation or information leaks.

On the announcement day, the stock price would jump up or fall down to its new intrinsic value and remain relatively constant for at least one month. Shleifer (2000) argued that this price change was not only rapid but accurate as well, i. e. announcements were not followed by further price corrections. The latter are often questioned and debated by the academics. Some of them emphasise the obstacles for accurate and timely price corrections: irrational market participants, uneven access to information, and differences in transaction costs. Event studies could depend on inverse test methodology, i. e. researching stock price stability in the absence of corporate news. Scholes (1972) confirmed the stability of stock prices in the absence of information.

The comparison of the active and passive portfolio management illustrates another point in favour of the EMH. If actively managed portfolios fail to outperform passive portfolios, it is then not profitable to collect market information, and the market is efficient. Allen, Brealey and Myers (2011) outlined the following returns of the U.S. mutual funds: mutual funds earned higher returns[1] than their benchmarks in 16 of the 47 years studied. The aggregate excess profit must have been negative or close to zero, which is in line with market efficiency. Malkiel (2003) estimated that around 70% of the mutual funds from 1991 to 2001 earned lower returns than their benchmarks. After having increased the data sample, Malkiel (2011) found that 66% of the U.S. mutual funds from 1970 to 2010 had lower returns than their benchmarks. Mutual funds with a constant excess return may suffer from data aggregation, but studies show that there are very few funds with a stable outperformance. Malkiel (2011) argued that mutual funds which were profitable in a short term did not remain profitable in a long term. In addition, the best mutual fund managers in one year earned only an average return the next year. Thus, their results were not consistent, which is compatible with market efficiency.

Multiple modern finance phenomena appear to be incompatible with the EMH. First, investing in small-cap companies yields generally higher returns than investing in large-cap companies. It was Fama and French (1988) who studied this phenomenon as well. They concluded that small firm effect did not discredit the EMH but was a result of a misleading assumption in the CAPM. Fama and French (1988) argued that the slope of the market line is greater than it should be in practice. In other words, the risk taken is less dependent on the correlation of company and market return. Conversely, many studies presented this phenomenon as a shortcoming of the EMH. Malkiel (2003) estimated that from 1963 to 1990 stocks of small companies returned approximately 1.4 times more than those of large companies. However, the empirical soundness of the small firm effect is no longer as strong as before. Mishkin and Eakins (2012) assumed that this was a result of extensive empirical studies: the modern investor was well aware of

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[1] After management fee.

this phenomenon and included it in modelling the risk. Close to the above-mentioned phenomenon is the so-called value effect, i. e. value stocks tend to outperform growth stocks. Surprisingly, a higher return was not necessarily due to the higher risk taken (Allen, Brealey and Myers, 2011). Vuolteenaho (2002) showed that 75% of the U.S. corporate profits could be explained by changes in the P/BV ratio. Shleifer (2000) claimed that the P/E and P/BV ratios could be used to predict the future share price, which is a contradiction to the market efficiency. Campbell and Shiller (1998) estimated that the P/E ratio could explain around 40% of the future stock price volatility. The value effect was also recognized by Fama and French (1995), but they interpreted it as a result of additional risk.

As mentioned earlier, excess volatility is among the key contradictions to the EMH. Shiller (2003) compared the curves of the discounted aggregate dividends of the U.S. companies and the S&P index. The obtained results showed that the discounted dividend curve had remained relatively flat over the last two decades, while the S&P fluctuated considerably (Shiller, 2003). In contrast, Shiller found significantly different results by examining non-aggregated data and assumed that the market may be inefficient on the macro-level but efficient on the micro-level. Schwert (2003) drew similar conclusions as he saw aggregated data being suitable for profitable predictions. Another phenomenon, closely related to excess volatility, is overreaction to unexpected corporate news. In other words, stock price tends to fall lower than it should and rise higher than it should according to its newly calculated fair value. This phenomenon is more apparent when unexpectedly bad news is announced (Mishkin, Eakins, 2012). In addition, studies have also indicated under-reaction to corporate news. Battalio and Mendenhall (2005) found that investors tended to underestimate financial announcements. Kaniel et al. (2012) argued that in 2000–2003 stock prices in the NYSE maintained a positive drift three months after the publication of corporate financial results. Other stock market anomalies also include mean reversion and inclusion into the index, but their empirical justification is ambiguous and not yet comprehensive.

Stock price seasonality is incompatible with the EMH as well. In particular, it is the so-called "January effect" which has drawn many studies. The "January effect" stands for the higher average returns in the first month of the year. Eakins and Mishkin (2012) argue that this occurs when investors close unprofitable positions at the end of the year to reduce the tax burden. Later, in the beginning of the next year, the reverse happens, and investors use their cash to open new positions. However, this assumption does not explain why institutional investors, who are free from the income tax, do not take the opportunity to buy more shares at the end of the year. Malkiel (2003) claimed that this market anomaly seems to be profitable on paper but difficult to exercise in practice due to transaction costs. In addition, the January effect is more common to small firms but does

not necessarily apply to the stock market in general (Schwert, 2003). Another seasonal anomaly in the stock market is called the "January barometer" as returns in January help to predict returns during the rest of the year. However, results on the January barometer are not clear-cut. Stivers, Sun and Sun (2009) researched data in 22 countries over 100 years and concluded that the January barometer was more pronounced in the last century and is less noticeable in the recent years. In turn, Marshall and Visaltanachoti (2010) argued that the January return data could not help to make a significant excess profit. Meanwhile, Bouman and Jacobsen (2002) showed that returns were relatively higher not only in January but also during the whole period between November and April. Equity markets also tend to show higher returns at the end of the week than in the beginning of the week. Furthermore, the stock market is most volatile at the beginning and at the end of the trading session (Allen, Brealey, Myers, 2011). Thus, in terms of frequency, the stock market seasonality is diverse.

A number of contradictions to market efficiency arise from the irrationality of market participants, which is analysed in behavioural finance. It is not only amateur investors who make irrational decisions. When asked about future returns of the S&P 500, individual investors saw them directly proportional to the current rate of return, while institutional investors saw them inversely proportional (Shefrin, 2007). Thus, in both cases investors had a false perception of the probability of future returns, which in behavioural finance is called "gambler's fallacy". This phenomenon is described as a human tendency to distort the probabilities of future events by the outcomes in the past. In addition to the gambler's fallacy, Baker and Nofsinger (2010) pointed out the following irrational phenomena as the most common ones: loss aversion, over-confidence, anchoring, framing, confirmation bias. Coval and Shumway (2005) found loss aversion to be the most common pattern in irrational behaviour and argued that investors are more risk-averse in the beginning of the day. Bailey, Kumar and Ng (2011) obtained similar results when analysing data on individual investors. The irrational behaviour may lead to short-term discrepancies in stock prices as well as long-term asset bubbles. According to Shiller (2003), it is the feedback effect which evokes asset bubbles. Shiller (2000) used studies in psychology to argue that the herd behaviour is common among human beings, including investors. Malkiel, Mullainathan and Stangle (2005) argued that asset bubbles emerged as investors failed to maintain a short position in a mispriced asset (due to accumulated loss). To round up, the irrational behaviour offers many challenges to the EMH as it questions investors' ability to make a correct judgment on the mispriced securities.

In modern finance, the EMH maintains arguments for as well as contradictions (see Table 1).

TABLE 1. **Arguments for and contradictions of the EMH**

Arguments for	Contradictions
• Return independence	• Small firm and value effects
• Inefficient trading rules	• Excess volatility and overreaction
• Event studies	• Seasonality
• Passive portfolio management	• Irrational behaviour

Source: compiled by the authors.

Table 1 encompasses the phenomena which vary in their empirical evidence. Differences arise due to uneven methods of analysis. For instance, there is no consensus on how risk may be measured in market efficiency tests. Further, it is arguable if irrational behaviour in financial markets has a considerable impact on asset prices. All this leads to an ambiguous status of the EMH in modern finance.

Research on the Baltic market

Stock market efficiency in the Baltic States has been insufficiently considered or covered by scholars. The first studies on the topic appeared fifteen years ago, but the total number of studies is still low. Researchers have tested weak and semi-strong forms of market efficiency in the region. The nature of data, research methods and the period of time analysed vary considerably. One can distinguish ten in-depth works on market efficiency in the Baltic States (see Table 2).

TABLE 2. **Research on stock market efficiency in the Baltic States**

Year	Authors	Form	Market	Data	Efficient?
1998	D. Klimašauskienė, V. Moščinskienė	Weak	Vilnius	Stocks	Yes
1998	V. Butkutė, P. Moščinskas	Weak	Baltic	Stocks	Yes
1998	I. Korhonen	Weak	Baltic	Index	No
2002	O. Basdevant, V. Kvedaras	Weak	Baltic	Index	No
2002	D. Linowski, T. Mihailov	Weak	Riga	Index	No
2003	M. Januškevičius	Weak	Vilnius	Index	No
2004	G. Mieška	Weak	Vilnius	Index	Partly
2005	K. Kiete, G. Uloza	Semi-strong	Vilnius, Riga	Stocks	Partly
2008	V. Jazepčikaitė	Semi-strong	Baltic	Stocks	No
2008	L. Laidroo	Semi-strong	Baltic	Stocks	No
2012	V. Eizentas et al.	Semi-strong	Vilnius	Stocks	No

Source: compiled by the authors.

Butkutė and Moščinskas (1998) as well as Korhonen (1998) carried out the first tests on market efficiency in the Baltic countries. Butkutė and Moščinskas (1998) ran unit root tests to analyse the randomness of stock returns where the null hypothesis of randomness could not be rejected for 16 out of the 25 stocks analysed. Korhonen (1998)

concluded that the Baltic stock markets are inefficient but significantly influenced by the U.S. stock market. Basdevant and Kvedaras (2002) had to reject the null hypothesis of market efficiency as well. On the other hand, they found that the Lithuanian and Estonian stock markets were approaching market efficiency since stock returns became harder to predict. Meanwhile, the Latvian stock market maintained a significant predictability of stock returns, and convergence to market efficiency could not be observed. Basdevant and Kvedaras (2002) argued that traditional market efficiency tests should not be applied to developing stock markets, and suggested applying a time-varying variance ratio. Jarmalaitė (2002) analysed the relationship between financial ratios and stock returns in the Baltic stock market and concluded that fundamental information was best reflected on the Estonian stock market.

About 2008, studies of Jazepčikaitė (2008), Laidroo (2008), Bistrova and Lace (2009) were published. Jazepčikaitė (2008) analysed the impact of mergers on market efficiency in the Baltic stock market. The study encompassed data on abnormal returns following the publication of corporate news in 2001–2007. Given the methodology, Jazepčikaitė (2008) was the first author to test the semi-strong form of market efficiency in the Baltic countries. However, Jazepčikaitė (2008) concluded that the market was not efficient. Laidroo (2008) analysed the impact of corporate news on stock returns and found that 22–37% of returns could be explained by fundamental data which is half as little as in developed stock markets. Both Jazepčikaitė (2008) and Laidroo (2008) concluded that fundamental analysis was a profitable tool as the Baltic stock market was not semi-strongly efficient. Conversely, Bistrova and Lace (2009) showed that fundamental analysis could not yield excess return in the Baltic countries. The authors indicated the P/E ratio as the most relevant in predicting future returns. A few years later, Gembickaja and Stankevičienė (2012) studied whether the momentum and contrarian trading strategies could gain excess return in the Baltic stock market. The authors concluded that, although there were some opportunities to gain excess profit in the short term, these opportunities were largely limited and disappeared completely in the long term. Laidroo and Grigaliūnienė (2012) shifted focus back to the fundamental analysis when studying investor reaction to corporate news. They found an overreaction to bad news during the booms and an under-reaction to good news during the recessions.

In addition to the general research on the Baltic countries, there were also some works on local markets. In 1998, Klimašauskienė and Moščinskienė (1998) studied returns of five Lithuanian stocks where the null hypothesis of weak-form efficiency could not be rejected. Linowski and Mihailov (2002) found that technical analysis was more profitable than „buy and hold" strategy in the Latvian stock market, which led them to conclude the market inefficiency. Januškevičius (2003) employed neural networks and simulated trading based on technical analysis. The trading rules beat the "buy and hold"

strategy, and Januškevičius (2003) concluded that the Lithuanian capital market was inefficient. Interestingly, neither Linowski and Mihailov (2002) nor Januškevičius (2003) adjusted returns according to risk in their studies. A year later, Milieška (2004) found that only certain parts of the Lithuanian market could be efficient, but the whole market was inefficient. His tools of analysis included autocorrelation tests and runs tests as well as trade simulation. Trading rules showed that market inefficiency could be profitably exploited. Kiete and Uloza (2005) argued that the Lithuanian stock market was semi-strongly efficient, while the Latvian market was not, which was rather surprising and difficult to reconcile with similar studies. Eizentas, Krusinskas and Stankevičienė (2012) found the opposite, i.e. that the Lithuanian stock market did not fit the requirements for the semi-strong efficiency.

The research carried out on market efficiency in the Baltic countries has not yet been comprehensive. Studies usually confirm market inefficiency, as one could expect considering the market size and age. Interestingly, some authors chose to analyse the semi-strong form of market efficiency having no strong evidence of weak efficiency. This was a misleading shift in assumptions, which should not be followed in the future research.

Testing the weak-form efficiency

Having analysed the previous research in the field, one can design a robust methodology for the future tests. As pointed out above, studies on the Baltic stock market may first focus on the weak-form efficiency as its empirical evidence is not yet strong. Due to a relatively long history of the EMH, there are well-established methods of the analysis of market efficiency. However, the authors suggest taking additional measures when studying developing stock markets, such as the Baltic stock market.

In case of a developing stock market, the market size and liquidity should be analysed first. This analysis is important for three main reasons: 1) the calculation of the basic descriptive statistics may help to make a better interpretation of the serial correlation and unit root tests; 2) it allows to split the market into different segments according to liquidity; 3) stock market liquidity goes usually in line with its efficiency. As for the equity markets, the liquidity concept encompasses the possibility to execute large transactions with a low cost (Banerjee, Ghosh, 2004). Low liquidity in the stock market provides a possibility to make rather accurate predictions of stock prices and gain an excess profit which shows market inefficiency. In addition, the liquidity indicators themselves can be used as independent variables in forecasting stock returns.

Tests of randomness in stock returns may be divided into four main groups: serial correlation, runs, variance ratio, and unit root. Serial correlation, or autocorrelation of a time series, measures correlation between different points in time. A relatively high serial correlation would indicate the predictability of stock prices, based on historical prices. One

way to conduct a serial correlation analysis is to calculate multiple correlation coefficients and compare them with critical values (e. g., Higgs and Worthington (2004)). Another way to measure a serial correlation is the Box-Pierce statistics[2] which is a weighted average of multiple correlation coefficients calculated at different time lags. The resulting coefficient is later compared with the critical value on *chi*-distribution. The Box–Pierce statistics has been often employed in studying market efficiency (e. g., Milieška (2004), Borges (2008), Ajao and Osayuwu (2012)). A few years after the Box–Pierce statistic appeared, it was modified with fit finite samples better. This modification is known as the Ljung–Box statistics and is currently widely used when testing market efficiency. According to Li (2009), it is the most common serial correlation test nowadays. The Ljung–Box approach was applied by Bui (2006), Al-Nahlehb and Al-Zaubia (2010), Chadha et al. (2012). Even though serial correlation is usually measured in linear terms, methods exist to measure non-linear correlations as well (see Bui (2006) and Magnus (2008)).

Closely related to serial correlation tests are runs tests[3] which also determine whether stock returns could be considered as a random process. One must first calculate positive and negative runs, i. e. positive and negative consequent changes in stock prices. Given the sample size and the number of runs, the test statistics is calculated. In sufficiently large samples, these statistics can be compared with the critical values of a normal distribution. Meanwhile, the initial data on stock prices do not necessarily need to be normally distributed as the runs test is a non-parametric statistics. Li (2008) argued that the runs test may be suitable for initial assumptions about market efficiency but not for an in-depth research and should be, therefore, used as a complementary method.

As pointed out by Li (2008), serial correlation in stock returns is a necessary but not sufficient condition of market efficiency. Researchers often choose to add the variance ratio to their studies. The variance ratio was proposed by Lo and MacKinlay (1988) and remains among the most common tools to analyse market efficiency (Lim, 2009). The variance ratio is a ratio of two independent variance coefficients in one sample. If this ratio is significantly close to zero, the given market is efficient. Variance ratios are often classified into individual and multiple (Charles and Darne, 2009). One can find many applications of the variance ratio in modern studies (e. g., Kim and Shamsuddin (2008), Borges (2008), Li (2008), Chadha et al. (2012), Basdevant and Kvedaras (2002)).

Market efficiency could be also analysed by running unit root tests for a time series of stock returns. These tests are based on the presumption that if a time series has a unit root it does not follow a deterministic process and is, therefore, hard to predict. In other words, if stock returns are not stationary, they may keep a weak-form efficiency. In terms of calculation, unit root tests are close to autocorrelation tests. There are two

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[2] Also known as Q-statistics.
[3] Also known as Wald-Wolfowitz test.

main modifications of unit root tests: the Augmented Dickey–Fuller (ADF) test and the Phillips–Perron test. The ADF regressions include a lagged dependent variable, while the Phillips–Perron method uses non-parametric statistics. The ADF test has been often applied in modern research, and many works on market efficiency have it among their methods of analysis (e. g., Klimašauskienė, Moščinskienė (1998), Butkutė, Moščinskas (1998), Bui (2006), Al-Nahlehb, Al-Zaubia (2010)).

The above-mentioned methods test the randomness of stock returns. However, if stock returns are not random, it could not necessarily be exploited by earning excess return. In order to measure the possible excess gains, the back-testing of technical analysis strategies is often employed. As pointed out earlier, if technical analysis is profitable, the market is inefficient, and vice versa. Technical analysis strategies derive from the three main concepts: momentum, trend, and patterns (Credit Suisse, 2012). Backtesting technical analysis is not as widely used as statistical methods, but having in mind the concept of the EMH, it should be conducted every time stock returns are not random. Backtesting has already been applied to the Baltic stock market by a few authors (Januškevičius (2003), Milieška (2004)).

To round off, a comprehensive methodology of testing the weak-form efficiency in a developing market may include liquidity analysis, statistical tests of randomness, and backtesting of technical analysis.

Conclusions

The concept of efficient market could be split into two parts. First, stock returns are random in an efficient market. Second, market participants cannot earn excess profit in such a market. Since its inception, the EMH had received much attention and was seen as the almost absolute truth in the eighties. However, since then, many studies have concluded market inefficiency, and the EMH is now seen as truth on relative terms instead. The EMH fails to explain excess volatility in stock prices, investor overreaction, seasonality in returns, asset bubbles, etc. On the other hand, stock returns are often found random, and investors are not capable of constantly earning an excess return.

Research work on market efficiency in the Baltic countries has not yet been comprehensive. Studies usually confirm market inefficiency to be dependent on market size and maturity. Interestingly, some authors chose to analyse the semi-strong form of market efficiency without having a strong evidence on weak-form efficiency. This was a misleading shift in the analysis, which should not be followed in future research.

Studies on the weak form of market efficiency in developing markets may first consider the liquidity analysis as it helps to break down the market into distinctive segments. In addition, statistical methods to test randomness in stock returns may be applied and opportunities to earn excess profit may be explored by running backtesting of technical analysis strategies.

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