Title: Essays on Turkish Equity Market

by Naghi Naghiyev

A thesis submitted for PhD in Finance

Supervised by:
Dr. Eugene Nivorozhkin
Dr. Svetlana Makarova

University College London, UK

April 2022

Declaration Page

‘I, Naghi Naghiyev confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.'

Abstract

Essays on the Turkish Equity Market is a critical examination of dynamic properties of the price formation in the Turkish equity market.

Chapter 1 examines the evidence of a weak-form efficiency of the Turkish equity market (TEM). A wide range of equity indexes and statistical tests, such as autocorrelation, stationarity, unit root, and variance ratio tests and estimation of the GARCH-In-Mean model, are employed to examine the random walk and martingale hypothesis in TEM. The results are effectively uniform and provide little supporting evidence regarding TEM's weak-form market efficiency hypothesis.

Chapter 2 makes a significant contribution to understanding the time-varying efficiency of TEM. We examine the validity and persistence of the size effect in the cross-section of Turkish equity returns while correcting for the effects of noisy prices using the buy-and-hold method implemented in the literature. The size effect for the overall sample period of 18 years is consistent with the estimates for developed markets but, as expected, becomes statistically insignificant when the biases in computed returns are alleviated by calculating the buy-and-hold and risk-adjusted returns.

Chapter 3 is a novel attempt to re-examine the time-varying efficiency of TEM, particularly using a natural experiment recently presented when Turkey faced the potential downgrade by MSCI from the emerging to the frontier market status in 2020. Turkey is similar to other emerging markets going through reversals in the degree of integration with the rest of the world. The decrease in the Turkey market betas from the historical highs is unlikely to signal a decrease in exposure to systematic risk and is more likely to be related to a prolonged decline in the market sentiment and a significant decrease in the degree of TEM integration. We also illustrate the likely effect of institutional investment flow on market betas of listed equities.

Impact Statement

The overarching goal of the PhD thesis Essays on Turkish Equity Market is a critical examination of dynamic properties of the price formation in the Turkish stock market.

Chapter 1 examines the evidence of a weak-form efficiency of equities traded on the Istanbul Stock Exchange (ISE). Unlike many other studies, this study analyses a comprehensive dataset consisting of 15 price and total return equity indexes capturing the majority of Turkish-listed equities and investment styles. A wide range of tests, such as autocorrelation, stationarity, unit root, and variance ratio tests, as well as estimation of GARCH-In-Mean model are employed to examine the random walk and martingale hypothesis in the Turkish stock market. Overall, the results provide little supporting evidence regarding the weak-form market efficiency hypothesis in the Turkish stock market. All statistical tests tend to be consistent with each other and indicate no evidence supporting weak-form market efficiency in the Turkish stock market. The results also tend to be consistent with those of previous literature, except for the results of the variance ratios.

Chapter 2 presents a novel attempt to examine the validity and persistence of the size effect in the cross-section of Turkish equity returns while correcting for the effects of noisy prices using the buy-and-hold method implemented in the existing literature. The size effect is related to the significant differences in the equity return across firms of different sizes. The stylised fact is that the average return in the lowest market-value decile tends to exceed the average returns of firms in the top decile even after risk adjustment. Chapter 2 makes a significant contribution to understanding the time-varying efficiency of the Turkish equity market. The observed size effect for the overall sample period of 18 years is consistent with the estimates for developed markets but, as expected, becomes statistically insignificant from zero when the biases in computed returns are alleviated through calculating the buy-and-hold returns. It also appears that the magnitude of the size effect fluctuates significantly across sub-periods, occasionally presenting investors with attractive returns, which nevertheless are hard to time. As expected, a more rigorous risk-adjustment procedure significantly decreases the magnitude of estimated excess returns.

Chapter 3 is a novel attempt to re-examine the time-varying efficiency of the Turkish equity market, particularly using a natural experiment recently presented when Turkey faced the potential downgrade by MSCI from the emerging to the frontier market status. Our results for Turkey appear to be consistent with the results for other emerging markets going through reversals in the degree of the market and the overall economic integration with the rest of the world. Historically, the decrease in the Turkey market betas from the historical highs is unlikely to signal a decrease in exposure to systematic risk and is more likely to be related to a prolonged decline in the market sentiment and a significant decrease in the degree of Turkish market integration. Our results also appear to provide support to “the inelastic markets hypothesis”, which implies that flows in and out of the market could have a significant impact on prices and risk premia. The results appear to illustrate the likely effect of institutional investment flow on market betas of listed equities.

To my father

Acknowledgements

First and foremost, I am grateful to my supervisors, Dr Svetlana Makarova and D. Eugene Nivorozhkin, for their invaluable advice, patience during my PhD study and never-ending support. Their plentiful experience has encouraged me throughout the research. Their support was not limited to academic advising but also included technical support. It is their kind help and support that have made my study in the UK a delightful time. I also would like to express my gratitude to Dr Konstantinos Delaportas, who encouraged me through all challenges and never hesitated to share his own PhD experiences. Finally, I am thankful to my parents, my wife, and my children, for putting up with my “PhD challenges”. I am lucky to have such a patient and listening wife, who stressed as much as I did, was happy as much as I was, going through all roller-coasters together with me all along. Thank you.

Table of Contents

Table of Figures

List of Tables

Introduction

This PhD thesis presents a critical examination of the historical behaviour of the Turkish Equity Market as captured by assets traded on the Istanbul Stock Exchange (ISE). In it, I apply a range of strategies to shed more light on the issues, such as market efficiency and integration, which have previously been debated by the existing finance literate, particularly in the area of emerging markets finance.

The efficient market hypothesis (EMH) has received remarkable attention in both academic and policy discourse during the last decades and has triggered numerous debates pertaining to its meaning, explanatory and forecasting power, political and financial repercussions, and overall validity. A thorough examination of the literature indicates that there is a series of disagreements among academics and market practitioners related not only to the validity of the EMH but also to how and whether it can be tested accurately. As Ţiţan (2015, 442-443) points out, "[e]ven if many tried to find the truth behind the EMH, no ultimate conclusion exists. There are many opposing opinions regarding this theory; for each article that confirms the hypothesis, there is another that invalidates it." Indeed, the existing literature is characterised by a plethora of different methods, statistical models, datasets under examination, time frameworks and last but not least, findings (Sewell, 2012). Although the ambiguity of the EMH has been well documented in the literature, as demonstrated by the multiple coexisting interpretations (Walter, 2006; Challe, 2008; Vuillemey, 2013), it is essential to discuss the EMH for primarily two reasons further. Firstly, it has had an impact on the practices and decision-making process of the market participants. Secondly, it has influenced the regulation of financial markets over the last decades and has contributed to establishing a regulatory and policy framework (Brisset, 2017; Charron, 2016; Delcey, 2019).

The Turkish equity market has been traditionally classified as an emerging market and has been extensively studied as part of the emerging markets group and on its own. A common feature of empirical emerging market studies is that the results evolve over time. Because of their nature, emerging markets tend to develop more dynamically relative to developed ones as they gradually mature from relatively low levels in terms of size, liquidity, and regulation.

The recent global trends towards passive and factor-driven investment strategies, particularly among institutional investors, tend to depend critically on the emerging markets' economic and trading environments. A market has to remain "accessible" and "investable" to be driven by global risk factors. In other words, it has to remain a meaningful part of a globally diversified equity portfolio.

As expected, the degree of emerging equity markets' integration with the global equity market tends to evolve over time. Despite typically positive long-run trends in the degree of emerging equity markets integration with the rest of the world, it is easy to find examples of "a temporary disintegration" (as in Turkey in Chapter 3 of this thesis) or a more permanent "disintegration", as demonstrated by Russia in the aftermath of the Ukraine War. The global investment trends mentioned earlier also suggest that the returns on investable market benchmarks, such as the ones provided by MSCI and other index providers, would be more likely to convey accurate information. The investable benchmark index returns are more likely to behave in accordance with the Efficient Market Hypothesis (EMH) compared to the generic capitalisation-weighted indices.

Before proceeding to present the papers that have been composed for this PhD, it is essential to provide an overview of the theoretical and empirical literature on EMH. The primary objective of this review is twofold. On the one hand, it critically examines and elaborates on the enduring ambiguity of EMH and discusses the key concepts that are omnipresent in any discussion related to the EMH (i.e. efficiency, market anomalies, random walk, etc.). On the other hand, it refers to emerging market economies with a particular focus on the case of ISE, as examined by various researchers during the last three decades. In reference to emerging market economies, it is essential to state that although one can notice an increase in empirical research, attention has been paid primarily in the literature to the developed markets of the Western world. This constitutes an omission, and this study seeks to highlight how ISE, in particular, may offer valuable opportunities for risk diversification to investors (Balaban, Candemir and Kunter 1996). Indeed, when it comes to the EMH, it is essential to discuss the implications that it has both for the regulatory authorities as well as for the investors "who make their decisions based on current market values and expected risk-return trade-offs that are associated with such investments" (Aga & Kocaman, 2006, p. 45).

To address the ambiguity of the EMH and to understand its relevance in investment terms, this section is divided into three subsections. The first section provides a theoretical and empirical overview of the EMH with the objective of discussing the core arguments in favour of EMH as well as the inherent contradictions and flaws. The second section discusses EMH in the context of emerging market economies and pays attention to the existing market inefficiencies. Lastly, the third section focuses on the particular case of the ISE. It presents the methods, datasets, series and critical findings related to the validity of the EMH in Turkey to identify which method, dataset and timeframes are more suitable for the case under examination.

EMH: a theoretical and empirical overview

EMH has a long intellectual history that goes back to the 16th century when the mathematician Girolamo Cardano in his book entitled "The Book of Games of Chance" (quoted in Sewell 2011, 2). Since then, many scholars started to reflect in broader terms and different disciplines on the significance of notions such as market efficiency. However, it was the French Mathematician Louis Bachellier who, in his work on speculation in 1900, developed the mathematics and statistics of Brownian motion to explain market efficiency in terms of martingale. Others followed, and, especially in the aftermath of the Wall Street Crash in 1929, attention was paid to stock market fluctuations, stock market forecasting, and investors' decision-making, something that Keynes (1936) famously termed 'animal spirits'. Although there were efforts to understand and operationalise market efficiency, it was first Eugene Fama who defined an efficient market as "a market where there are large numbers of rational profit maximisers actively competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants" (1970, 383). Fama argues that prices quickly absorb new information under these circumstances and adjust accordingly. This suggests that in an environment where numerous rational participants compete with one another, discrepancies between the actual prices and intrinsic values, albeit difficult to measure, can be eliminated and lead to random price fluctuation around the share's intrinsic value. Regardless of the various definitions found in the literature, Fama's work still represents both the starting point and the main point of reference in the existing literature, as it has triggered numerous debates about the validity of EMH and paved the way for the development of new statistical methods.

According to Fama's original work, some conditions are necessary for the market to become efficient. Firstly, there need to be numerous investors who are rational and are actively participating in the market. Secondly, in the presence of irrational investors, the rational participants would act in such a way as to counteract their impact without causing any change in the prices. Lastly, there are no transaction costs, free access to information, and the share prices adjust immediately after any new information gets released. Therefore, the core assumptions refer to liquidity, the existence of a large number of rational market participants, the limited impact of irrational decisions on the price, and the free dissemination of information at approximately the same time. The term "efficiency" represents the core concept of the EMH. This term implies that investors cannot beat the market unless they decide to invest in higher-risk assets (Malkiel, 2011; Ţiţan, 2015).

Market efficiency is categorised into the following three categories: i) weak, ii) semi-strong, and iii) strong. Weak form efficiency refers to the information set, including only the history of prices. However, Fama (1991) expanded this definition to incorporate variables such as dividend yields and interest rates. It follows that in a weakly efficient market in a stock exchange, the share price reflects all information related to the past and includes data such as trading volumes and historical price action. This means that in a weakly efficient market, technical analysis – defined simply as the analysis of historical data and past trading activity with the objective of predicting price movements – yields no excess return.In a semi-strong efficient market, the price is not limited to the reflection of historical data. However, it further includes information which is publicly available such as dividend pay-outs, acquisition or merger plans, and changes in corporate governance, among others. All information reflected on it is publicly available. Lastly, strong form efficiency refers to the information set that includes all information known to any market participant (i.e. publicly available and private information). It is important to note that these forms are nested in that each successive set is a superset of the preceding set.

Nevertheless, as mentioned, various scholars have criticised the EMH during the last decades. Grossman and Stiglitz (1980) argued that the information costs serve as an obstacle to market efficiency, further suggesting that the return on investment needs to exceed the information costs. Otherwise, the inclination to govern information for investment would be limited. Referring to the concept of excess volatility, De Bondt and Thaler (1987) argued that the volatility of the share prices has been increasing. This could not be attributed to the information produced by fundamental analysis. The key observation was that market participants have the inclination to overreact to any announcements. Attention was also paid to the so-called 'January paradox', where one could notice higher stock returns that the release of fundamental information could not explain. Other scholars, such as Black (1986), argued that noise traders impact market prices. Furthermore, Jegadeesh and Titman (1993) find evidence against the

EMH in their work, and others have followed during the last decades. As Degutis and Novickytė (2014, 20) point out, "[t]he 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".

Overall, there are multiple market anomalies that either are not included or cannot be explained by the EMH. The anomalies manifest in different forms, and according to Thaler (1999, 13-14), the main categories are: "i) volume, ii) volatility, iii) cash dividends, iv) the equity premium puzzle, v) predictability". Regarding volume, one would assume, based on standard models of asset markets, that the volumes would be thin as in an environment characterised by rationality, investors would be unwilling to sell, for instance, shares of Apple, wondering what the aspiring buyers know that they do not. However, the reality is more complex as there are liquidity and rebalancing needs. Concerning volatility, one would expect that prices change would change in a way reflecting changes in the intrinsic value of an asset.

Nonetheless, according to Shiller's work (1981), prices change more often and are more volatile. Dividends also are puzzling as under the EMH; they would be irrelevant. However, considering the various tax implications (i.e. high taxes for dividends), many market participants prefer repurchasing shares rather than paying cash dividends. In addition, the equity premium puzzle presents another challenge as the return differential between equities and bonds (e.g. T-bills) is too great to be explained solely by risk. Lastly, when it comes to predictability, although the main proposition of EMH in the 1970s was that "future returns cannot be predicted on the basis of existing information" (Thaler, 1999, p. 14), now a widespread assumption is that prices are characterised at least to some extent by a degree of predictability.

The existence of market anomalies has triggered numerous debates. Although Fama acknowledges the existence of these anomalies, he believes that they should be seen as derived from either asset pricing theories or simply chance (Fama & French, 1998). Such claims have gained importance from a behavioural perspective in recent years. For example, Kahneman and Tversky (1979) argue that these anomalies result from the investors' cognitive limitations that can lead to erroneous decisions. Overall, the debate on the validity of the EMH is ongoing. Yen and Lee (2008), in their survey over the last five decades, which analysed the empirical evidence on the EMH, concluded that it no longer has the acceptance that it had in the past.

For this reason, Lo (2004) proposes the adaptive market hypothesis, which suggests that "market efficiency is not an unconditional phenomenon but a criterion that varies continuously over time and across markets" (Mobarek & Fiorante, 2014, p. 218).

EMH In the Context of Emerging Market Economies

EMH has been one of the most contested issues in finance, but a careful examination of the literature reveals that attention has been primarily paid to developed economies. This has to do with a number of reasons, such as data availability. However, the primary reason is that, under the prevailing views, emerging markets are less frequently efficient than developed ones.

Numerous particularities of emerging markets can explain the need for more efficiency. The main observation is that low liquidity in a market hampers information dissemination in many different ways. More precisely, it is stated that it seriously limits the capacity of the market-makers and the market participants to accommodate orders (Chordia et al., 2005). Furthermore, emerging markets tend to privilege the emergence of powerful players who have the capacity to cause a deviation of a share price from its intrinsic value (Mobarek & Keasey, 2000). In addition, the low institutional quality and the poorly designed and/or limited protected regulatory framework alongside limited corporate information, weak experience in auditing, and negligent disclosure requirements result in weak and often distorted fundamental information (Blavy, 2002). In this context, many also refer to the significance of political and economic irregularities accompanied by market fragmentation that causes low efficiency (El-Erian & Kumar, 1995). Lastly, the fact that these markets are characterised overall by an underdeveloped and weak 'culture of equity' suggests that market participants do not have the necessary tools and knowledge to process and respond accordingly to the information available, thus weakening efficiency (Aloui, 2005).

Nevertheless, there still needs to be consensus on the degree of efficiency of the emerging markets as the empirical results are mixed. The primary reason is that although many treat these markets as a monolithic group, the reality is more complex as there are significant differences in terms of countries' institutional quality and market development (Lagoarde-Segot & Lucey, 2008, p. 95). Lastly, some point to the information leakage prior to public announcements (Bhattacharya et al., 2000) and high serial correlations in the returns (Harvey, 1993).

Some authors, however, have found evidence in favour of the EMH. For example, Dickson and Muragu (1994) analysed the Stock Exchange in Nairobi, and their findings supported the EMH, whereas Balkiz (2003) analysed the stock exchange in Kuala Lumpur and identified limited support for the EMH in its weak form. Overall, without going into further details, one can discern studies that refer to the non-randomness of stock returns in emerging markets (Balaban, 1995; D'Ambrosio, 1980; Grieb & Reyes, 1999; Kawakatsu & Morey, 1999; Urrutia, 1995) and studies that examined the same markets and arrived to the opposite conclusion (Butler & Malaikah, 1992; Liu, Song, & Romilley, 1997; Panas, 1990; Buguk & Brorsen 2003). As discussed in the next section, the ISE constitutes an interesting case as the previous findings are mixed.

Development of the Istanbul Stock Exchange and the financial sector in Turkey and previous work on Turkish EMH

Various researchers have examined the ISE during the last three decades. However, as the review will demonstrate, the findings are mixed and inconclusive. This ambiguity might be derived from the analysis of different markets characterised by different levels of development as well the employment of different methods and models with various levels of restrictive assumptions. Adopting a historical perspective/approach, the primary objective is to refer to the main findings, the datasets, and the timeframe and, most importantly, analyse the methods used to identify the most suitable models and variables for this case under examination.

Nonetheless, before analysing the literature, it is essential to provide a brief overview of Turkey's stock exchange. The history of the stock exchange dates back to the late Ottoman period. In 1866 The first stock exchange in Istanbul, the Ottoman Stock Exchange, was established during the reign of Sultan Abdulaziz. The contemporary period of its development began in 1954 when it became a member of the International Organization of Securities Commissions (IOSCO), a global regulatory organisation for securities markets. The milestone date was 1985 when it was officially established under the name of the Istanbul Stock Exchange, also called Borsa Istanbul (see Chambers, 2006). In 2005, the ISE underwent a major restructuring with the establishment of a new holding company, the Istanbul Stock Exchange Group (ISEG), which was responsible for the management and development of the exchange. In the same year, the market for derivatives was established, and the volume of daily stock transactions increased significantly. Further on, in 2013, the ISE merged with the Istanbul

Gold Exchange and the Derivatives Exchange of Turkey to form Borsa Istanbul, a fully integrated exchange for equities, commodities, and derivatives.

Today, Borsa Istanbul is one of the largest exchanges in the region, with a broad range of products and services, including equities, bonds, commodities, and derivatives. The exchange is a crucial driver of economic growth in Turkey and an important hub for international investors looking to access the Turkish market. It is also well integrated within the global financial market.

The financial sector in Turkey has a long and complex history, with many changes and reforms over the years. In the early years of the Turkish Republic, the financial system was mainly under state control, with a centralised banking system and limited private sector involvement. In the 1960s and 1970s, the government began to liberalise the financial system, allowing for the establishment of private banks and other financial institutions. The government also began to deregulate the economy and encourage foreign investment. Further on, in the 1980s, the government undertook a major reform of the financial sector, known as the "1980 Financial Revolution". This included the privatisation of state-owned banks, the establishment of a more independent central bank, and the liberalisation of interest rates. The reform also allowed for removing restrictions on foreign investment and establishing a regulatory framework for the financial sector.

Moreover, the government undertook a major program of economic stabilisation, including fiscal austerity and inflation targeting. In the early 2000s, the government continued to pursue financial sector reforms, mainly through establishing a deposit insurance system and modernising the banking sector. The government also implemented several economic reforms to reduce inflation and increase financial stability. In the 2010s, the Turkish financial sector continued to grow and modernise, establishing new financial institutions and expanding existing ones. This results in establishing positive relations between financial development and economic growth, which was found to be statistically significant by Abar (2022).

However, ongoing economic problems, including inflation and political instability, negatively impacted the development of a dynamic capital market and stock exchange (Chambers, 2006). Hence, while discussing in the subsequent sections the evolving efficiency of the Turkish Stock exchange, it is important to mention that regardless of its development during the last decades, the market remains vulnerable to the macroeconomic conditions of the country and the various political crises of the last years. Despite the challenges, the financial sector in Turkey has become increasingly modern and integrated with global financial markets, and the country has emerged as an important financial centre in the Middle East and North Africa region. According to World Bank data, in 2022, the market capitalisation in Turkey, commonly called a market cap, is the market value of a publicly traded company's outstanding shares, which was at the level of 237,474 mil. US$. This gives Turkey the 33rd position out of 100 countries listed and one of the leading in the region. This is above such countries in the Region as Qatar (165,396 mil. US$), Kuwait (105,987 mil. US$) and others.

Erol and Aydogan (1991) were the first to examine the ISE. They arrived at the conclusion that stock returns appear to be influenced by economic variables such as unexpected inflation and real interest rates. Muradoglu and Önkal (1996) observed a delayed relationship between the financial and monetary policies, and the core finding of their research was that the ISE is not semi-strong form efficient. Özmen (1997) found that the negative Monday effect, which was observed in many developed capital markets, was not observed in the case of the ISE, and Monday was the second-highest return day of the week after Friday. The analysis also showed that, on average, the calendar months did not have the same returns.

Muradoglu and Oktay (1993) conducted a similar research between 1988-1992 and identified a strong day-of-the-week effect. More precisely, it was found that Fridays provided the highest return, further indicating that there is also a strong calendar month and the January effect in the ISE. The overarching argument was that the ISE is not weak form efficient. Muradoglu and Ünal (1994) also observed that the stock returns in the ISE presented a significant deviation from the weak form efficiency. Demire and Karan (1994) confirmed these findings in his research, arguing that in 1988-1993, Fridays provided the highest return and that there was a January effect. Muradoglu and Metin (1995) argued that the ISE is not semi-strong form efficient, and in the study of Balaban, Candemir and Kunter (1995), one could find similar results.

Other authors found evidence of efficiency. In particular, Zychowicz et al. (1995) concluded that the daily and weekly returns in the ISE do not follow a random walk, something which needed to be confirmed by the monthly data. Balaban (1995) examined the daily returns from 1988 to 1994 and rejected the weak form of efficiency. Over a similar period, Demire and

Karan (1996) showed that excess returns could be achieved in the long run, which again he used as evidence against the EMH.

Balaban and Balu (1996) examined the period from January 1988 – June 1995 in order to evaluate the inside-of-month effects. The main finding was that although there was no significant difference in statistical terms, the first half of the month seemed to provide better returns than the second half of the month. Balaban and Candemir (1995) focused on the holiday effects in ISE and confirmed previous studies on the impact of holidays on the behaviour of the stock market. More evidence on day-of-the-week effects was provided by Dagli (1996) arrived at the conclusion that Friday produced the highest average return, whereas Tuesday produced the lowest. Özmen (1997) tested the period January 4, 1988 – June 7, 1996, to identify whether the ISE was weak-form efficient. The findings revealed seasonal trends in certain periods, thus indicating that future prices can be predicted based on the analysis of historical data. Demirer and Karan (2002) also examined the "daily effect" in the ISE and identified anomalies inconsistent with EMH.

Buguk and Brorsen (2003) used various tests to examine the efficiency and still needed to get a consistent view of the efficiency of the markets. The results were different in other comparative works where Turkey was not the only country in the sample. For example, Smith and Ryoo (2003) focused on five medium-size stock markets in Europe with the characteristics of emerging market economies. Regarding Turkey, the findings indicated a random walk for the ISE. The critical factor confirming or rejecting the hypothesis was, according to the authors, the levels of liquidity. More precisely, they stated that "liquidity is much greater on the Istanbul market than in any other markets in the sample. Consequently, the Istanbul market has a more active price-formation process with important implications for weak-form efficiency" (Smith and Ryoo 2003, 298, 300).

Kasman and Torun (2007) used the ARFIMA-FIGARCH model to examine the dual long-memory property of the ISE, and the tests analysed both returns and volatility. According to the findings, there is strong evidence of long memory in both returns and volatility, which is inconsistent with the efficient market hypothesis. However, the main contribution of this work is that the presence of long memory in volatility implies that uncertainty or risk is an essential determinant of ISE daily returns. Ozdemir (2008) examined ISE, and his findings indicated that the ISE is a weak form efficient market. This applied to the period he examined (1990-

2005) and the subperiods he tested. Similar results were produced by Karan and Kapusuzoglu (2010), who also tested the overreaction hypothesis. Aga and Kocaman also confirmed the efficiency (2011) further confirmed the weak form efficiency in Turkey. Later work by Kapusuzoglu (2013) and Ozer and Ertokatli (2010), who employed nonlinearity and chaos theories, confirmed the existence of nonlinear structure and chaos in the ISE market. This implies that the ISE could be more efficient. Nonetheless, Gozbasi, Kucukkaplan and Nazlioglu (2014) examined the market using a linearity test that indicated nonlinear behaviour. In addition, they developed a nonlinear unit root test and found that the ISE index is weak-form efficient.

The results of all the papers, the periods and the methods are presented in Appendix. The conclusion is that different methods, datasets, and conflicting results characterise the literature on the validity of the EMH in Turkey. The decision taken was to include only some of the studies but the most representative ones and, in particular, the ones that can contribute to the methodology of this paper. Indeed, the literature on the EMH in Turkey is characterised by a series of methods, including the Runs test, autocorrelation test, serial correlation coefficients, OLS regression, Maximum likelihood test, Granger causality, Kruskal - Wallis test, three-way ANOVA, ADF unit root, fractional integration, variance ratio tests, ARFIMA-FIGARCH model, Structural breaks unit root test, Non-linear programming model, Martingale hypothesis, and Non-linear ESTAR unit root, among others. Such ambiguity in the results is, in fact, in line with the results obtained for most of the emerging markets. As market inefficiency forms differ vastly, it may not be possible to examine all of them using aggregate stock market indices. Hence, it is concluded that a new approach to testing the ISE market efficiency is needed.

Overview of Chapters and Summary of the Results

The results of Chapter 1 do indeed indicate that the behaviour of the return series for the alternative Turkish market indices tends to vary sufficiently to produce different test results in tests for the weak-form market efficiency. Although most statistical tests conducted so far provide little support for the EMH in the Turkish Equity Market, more sophisticated tests, e.g., those based on the GARCH-in-Mean model, provide some support for the weak-form market efficiency. Notably, the MSCI Turkey price and total return indices do not appear to support the weak-form efficiency of the market. In contrast, the MSCI Turkey Investable index and the MSCI size-caped indices tend to behave efficiently. As the latter set of indices is used for investment purposes and portfolio management (e.g., size-factor rotation strategies), we argue that the evidence derived from these indices' behaviour is more credible. The market index choice could bias the previous results of the literature. The overall conclusion of Chapter 1 is that the Turkish equity market is moderately efficient. However, the results tend to be sensitive to the sample period, the test choice, and, as we showed, the market index choice. A longer time series for investable indices accumulated over time will likely help derive more credible information on the equity market efficiency in Turkey.

Chapter 2 of the thesis continues to explore historical developments in Turkish capital markets and stylised facts on the informational efficiency of the Turkish equity market. We inspect a classical challenge to the EMH presented by a market anomaly labelled “the size effect”. The size effect is related to the significant differences in the equity return across firms of different sizes. The stylised fact is that the average return in the lowest market-value decile tends to exceed the average returns of firms in the top decile even after risk adjustment. The phenomenon has been observed across various markets. Chapter 2 presents a novel attempt to examine the validity and persistence of the size effect in the cross-section of Turkish equity returns while correcting for the effects of noisy prices using the buy-and-hold method traditionally adopted in the literature but never applied in the context of the Turkish market. The observed size effect for our overall sample period of 18 years is consistent with the estimates for developed markets. As expected, it becomes statistically insignificant from zero when the biases in computed returns are alleviated by calculating the buy-and-hold returns. It also appears that the magnitude of the size effect fluctuates significantly across subperiods in both rebalanced and buy-and-hold portfolios, occasionally presenting investors with attractive returns, which nevertheless are hard to time and/or capture. We also show that more rigorous risk-adjustment procedures significantly decrease estimated excess returns' magnitude. Based on only moderate impediments to trade and information governing in Turkey, surveyed in Chapter 2, and the obtained empirical results, we argue that the overall evidence suggests that equity pricing in the Turkish stock market is likely to be only marginally less efficient than the developed markets.

Chapter 3 is a novel attempt to re-examine the time-varying efficiency of the Turkish equity market, particularly using an opportunity recently presented when Turkey faced the potential downgrade by MSCI from the emerging to the frontier market status. Our results for Turkey are consistent with those for other emerging markets going through reversals in the degree of the market and the overall economic integration with the rest of the world. The decrease in the market betas of the Turkish market from the historical highs found in Chapter 3 is unlikely to signal a decrease in exposure to systematic risk. It is more likely to be related to a prolonged decline in the market sentiment and a significant decrease in the degree of Turkish market integration and efficiency over the period studied. Our results also support a likely effect of institutional investment flow on market betas. As we argue, this should be expected in view of the increased popularity of index and factor-based investing strategies. According to our results, the evolution of Turkish equity market beta estimated with respect to global benchmarks and analysed in Chapter 3 is unlikely to serve as a meaningful proxy of country risk in a globally diversified portfolio when the degree of market integration varies significantly over time. According to our results, the country beta appears to capture well the extent of equity market integration/segmentation, which becomes particularly visible when a country faces the possibility of reclassification by an index provider, as in the case of Turkey in 2020. Also, the riskiness of the Turkish market is not adequately captured in the conventional multifactor model framework.

Significance of the Results

The results presented in the three chapters of the thesis could be of interest to a wide range of audiences. From the academic perspective, the presented results generate new evidence about a significant and globally critical market. We also raise a number of methodological issues which appear to have a significant effect on results. We also drew attention to the data sources used, which appear to affect the results of studies significantly. The results generated for the Turkish market are consistent with the studies of many other similar markets, setting an influential agenda for future research, which is warranted. The results of the presented studies are also of interest to market practitioners, who have first-hand experience with many issues raised and addressed in the thesis. Finally, the presented results could be of interest to the policymakers promoting equity market development and portfolio investments and dealing with the destructive effects of volitive capital flows.

Appendix

Table 1: EMH in the Turkish Stock Market – summary of methods and findings (selection)

Study	Data	Tests used	Series	Validity of EMH
Balaban (1995)	04.01.1988-05.08.1994 (daily)	Runs test OLS Regression	ISE composite index	Reject
Muradoglu and Metin (1996)	01.1986-12.1993 (monthly)	ADF unit root test Engle-Granger and Johansen tests	ISE composite index	Reject
Antoniou et al. (1997)	1988-1993 (daily)	Logistic Map	ISE composite index	Reject (1988-1990) Non-Rejection (1991-1993)
Balaban and Kunter (1999)	01.1989-07.1995 (daily)	Granger causality tests	ISE composite index, Foreign exchange market and interbank money market	Reject
Demirer and Karan (2002)	04.01.1988 – 29.03.1996	Kruskal-Wallis Test Three-way ANOVA	ISE composite index	Reject
Buguk and Brorsen (2003)	1992-1999 (weekly)	ADF unit root Fractional integration Variance ratio tests	ISE composite, industrial, and financial indexes	Non-Rejection
Müslümov et al. (2003)	1990-2002 (monthly)	GARCH	ISE100 index	Reject
Tas and Dursunoglu (2005)	1995-2004 (daily)	ADF unit root test Runs test	ISE30 index	Reject
Kasman and Kırkulak (2007)	1988-2007 (weekly)	ADF and KPSS unit root tests ZA and LP unit root tests GPH fractional integration test	ISE100, ISE30, service, industrial, financial and other sub-sector indexes	Non-Rejection
Özdemir (2008)	02.01.1990-14.06.2005 (weekly)	LP two structural breaks unit root test ADF unit root, Runs test Variance ratio test	ISE100 index	Non-Rejection
Çevik and Erdoğan (2009)	2003-2007 (weekly)	Bai and Perron Multiple Structural Break Test; Geweke and Porter-	ISE, banking sector	Reject

		Hudak Fractional Integration Test; MLP		
Ergül (2009)	1988-2007 (daily)	ADF and PP unit root tests	ISE100, ISE50, ISE30 indexes, ISE service index, ISE financial index, ISE industrial index	Non-Rejection
Duman Atan et al. (2009)	03.012003-30.12.2005 (15 minutes/daily)	ADF and KPSS unit root tests ELW	ISE100 index	Non-Rejection
Karan and Kapusuzoglu (2010)	2003–2007	Nonlinear programming model	21 firms' stocks in ISE-30 index	Non-Rejection
Karacaer et al. (2010)	30.05.2005-30.05.2008 (daily)	OLS regression	ISE100 index	Reject
Ozer and Ertokatli (2010)	02.02.1997-16.03.2009	ADF unit root test BDS nonlinearity test Hinich bispectral test NEGM test	ISE-100 index	Reject
Aga and Kocaman (2011)	01.1996-11.2005 (monthly)	OLS regression	ISE-20 index developed by Aga and Kocaman (2006)	Non-Rejection
Çevik (2012)	03.01.1997-27.05.2011 (daily)	FIGARCH, Modified Log-Periodogram (MLP), Exact Local Whittle ADF, PP and KPSS unit root tests	ISE, 10 sub-sectors	Reject
Gozbasi et al (2014)	01.07.2002-07.07.2012 (daily)	Kruse unit root test	ISE composite index, ISE industrial and financial indexes	Non-Rejection

Source: Author’s compilation; Kiliç and Buğan 2016, 264-265; Gozbasi, Kucukkaplan and Nazlioglu 2014, 382

Chapter 1: Is the Turkish Stock Market Weak-form efficient?

Introduction

The efficiency of the Turkish stock market is a subject of debate among researchers and analysts. Some studies have found evidence of market inefficiencies, including instances of insider trading and market manipulation. However, others have suggested that the market has become more efficient in recent years due to improvements in regulation, technology, and investor awareness. Ultimately, whether or not the Turkish stock market is efficient may depend on various factors, including the specific stocks being traded, the prevailing market conditions, and the behaviour of market participants.

The empirical literature on the Turkish Stock Market predominantly uses the ISE benchmark indices in the tests employed and usually opt-in for just one or a few indices. In contrast to the previous literature and with the working hypothesis in mind, a wider range of the available Turkish equity indices is considered in this study. This has proven to have several advantages. Firstly, it allows for the inclusion of the family of so-called investable indices, which provides more credible information on market returns as institutional investors typically choose them as benchmarks. Secondly, the individual indices capture different market segments (e.g., market capitalisation segments), and these segments are significantly heterogeneous in terms of liquidity and exposures to the risk factors, as recognised by market practitioners Bender et al. (2013). The conventional view of the theory is that EMH should not necessarily be supported in all market segments, and the observed support is likely to be time-varying. This is particularly relevant for the Turkish public equity market, which has matured significantly since its relatively recent re-establishment. Finally, although the returns on all selected equity indexes are highly correlated, the correlation varies over time, and the indices exhibit substantial heterogeneity, particularly during volatile periods.

In this regard, the aim is neither to provide an in-depth history of the EMH nor to analyse all of the findings in the literature, as this would exceed the scope of the research in this paper. The primary objective of this paper is to focus on the particular case of the Istanbul Stock Exchange (ISE) and examine the evidence of weak-form efficiency in this market. To this end, this study analyses a dataset comprising 15 price and total return equity indexes for which the weekly continuously compounded returns (Monday to Monday) were calculated. The time frames include different sub-periods from 1988 to 2018. Lastly, in terms of methods, a range of tests is employed, including autocorrelation, stationarity, unit root, and variance ratio tests, as well as estimation of the AR-GARCH-In-Mean model to examine the efficient market hypothesis in ISE.

The following section summarises the literature on the Martingale Hypothesis and the Evolving Market efficiency. Section 3 presents the analytical methods used, and section 4 illustrates the data. Section 5 presents the results of the analysis, and section 6 the discussions. In section 7, the conclusions recapitulate the key findings and highlight the contribution of this study, which derives essentially from the time frame under examination, which covers a period of twenty years, the plurality of methods used that enhance the validity of the main finding, and the analysis of a host of different indexes, that has been under-examined in the existing literature. Last but not least, it should be noted that besides the aforementioned aspects that demonstrate the relevance of this paper to the current literature on EMH, the primary contribution of this paper is that it seeks to introduce a way of measuring the 'degree of inefficiency' further exploring a possible evaluation of the market towards efficiency.

Literature Review

The introductory chapter provided a detailed review of the various debates that have been, as well as the approaches that have been used to assess the efficiency of the Turkish stock market empirically. To avoid becoming repetitive, the objective of this section is to present and review the empirical approaches that will be used in this chapter. In particular, the review will be on the martingale hypothesis and the evolving market efficiency.

Martingale Hypothesis

A market is efficient when the prices 'fully reflect' the available information. Based on the notion of rational expectations of the pricing of various assets, the argument is that (rational) market participants use the information available to make decisions. As a result, any attempts to trade and beat the market based on the price movement result in "noise trading" (McCauley et al., 2008). In this context, the introduction of the Martingale – a generalisation of the 'fair game' concept – is critical. The underlying idea is that martingales "are random variables whose future variations are completely unpredictable given the current information set" (Delima, 2014, p. 29). Mandelbrot (1966) was one of the first to argue that in the context of competitive financial markets characterised by depth and liquidity, the returns are not predictable, and the prices of different assets follow a martingale. This suggests that a stock's price action pattern is a Martingale Difference Sequence (MDS).

The martingale approach has also been used to test the efficiency of the market (Charles et al., 2010; Kim et al., 2010). It indicates that the conditional mean of price changes is unpredictable. In more detail, suppose that Ω_t is the information set at time t. The martingale property implies that $\mathrm{E}[R_{t+1}|\Omega_t] = 0$. In other words, based on the information in time t, the expected return of a stock is, on average, zero martingales. This implies that there is no conditional dependence in the conditional mean of the return series (Lim & Luo, 2012). Thus, it is not possible for an investor to successfully predict the abnormal returns of an asset. The existence of the martingale process implies no mean reversion and no predictable future prices; hence, it indicates the presence of weak form efficiency.

The Martingale approach is similar to the random walk theory, which suggests that the series of prices is a unit root process in which the errors are assumed to be an i.i.d. process. The requirement of the i.i.d. process of the error term is not included in the martingale process, which makes the martingale process a relaxed version of the random walk. While the random walk requires identically and independently distributed increments, "the martingale allows for uncorrelated increments with a general form of heteroskedasticity" (Kim and Shamsuddin, 2008, p. 519). The relaxation of this assumption makes the Martingale an appropriate method for examining EMH. Moreover, just looking at whether the series are serially uncorrelated is a necessary but not sufficient condition for market efficiency. In addition, it can be linked with assumptions of preferences and returns of market participants, offering an even wider flexibility of the approach (LeRoy, 1989).

Although there has been some literature examining the martingale in the EMH context, there has not been any systematic review of this in the context of the Turkish stock market. I believe this is an additional contribution to this work.

Evolving Market Efficiency

A significant trend in the realm of finance has been the development of the literature on emerging market economies. A key observation in the literature is that the pace and the level of development are different across these economies, as some appear to develop and mature faster than others. Due to the particularities of these markets, especially with their rapidly evolving nature, researchers have argued that traditional econometric approaches are not appropriate for dealing with them (Zalewska-Mitura & Hall, 1999). In the topic of efficiency, conventional econometric methods are not suitable for emerging markets, as these suffer from a lack of liquidity, the microstructure of these markets, and the nature of the participants (Abdmoulah, 2010). To deal with this, in the context of the EMH, a new idea has been proposed that aims to capture the efficiency of the market across time, known as “evolving market efficiency”. As a result, a market characterised by evolving efficiency is known as “adaptively efficient”. This means that potential profit opportunities arose in the past, and investors can study them and adapt their strategies; this will result in a progressive normalisation of the markets and a return to efficiency (Lim & Brooks, 2011).

In this context, Emerson et al. (1997) were one of the first to use a time-varying parameter model to measure the changing degree of market efficiency. Using a Kalman filter technique and time-varying autocorrelation coefficients, the authors sought to measure the changing degree of return predictability (i.e., the evolving market efficiency). Zalewska-Mitura and Hall (1999) formalised this approach to test for evolving efficiency by offering a quantitative measurement. Moreover, it becomes necessary to examine the variance structure of the series, as a changing variance structure can generate a spurious serial correlation property and an inaccurate rejection of the efficiency hypothesis (Muslumov et al, 2003).

Therefore, a key observation that relates directly to this paper is that market efficiency should not be seen as static – an all-for-one condition – but as something dynamic/evolving over time and across different markets. This implies that markets characterised by a weak form of efficiency face a series of dynamics such as trends, bubbles and crashes. The main implication of this approach is that the question that needs to be addressed in this paper is not whether the ISE is efficient but whether it becomes more efficient, an issue that has not been studied in previous work on the Turkish market (Muslumov et al., 2003).

Methods

Methods applied for testing the Efficient Market Hypothesis are vastly different in nature, interpretation and techniques. The most commonly used methods are event studies (for a review and applications for Turkey, see Basdas and Oran, 2014), portfolio simulations (Jawadi, Ftiti and Mouna, 2017), machine learning and data mining (Barbopoulos et al., 2021) and statistical testing. Previous literature in Turkey has explored the issue of efficiency using various tests. A summary of the most relevant work, detailing the index, time period, test, and results, can be found in appendix Table 5.

Stationarity Testing

For testing the necessary condition for the existence of market efficiency, it has to be first established whether the series of the logarithm of prices are integrated of order one and, consequently, whether the series of rates of returns are stationary. In this context, several tests are used to test for the random walk and martingale hypothesis. More specifically, as stated in The presence of a unit root in the $R_{i,t}$ series defined in (1) implies no-mean reversion. In the case of an external shock, the future values of a return series with a unit root will not return at their initial levels, and the series will follow a random pattern. In other words, predicting future returns is not possible, thus indicating a weak-form market efficiency. This implies that the rejection of a unit root null hypothesis implies stationarity, mean reversion, and, therefore, predictable future values. Since predictability is possible, the market represented by the series for which the unit root process is rejected means that the market is not efficient (Buguk & Brorsen, 2003; Kapusuzoglu, 2013; Ozer & Ertokatli, 2010).

The first test that will be used is the Augmented Dickey-Fuller (ADF) test to test for the existence of a unit root. For each equity index, I estimated the following model (in the notation below, which represents the first differences of log prices for each index:

$$\Delta Y_t = c_0 + \beta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-1} + \varepsilon_t \tag{2}$$

Where Δ stands for first differences and ε is the error term. Under the null hypothesis f, the existence of the unit root (that is, non-stationarity) $H_0: \beta = 0$ and under the alternative hypothesis of stationarity $H_1: \beta < 0$. In most economic and financial time series, the first differences of the l series tend to be stationary, i.e., the series tend to be integrated of order one.

In most economic and financial time series, the first differences of the raw series tend to be stationary. However, it may be the case that the first differences may be non-stationary (Asteriou & Hall, 2011). For robustness, we examine the stationarity of the first differences further by considering an alternative version of the ADF test. According to this test, the following regression is calculated:

$$\Delta^2 Y_t = c_0 + \beta \Delta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta^2 Y_{t-1} + \varepsilon_t \tag{3}$$

Where $\Delta^2 Y_t$ is the second difference of the series of an index return.

In this case, the null and the alternative hypothesises change to $H_0: \beta = 0$ and $H_1: \beta < 0$. Equations (3) and (4) can be further extended by inserting a time trend to control for increasing or decreasing trends in the series, which usually are present in economic and financial time series (Asteriou & Hall, 2011). To achieve this, we assume that $c_0 = \alpha_{0+}\alpha_1 t$.

An alternative approach to test for the existence of a unit root is the Phillips-Perron (PP) test. The PP test relaxes the constraint of the ADF test imposed by the necessity of selecting the lag length of the dependent variables as regressors (that is, k in equation (4)) and uses a nonparametric correction instead. Similarly to ADF, the null and alternative hypothesis of the PP test are the same, and it can be performed with the inclusion of a time-trend as well.

However, the absence of a unit root does not necessarily imply stationarity and, thus, market efficiency (Kwiatkowski et al., 1992). To explicitly deal with this issue, an extension of ADF and PP tests is employed: the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. KPSS is based on linear regression, similar to the ADF and PP tests. If there is no evidence of rejection of the null hypothesis of stationarity, the market represented by the index under examination does not indicate weak form efficiency (Kasman & Kırkulak, 2007). Hence, the KPSS test is a stationarity test, whereas ADF and PP tests are unit root tests.

Note that for the results to be robust, the results should either reject the null hypothesis of ADF and PP tests and not reject the null hypothesis of the KPSS test or not reject the null hypothesis of ADF and PP tests and reject the null hypothesis of the KPSS test.

Lastly, it is possible that the data exhibit structural brakes. Hence unit root tests must take into account structural brakes in log returns. To this end, “the Innovational Outlier Test” is employed (Perron and Vogelsang 1992). Accordingly, the following regression is estimated:

$$Y_t = c_0 + \theta DU_t(T_b) + \omega D_t(T_b) + \beta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-1} + \varepsilon_t \qquad (5)$$

where $DU_t(T_b)$ is an intercept brake and $D_t(T_b)$ is a trend brake.

Autocorrelation tests

Once the stationarity of a series of returns is confirmed or at least not rejected by the tests described above, sufficient conditions of market efficiency are tested by applying autocorrelation tests. To test for the martingale hypothesis, I apply the Ljung–Box Q statistic. This is calculated in the following way:

$$Q = n(n+2)\sum_{k=1}^{g}\frac{\hat{\rho}_k^2}{n-k} \tag{1}$$

where n is the sample size, $\hat{\rho}_k$ is the sample autocorrelation at lag k, and g is the number of lags being tested (Ljung and Box, 1978).

Under the null hypothesis, the statistic Q follows an asymptotic chi-squared distribution with g degrees of freedom. The null hypothesis for this test suggests that there is no serial correlation in the returns $R_{i,t}$. The rejection of the no-autocorrelation hypothesis indicates the presence of serial correlation; hence, predictability is possible, and weak form efficiency does not hold (Balaban, 1995; Kapusuzoglu, 2013).

The GARCH-In-Mean model

Tests described above use the entire sample period and do not allow for testing the evolution of efficiency in financial markets (Müslümov, Aras & Kurtuluş 2003; Abdmoulah, 2009). Moreover, financial data usually suffer from non-linearities, such as infrequent trading caused by thinness, lack of liquidity and regulatory changes (Abdmoulah, 2010). Moreover, financial data often exhibit volatility clustering, leptokurtosis, and leverage effect (Abdmoulah, 2009). For those reasons, the GARCH-in mean model is one of the models that has become commonplace in the financial literature.

This section tests the evolving hypothesis by estimating the GARCH-In-Mean model. The GARCH-in mean model includes the variance parameter to control for changes in variance structure. Changing conditional variance structure results in spurious correlations and hence the incorrect rejection of the null hypothesis of tests (Müslümov, Aras & Kurtuluş 2003). By employing the GARCH-In-Mean model, we can make more accurate deductions regarding autocorrelation. The AR(1)-GARCH(1,1)-in-mean model is defined as:

$$R_t = a_0 + a_1 \mathrm{R} + \delta h_t + e_t,\ e_t \sim N(0, h_t) \tag{7}$$

$$h_t = \mathrm{b} + b_1 h_{t-1} + b_2 e_{t-1}^2 \tag{8}$$

where Y_t is the series under examination, a_0 the constant of the mean equation, a_1 the coefficient of lagged values of the series, h_t is the conditional variance, which measures the volatility of returns, δ represents the risk-premium parameter in the conditional model, e_t is the error term of the mean equation. Conditional variance is represented by its autoregressive term h_{t-1}, the GARCH character of the model, and by the squared values of the past residuals, e_{t-1}^2, which is the ARCH factor, b is the constant term of the variance equation and b_1 is the coefficient of the lagged conditional variance term, and b_2 is the squared values of the past residuals. Lastly, $b_1 + b_2$ capture the extent of volatility persistence.

Following Müslümov, Aras & Kurtuluş (2003), if the autoregression parameter, a_1, is statistically significant, predictability in series is possible. Hence weak form efficiency is not supported. Moreover, if the GARCH parameter, b_1, is statistically significant, past volatility levels affect current volatility. This is another point that implies no support for weak form efficiency. It also implies that the variance structure changes.

In addition, evolving efficiency will be examined by estimating the GARCH-in-mean model in different sub-periods of the sample. The statistical significance of the correlation coefficient will reveal each index's tendency to deviate from the state of efficiency (Müslümov, Aras & Kurtuluş 2003). For each index, two separate periods are calculated, with the cut-off point being determined by the existence of structural breaks. In most instances, the cut-off year is either 2004 or 2006, dates which match the end of the banking crisis or the beginning of the great recession.

Variance ratios

To jointly tackle the necessary and sufficient conditions for market efficiency, perform variance ratios tests. By examining the size and the power of variance-ratio tests, Lo and MacKinlay (1988) found that the variance-ratio tests are more powerful than the unit-root test alternatives, particularly when the returns are not normally distributed. The idea behind the variance ratio test is that if a series is a random walk, the variance of its q differences grows proportionally with the difference q. That is, the variance-ratio test statistic is based on a ratio of variance estimates of the returns of a series or the first differences, $R_t = Y_t - Y_{t-1}$, and the variance is evaluated for returns over q period horizon, that is for $Y_t - Y_{t-q}$. Formally, the variance ratio, $VR(q)$, is defined as $VR(q) = \frac{\sigma^2(q)/q}{\sigma^2(1)}$, where $\sigma^2(q)$ is the estimated variance of returns over q period horizon, that is, $VAR(Y_t - Y_{t-q})$ and $\sigma^2(1)$ is the estimated variance of returns over one period, that is $VAR(R_t)$ (see Charles and Darné, 2009, for a comprehensive overview of various modifications of the test). Under the null hypothesis of random walk, uncorrelated returns imply that the period q variance is asymptotically equal to q times the period 1 variance, i.e., $VR(q) = 1$. The alternative hypothesis implies the predictability of returns, that is, a rejection of market efficiency.

Despite its attractiveness of considering the necessary and sufficient conditions simultaneously, the variance ratio tests also have some disadvantages. Among others, they consist of:

(1) Sensitivity to sample size;
(2) Sensitivity to measurement error;
(3) Inability to detect certain forms of predictability;
(4) Potential for false positives.

Consequently, it is essential to note that variance ratio tests are just one of many tools available for testing the EMH, and they should be used in conjunction with other tests, such as unit root and autocorrelation tests.

Overlapping horizons increase the efficiency of the ratio estimator and add power to the test. Following Buguk and Brorsen (2003) and Ozdemir (2008), I use sequential testing using multiple values of q, which, according to Cecchetti and Lam (1994), results in smaller sample size distortions relative to those that result from the asymptotic approximation of critical values of the distribution of the test statistic.

I initially applied the Lo and MacKinlay (1988) variance ratio statistic (LOMAC), assuming heteroskedastic increments to the random walk and allowing for a non-zero innovation mean and bias-corrected variance estimates. Moreover, I also use alternative versions of the LOMAC test. Wright (2000) proposed alternative variance ratio tests using rank scores (van der Waerden scores) or signs of the data. The tests have the advantage of computing the exact distributions of test statistics without any asymptotic approximations. Moreover, the tests are more powerful than the basic Lo and MacKinlay (1988) variance ratio test when data are highly nonnormal (Buguk and Brorsen, 2003).

I also use the wild bootstrap variance ratio test proposed by Kim (2006). This test has not been widely employed in the existing literature, so our results can be considered a novel feature of this paper. The test improves the small sample properties of variance ratio tests and provides a less restrictive test of the martingale hypothesis. The test in Kim (2006) is based on the samples of observations formed by weighting the original data by the mean and one variance of random variables and using the results to form bootstrap distributions of the test statistics.

Data

The purpose of this section is to describe the data selection process and the statistical tests used to examine the existence of weak-form market efficiency in the Turkish stock market. This section is structured in the following way: it starts by describing the selected data and how it is configured to be able to test market efficiency and continues by presenting the various methods used to test market efficiency.

Data Selection

Most studies focus on the Istanbul Stock Exchange composite index (ISECI) to study the existence of weak-form market efficiency in the Turkish stock market. Since ISECI has been studied extensively, this study focuses on other indexes used to track the performance of the Turkish stock market that were rarely or not used in the existing studies. Moreover, this study uses various indexes to check for robustness instead of focusing on only one index. In other words, if multiple indexes exhibit characteristics in favour or contrary to weak-form market efficiency, then the corresponding conclusions regarding market efficiency will be more robust relative to those based only on one index. This has several advantages. Firstly, we include the family of the so-called investable index, that is, indices of the tradeable aimed at gaining exposure to distinct risk and reward profiles and simplifying the construction of alternative investments (see Duc, 2004; for a critical view on their performance at the ISE, see Atilgan, Bali and Demirtas, 2013). Such indices can be used to help tailor risk-hedging strategies with greater precision, enhance long-term returns and construct more resilient portfolios, which provide more credible information on market returns. Secondly, such indices capture different market segments (e.g., market cap), which are significantly heterogeneous regarding liquidity and risk factors exposure. The conventional view is that EMH is not necessarily supported in all market segments, and the support is likely to be time-varying. Finally, although the returns on all selected equity indexes are highly correlated, the correlation varies over time, and the indices exhibit substantial heterogeneity during volatile periods. Overall, using a more comprehensive range of indices could be viewed as an attempt to provide more robust evidence concerning EMH in the Turkish equity market.

These indices are not publicly available, which offers an extra degree of innovativeness to this work. For this study, the data were compiled using exclusive access to Datastream (Datastream International 2023). One of the objectives of this chapter is to test for efficiency using the widest sample and time series possible, an attempt which has not been done in previous work.

In this study, the Turkish stock market is represented by the following 15 stock market indexes for Turkey:

1. Morgan Stanley Capital International (MSCI) Turkey Price Index,
2. Morgan Stanley Capital International (MSCI) Turkey Total Return Index,
3. Financial Times and Stock Exchange (FTSE) Turkey Price Index,
4. Financial Times and Stock Exchange (FTSE) Turkey Total Return Index,
5. Borsa Istanbul stock exchange (BIST) 100 Price Index,
6. Borsa Istanbul stock exchange (BIST) 100 Total Return Index,
7. Standard & Poor's International Finance Corporation Investable (S&P/IFCI) Turkey Price Index,
8. Standard & Poor's Broad Market Index (S&P/BMI) Turkey - Price Index,
9. Turkey Thomson Reuters Datastream Price Index,
10. Turkey Thomson Reuters Datastream Total Return Index,
11. Morgan Stanley Capital International (MSCI) Turkey (Large Capitalisation) Price Index,
12. Morgan Stanley Capital International (MSCI) Turkey (Middle Capitalisation) Price Index,
13. Morgan Stanley Capital International (MSCI) Turkey (Small Capitalisation) Price Index,
14. Morgan Stanley Capital International (MSCI) Turkey (Small-Middle Capitalisation) Price Index,
15. Morgan Stanley Capital International (MSCI) Investable Market Index (IMI) Turkey.

Looking in more detail at every index, the MSCI Turkey Index measures the performance of the Turkish market's large and middle capitalisation segments. It has 16 constituents and covers about 85% of Turkey’s equity universe (msci.com, 2019). The BIST 100 index is the main index for Borsa Istanbul Equity Market. It has 100 constituents selected from the BIST Stars (companies with a market value of more than 100 million TRY), BIST Main markets (companies with a float-adjusted market value of less than 100 million TRY) and the Collective and Structured Products Market (stocks of real estate investment trusts and venture capital investment trusts). BIST 100 index includes the stocks that the BIST 30 and BIST 50 indexes cover (borsaistanbul.com, 2018). S&P/IFCI Turkey is a subset of the S&P/IFCI, which is the S&P Indexes' leading emerging market index. The S&P/IFCI is one of the three indexes in the S&P Global Equity Index series. Frontier markets and developed/emerging markets are covered by the other two indexes, which comprise the S&P Global Equity Index: S&P Frontier BMI (Broad Market Index) and the S&P Global BMI (markets.ft.com, 2019). S&P Turkey BMI is a subset of S&P Global BMI, which measures stock market performance at a global level. The index includes all public companies with float-adjusted market values of more than 100 million USD (S&P Dow Jones Indexes, 2014). The MSCI Turkey, Large, Middle, Small and Small-Middle Capitalisation indexes are subsets of the MSCI Turkey Index. The MSCI Turkey Investable Market Index (IMI) measures the performance of the Turkish market's large, mid and small-cap segments. It covers approximately 99% of Turkey's free float-adjusted market capitalisation and has 46 constituents[1] (MSCI 2020).

As can be observed, in some cases, the price and total return indexes are considered. The main difference between a price and a total return index is “that the total return index tracks the capital gains of a group of stocks over time and assumes that any cash distributions, such as dividends, are reinvested into the index” (Ooi and Dung, 2019).

[1] Full details of the indices used can be found in the appendix

Table 2: Selected Turkish Equity Indices

Index	Part of	Coverage
MSCI Turkey Index	Large and Mid-capitalisation segments of the Turkish market	16 constituents - 85%
BIST 100 index	Borsa Istanbul Equity Market	100 constituents from BIST Stars, BIST Main markets, Collective and Structured Products Market
S&P/IFCI Turkey	S&P/IFCI	
S&P Turkey BMI	S&P Global BMI	Broad Market Index
MSCI Turkey (Large Cap)	MSCI Turkey Index	Large-Cap Stocks
MSCI Turkey (Middle Cap)	MSCI Turkey Index	Mid-Cap Stocks
MSCI Turkey (Small Cap)	MSCI Turkey Index	Small-Cap Stocks
MSCI Turkey (Small-Mid Cap)	MSCI Turkey Index	Small & Mid Cap Stocks
MSCI Investable Market Index	Large, Mid and Small-Cap .	Broad Investable Index

Source: Author's compilation. Thomson Reuters Datastream. / Note: Selected indices are adopted in both the price and total return versions.

The dataset covers the period from January 1988 to January 2019. Instead of using the actual index prices, we have decided to use returns. The returns are preferred as, in general, indices are non-stationary (Escanciano & Lobato, 2009). However, due to differences in data availability, not all indexes cover the same period. Following Buguk & Brorsen (2003), weekly returns are ideal for testing the hypothesis of weak-form market efficiency since weekly data exhibit fewer biases caused by “nontrading, the bid-ask spread, asynchronous prices, etc.” (p. 581). Weekly returns yield a large number of observations and, at the same time, reduce the biases that daily data incur. For all of the analysis and all tests listed below, weekly returns are used. In Table 3: Date range of Turkish stock market indexes4, there is precise information regarding each index cover period and the number of observations analysed.

Table 3: Date range of Turkish stock market indexes

Index	start	end	number of observations using weekly indexes
MSCI Turkey Price Index	06/06/1994	18/06/2018	1255
MSCI Turkey Total Return Index	06/06/1994	18/06/2018	1255
FTSE Turkey Price Index	29/09/2003	18/06/2018	769
FTSE Turkey Total Return Index	29/09/2003	18/06/2018	769
BIST 100 Price Index	11/01/1988	18/06/2018	1589
BIST 100 Total Return Index	08/02/1988	18/06/2018	1585
S&P/IFCI D Turkey Price Index	03/07/1995	28/01/2019	1231
S&P TURKEY BMI Price Index	02/01/1995	28/01/2019	1257
Turkey DataStream Price Index	11/01/1988	18/06/2018	1589
Turkey DataStream Total Return Index	11/01/1988	09/01/2017	1514
MSCI Turkey (Large Capitalisation) Price Index	06/06/1994	30/04/2018	1248
MSCI Turkey (Middle Capitalisation) Price Index	06/06/1994	30/04/2018	1248
MSCI Turkey (Small Capitalisation) Price Index	06/06/1994	30/04/2018	1248
MSCI Turkey (Small and Medium Capitalisation) Price Index	06/06/1994	30/04/2018	1248
MSCI Turkey (Investable Market)	06/06/1994	30/04/2018	1248

Source: Thomson Reuters Datastream. Author's calculations.

As the data were in daily form, the weekly return series ($R_{i,t}$) for each index were calculated[2]. This was done by taking the differences of the natural logarithm of weekly (from Monday to Monday) closing prices of the index i for the week t ($P_{i,t}$) and $t-1$ ($P_{i,t-1}$),
i.e.

$$R_{i,t} = ln(P_{i,t}) - ln(P_{i,t-1}) \qquad (9)$$

To get a clearer idea of the relationship between these indices, the following table illustrates the correlation between the returns of the various indices.

[2] Note that price indices are not adjusted for dividends, as there are captured by the total returns.

Table 4: Correlation Matrix between indices

Variables	MSCI Turkey Price Index	MSCI Turkey Total Return Index	FTSE Turkey Price Index	FTSE Turkey Total Return Index	BIST 100 Price Index	BIST 100 Total Return Index	S&P/IFCI D Turkey Price Index	S&P TURKEY BMI Price Index	Turkey DataStream Price Index	Turkey DataStream Total Return Index	MSCI Turkey (Large Capitalisation) Price Index	MSCI Turkey (Middle Capitalisation) Price Index	MSCI Turkey (Small Capitalisation) Price Index	MSCI Turkey (Small and Medium Capitalisation) Price Index	MSCI Turkey (Investable Market)
MSCI Turkey Price Index	1														
MSCI Turkey Total Return Index	1.000***	1													
FTSE Turkey Price Index	0.998***	0.997***	1												
FTSE Turkey Total Return Index	0.997***	0.998***	0.999***	1											
BIST 100 Price Index	0.990***	0.990***	0.998***	0.998***	1										
BIST 100 Total Return Index	0.984***	0.984***	0.967***	0.967***	0.965***	1									
S&P/IFCI D Turkey Price Index	0.991***	0.991***	0.997***	0.997***	0.989***	0.981***	1								
S&P TURKEY BMI Price Index	0.985***	0.985***	0.998***	0.997***	0.990***	0.973***	0.990***	1							
Turkey DataStream Price Index	0.994***	0.994***	0.996***	0.995***	0.970***	0.985***	0.991***	0.984***	1						
Turkey DataStream Total Return Index	0.014	0.014	-0.005	-0.006	0.016	0.018	0.028	0.026	0.022	1					
MSCI Turkey (Large Capitalisation) Price Inde	0.756***	0.756***	0.752***	0.751***	0.743***	0.754***	0.759***	0.749***	0.757***	-0.001	1				
MSCI Turkey (Middle Capitalisation) Price Inde	0.754***	0.754***	0.754***	0.753***	0.755***	0.748***	0.758***	0.752***	0.753***	0.01	0.897***	1			
MSCI Turkey (Small Capitalisation) Price Inde	0.767***	0.767***	0.772***	0.772***	0.767***	0.758***	0.757***	0.757***	0.764***	0.002	0.886***	0.926***	1		
Turkey (Small and Medium Capitalisation) Pric	0.776***	0.776***	0.779***	0.778***	0.776***	0.768***	0.772***	0.770***	0.774***	0.007	0.910***	0.980***	0.982***	1	
MSCI Turkey (Investable Market)	0.779***	0.779***	0.773***	0.772***	0.772***	0.774***	0.778***	0.771***	0.779***	0.004	0.979***	0.952***	0.948***	0.969***	1

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

As expected, there is a high positive correlation between almost all indices, which is to be expected as they are all capturing a similar market. However, the correlation is not as strong in some instances, with values around 0.75, especially between the various subcategories of the MSCI and the main indices. An index with particular interest is the total return index, which seems to be completely uncorrelated with all other variables. This suggests that some particularities in this index need to be explored further.

Descriptive statistics

Table 6 presents the descriptive statistics of the log returns of the series of indexes. Each table row presents the mean, median, standard deviation, skewness, and kurtosis of each series of log returns. It also presents the Jarque-Bera test statistic for normality and the corresponding significance value.

Table 5: Descriptive statistics of the weekly log returns of the series of indexes

	Mean	Median	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability
MSCI Turkey Price Index	-0.001	0.005	0.075	-0.432	7.170	948.433	0.000
MSCI Turkey Total Return Index	0.000	0.005	0.075	-0.440	7.168	948.970	0.000
FTSE Turkey Price Index	0.001	0.006	0.058	-0.566	5.096	181.854	0.000
FTSE Turkey Total Return Index	0.001	0.007	0.058	-0.570	5.070	178.924	0.000
BIST 100 Price Index	-0.001	0.004	0.080	-0.371	6.366	786.175	0.000
BIST 100 Total Return Index	0.000	0.004	0.078	-0.257	6.299	736.066	0.000
S&P/IFCI D Turkey Price Index	-0.001	0.004	0.075	-0.355	7.251	952.543	0.000
S&P TURKEY BMI Price Index	-0.001	0.005	0.075	-0.418	8.005	1348.359	0.000
Turkey DataStream Price Index	-0.001	0.002	0.077	-0.336	6.342	768.897	0.000
Turkey DataStream Total Return Index	0.001	0.004	0.078	-0.358	6.274	707.901	0.000
MSCI Turkey (Large Capitalisation) Price Index	0.001	0.003	0.068	-0.248	5.033	227.843	0.000
MSCI Turkey (Middle Capitalisation) Price Index	0.002	0.006	0.062	-0.416	5.578	381.557	0.000
MSCI Turkey (Small Capitalisation) Price Index	0.001	0.007	0.059	-0.763	7.526	1186.385	0.000
MSCI Turkey (Small and Medium Capitalisation) Price Index	0.002	0.007	0.059	-0.616	6.431	690.926	0.000
MSCI Turkey (Investable Market)	0.001	0.004	0.063	-0.435	5.463	354.905	0.000

As can be observed, the mean and the median values are close to zero. The standard deviation is small and, in some cases, close to 0.1. Skewness is negative and not less than -1. Hence the distributions are slightly skewed to the left. Values of kurtosis above 3 indicate fat tails in the distribution of all series and a leptokurtic distribution. Thus, skewness and kurtosis values indicate that the returns do not follow normal distributions.

The means of weekly returns are, for most series, small and positive, reflecting the fact that the series is not deflated; hence, there should correspond to the inflation rate in the long run and after annualisation. The medians of the returns are markedly higher, which is consistent with the significant negative skewness observed in all index returns. The difference of risk-return profiles between large-, medium-, and small-cap indices is not very pronounced, although the skewness and kurtosis tend to be higher for a presumably riskier group of smaller capitalisation stocks. The reported Jarque-Bera test for testing the null hypothesis of the normal distribution rejects it for all studied indices. The non-normality indicates that either the markets are not efficient due to the presence of speculation on the market or that there is a presence of the ARCH-type effects, discussed further in this chapter. In any case, it excludes the possibility of the normal random walk of prices and weakens the power of the applied unit root tests.

A first glance at the above table suggests that the Turkish market is inefficient. As we presented above, an efficient market should have normally distributed returns based on the random walk model. Since the Jarque-Bera test for normality seems to reject the null hypothesis for all indices, then that is the first indication that the Turkish market is not weak-form efficient. To further add to this analysis, it is helpful to provide a graphical illustration of the series returns. The following Figure presents the graphs log returns of log-returns of indexes. Each sub-graph of the series corresponds to each series of log returns.

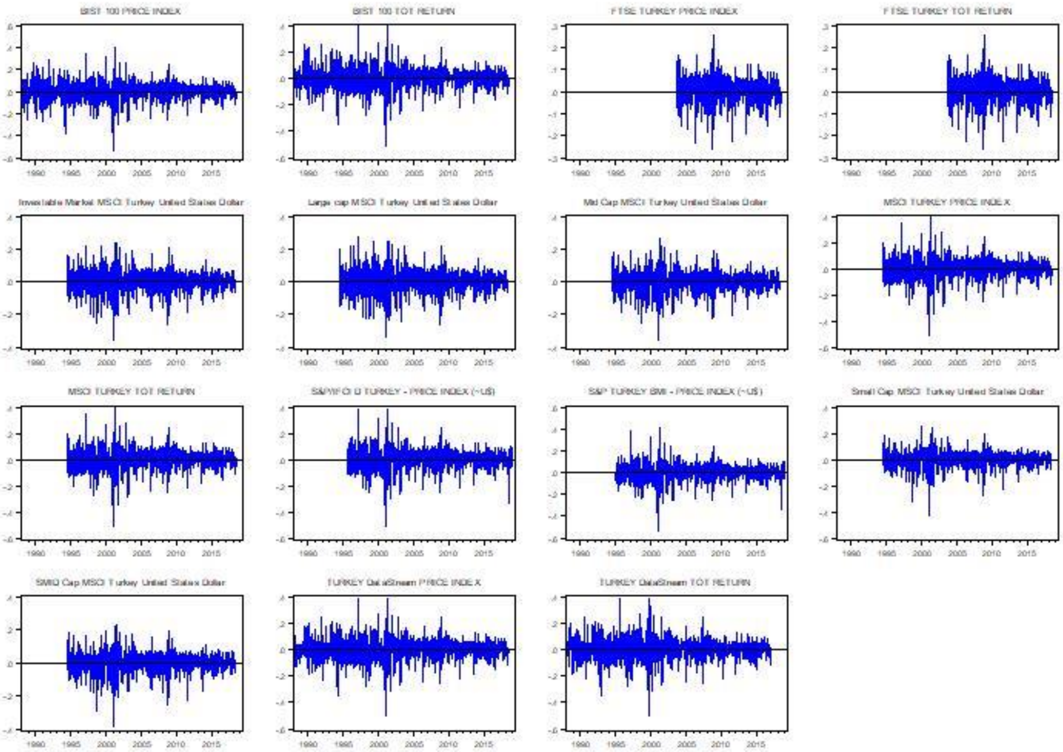


Figure 1: Log weekly returns of the series of log returns of indexes.

Log returns are centred around zero, indicating the series' stationarity. Stationarity implies no weak efficient market. Moreover, there are some outliers in the series' log-returns distribution. At first glance, the series does not exhibit structural brakes. To further examine the potential for structural breaks, it is necessary to look at a time series plot of the Turkish stock market. This is done in the graph below, with BIST 100 as the reference.

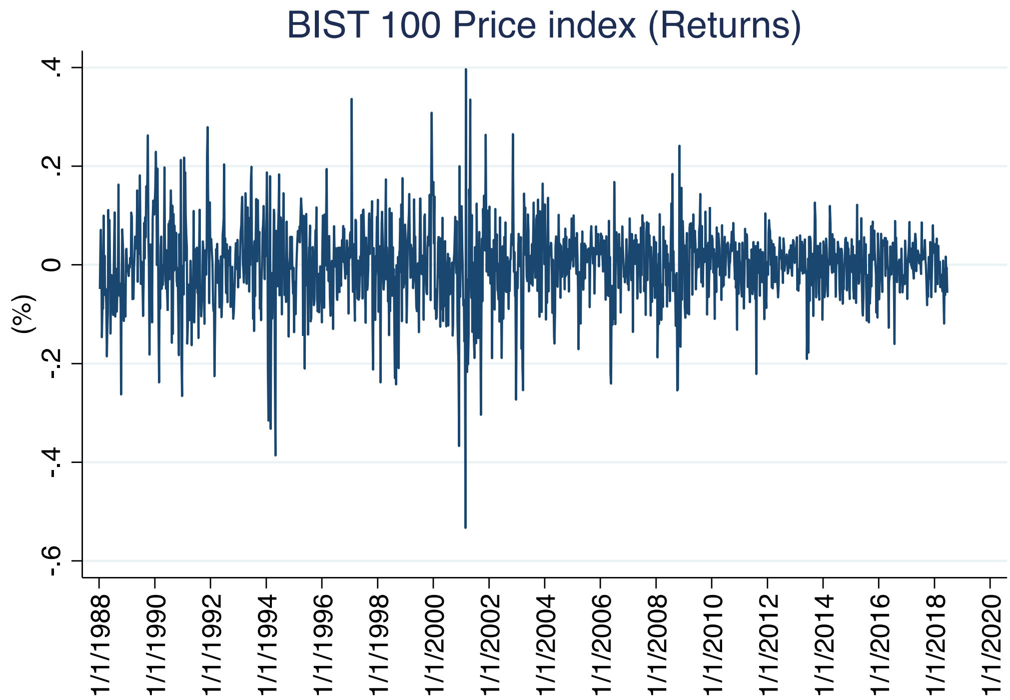
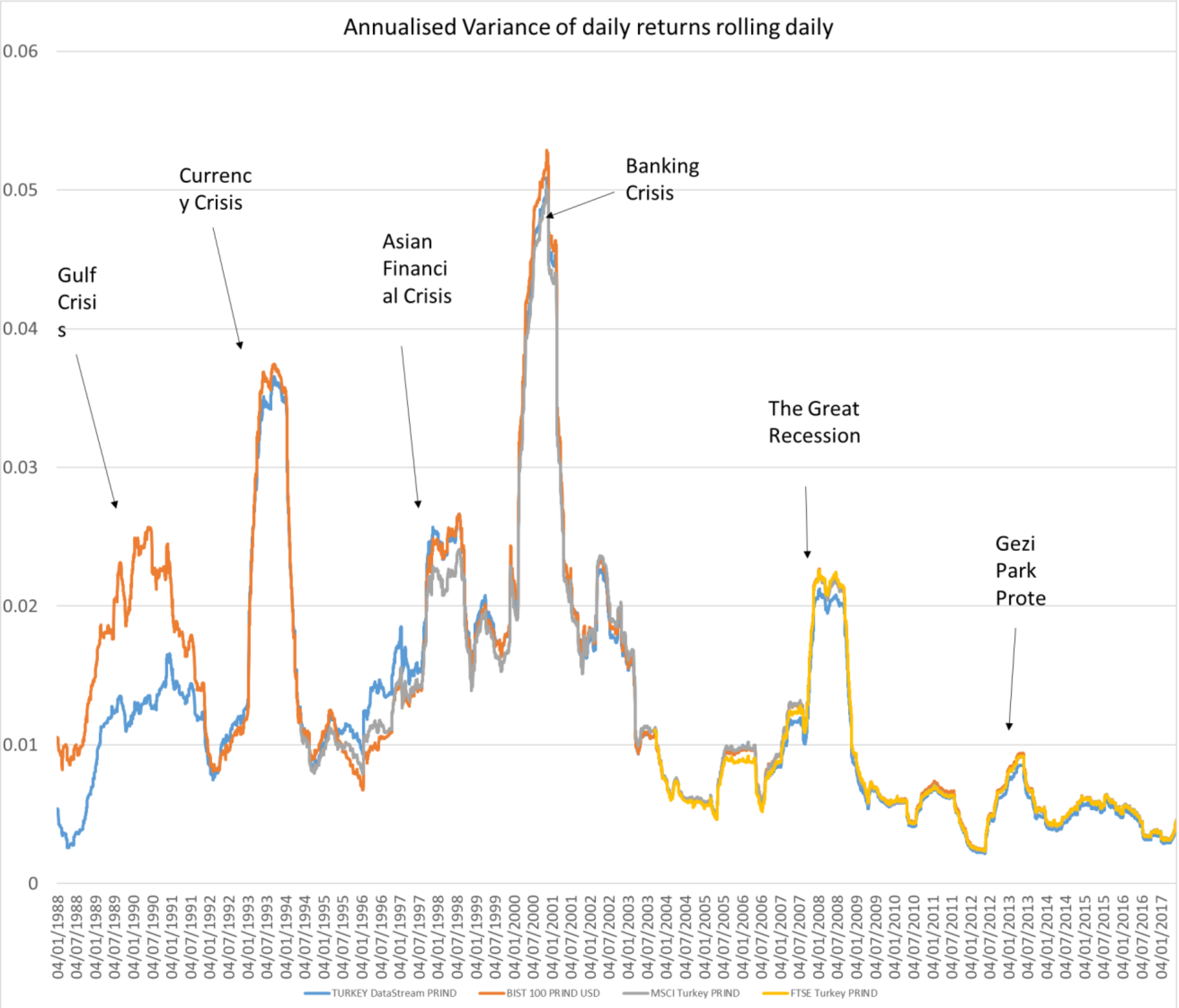


Figure 2: BIST 100 Price index

Clearly, there are periods of increased volatility in the returns, which can be perceived as indications of abnormal returns. To explore this further, the following graph illustrates the annualised variance of daily returns. The following graph depicts the annualised variance of daily log returns of MSCI, FTSE, BIST and Datastream Turkish price indexes, using a rolling window of one year.

Figure 3: Annualised variance of daily returns rolling daily



Indeed, in periods characterised by significant economic events, the variance curves of Turkish stock market index returns exhibit abrupt increasing and decreasing patterns. The periods of abrupt changes in variance structure occurred in the following periods: 1989-1992 (Gulf crisis), 1993 - 1994 (currency crisis), 1998-1999 (Asian financial crisis), 2000-2002 (banking crisis), 2008-2009 (great recession), 2013-2014 (Gezi Park protests). Hence, changes in the variance structure can be observed in the log-returns of the series, and they should be considered in the weak-form efficiency tests. It is interesting to observe that the differences between the rolling variances for different series depicted in Figure 1 are gradually diminishing in time. Except for the period of 1996-1998 and the initial first two quarters of 1988, they are visible practically only in periods of crisis. This prompts a preliminary conclusion that the heterogeneity in the market might gradually diminish in time which might, as a result, positively reflects on market efficiency.

Results

The purpose of this section is to present descriptive statistics and analyse the results of the statistical test applied to the indexes described in the previous section. First, the results of autocorrelation, stationarity and unit roots will be analysed, which reflect the traditional random walk hypothesis. The second subsection presents our analysis of the martingale hypothesis with the results of variance ratios tests. In the third section, the results of the AR-GARCH-In-Mean model will be presented, which capture the evolving efficiency hypothesis. Lastly, the results of trend regression are presented to evaluate the extent to which the efficiency has changed over time.

Autocorrelation, stationarity, and unit roots.

The first set of results of the EMH revolves around the autocorrelation and stationarity of the time series of log returns. The appendix reports the results of the Ljung-Box Q. In 97% of the tests, the null hypothesis of no serial correlation is rejected, indicating persisting serial correlation of index returns. Strong autocorrelation in the series suggests that future prices are predictable.

The series of the MSCI large-cap index and the MSCI Turkey Investable Market exhibit autocorrelation from the 7^{th} to the 36th lag, and the MSCI mid- and small-cap index series exhibit autocorrelation from the second lag. This pattern implies that the efficient market hypothesis holds for a short-term period, but in the long run, it does not. This is consistent with a martingale process over short intervals, where systematic short-run changes in fundamental values are negligible. Hence, the predictability of returns and positive abnormal returns do not occur. Profits due to no presence of market efficiency may occur in the MSCI indexes in the long run rather than in the short run. This contradicts the finding of studies that report autocorrelation in the short run and positive profits due to short-term reversals (e.g. Lehmann, 1990; Jegadeesh, 1990). Moreover, this provides evidence of evolving market efficiency, as there are periods during which the market is efficient and periods that it is not.

The Ljung–Box Q test results are consistent with the prior literature. Both Balaban (1995) and Kapusuzoglu (2013) employed Ljung–Box Q test and found statistically significant autocorrelation coefficients in Istanbul Securities Exchange Composite Index (ISECI) during 1988-1994 and 1996-2012, respectively. Therefore, there is no evidence supporting weak-form market efficiency according to Ljung–Box Q test.

In the appendix, the results of the ADF test are reported. Each row of the table shows the test results for each index with the values of ADF test statistic (t-statistic) and the MacKinnon (1996) one-sided p-values in the parenthesis. ADF tests were conducted under models which contain both constant and constant-trend components. Each column corresponds to test regressions which combine the presence of constant, constant-trend components. The presence of no evidence of unit root in all indexes implies that all series do not exhibit martingale and random walk characteristics. This indicates that the Turkish stock market, represented by the 15 indexes, is not a weak-form efficient market.

The results support prior the findings of the previous literature. For example, the ADF test is used by Buguk and Brorsen (2003) on the ISECI and industrial and financial index returns during 1992-1999, and they found no evidence of EMH. Similarly, Kapusuzoglu (2013) rejected the EMH in all specifications of the ADF test (with constant and with constant trend). Moreover, Ozer and Ertokatli (2010) also rejected it in the ISE 100 index from 1997-2009. Therefore, according to the ADF test, there is no evidence supporting weak-form market efficiency.

In the Appendix, the results of the PP test are reported. Each row of the table shows the test results for each index with the values of the PP test statistic (adjusted t-statistic) and the MacKinnon (1996) one-sided p-values in the parenthesis. PP tests were conducted under models which contain both constant and constant-trend components. Moreover, models use as a dependent variable the series of log returns of series. Each column of the table, corresponds to test regressions which combine the presence of constant, constant-trend components. As observed, the unit root hypothesis is rejected in all cases. The presence of no evidence of unit root in all indexes implies that all series do not exhibit martingale and random walk characteristics, a finding consistent with the literature that employed similar tests (e.g. Kapusuzoglu 2013).

In the Appendix, the results of the KPSS test are reported. Each row of the table shows the test results for each index with the values of the KPSS test statistic (LM statistic) and the asymptotic critical values for 1%, 5% and 10% levels of statistical significance. KPSS tests were conducted under models containing both constant and constant-trend components and using the series of log returns as a dependent variable. Each panel of the KPSS corresponds to test regressions that combine constant and constant-trend components. The null hypothesis of stationarity cannot be rejected at a 1%, 5%, or 10% significance level. Since all indexes exhibit no evidence against stationarity, mean reversion in the series is possible in the presence of a shock. Since mean reversion is possible, predicting future prices is also possible. Hence there is no evidence supporting martingale and random walk process or weak-form efficiency in the series. This is consistent with prior work (e.g. Kasman and Kırkulak 2007), as well as the results of the previous stationarity tests.

In the appendix, the results of the innovational outlier test are reported. Each row of the table shows the test results for each index with the values of the innovational outlier test statistic (Augmented Dickey-Fuller test statistic) and the asymptotic critical values for 1%, 5% and 10% levels of statistical significance. The null hypothesis of unit root is rejected at the 1% significance level. The presence of no evidence of unit root in all indexes implies there is no efficiency in Turkish markets.

Variance ratios

The final set of results for jointly testing the necessary and sufficient conditions for the EMH consists in running the Lo and MacKinlay (1988) and Wright (2000) variance ratios tests. In the Appendix, the results of the Lo and MacKinlay LOMAC variance ratio tests are reported. Panel A reports the values of the Chow-Denning statistic, which is used to examine the joint null hypothesis of random walk based on multiple variance ratios calculated using the variance of the first and q differences of each series. Panel B reports the values of Liu and He (1991) z test statistic for testing the null hypothesis of random walk based on the variance ratios calculated using the variance of the first and q differences of each series. The z test is robust under heteroscedasticity, and it is reported for each index and for each value of q separately. Following Buguk and Brorsen (2003), I applied the following choice of q values: $q = 2, 4, 8, 16$.

According to LOMAC variance ratio tests, both joint and individual tests reject the null hypothesis of equality of variances for all indices. We also conducted tests using the variance ratio test proposed by Wright (2000). In our reported results, both joint and individual tests reject the null hypothesis of equality of variances for all indices. Hence, there is no supporting evidence that variance grows proportionally with time, which in turn indicates the predictability of returns. Hence, weak market efficiency is not supported.

The results of variance ratio tests do not appear to be consistent with some of the prior literature. The LOMAC variance ratio test is employed by Buguk and Brorsen (2003), where the null hypothesis of equality of variances could not be rejected. It is also applied by Ozdemir (2008) for the Istanbul Stock Exchange National 100 index for the period 1990-2005, where the null hypothesis of equality of variances could not be rejected. Wright (2000) rank- and sign-based variance ratio tests are employed by Buguk and Brorsen (2003), and the results were mixed, but in most of the cases the null hypothesis could not be rejected.

To check the robustness of our result, in the Appendix, the results of the Wild Bootstrapped Variance Ratio Test is reported (Kim, 2006). Panel A reports the values of the Chow-Denning statistic, which is used to examine the joint null hypothesis of martingale based on multiple variance ratios calculated using the variance of the first and q differences of each series. Panel B reports the values of LOMAC statistic which is used to examine the null hypothesis of martingale based on the variance ratios calculated using the variance of the first and q differences of each series. LOMAC test statistic is reported for each index and for each value of q separately. According to Kim’s (2006) variance ratio tests,both joint and individual tests reject the null hypothesis of martingale. Hence weak market efficiency is again not supported.

It is, however, important to recall the possible limitations of the variance ratio tests. In the context of the Istanbul Stock Exchange, two aspects seem to be particularly relevant: (1) potential for false positives and (2) sensitivity to the measurement error. For the former, the variance ratio tests can sometimes produce false positive results, suggesting the presence of long-term predictability when none actually exists. In this context, it is interesting to note that, according to the results in Table A for some of the investibles, e.g. MSCI Turkey (Large-Cap) and MSCI Turkey (Investable Market), the short-run autocorrelations are actually insignificant; the significance appears only when longer lags are taken into account. It suggests a possibility for the existence of a false positive here. For the latter, the Variance ratio tests can be sensitive to measurement error, which can arise from factors such as rounding or data entry errors. If the data is not measured accurately, this can lead to inaccurate results. This might particularly be true for data from emerging markets with relatively large volatility. In such a case, and also in the presence of possible missing values, measurement errors might occur, distorting the results.

AR-GARCH-in-mean

The third set of results of the EMH revolves around the estimation of AR(1)-GARCH(1,1)-in-mean. To compare the results of this method with the ones of Method 1, AR(1)-GARCH(1,1)-in-mean model is estimated using both levels and first differences of the indexes. Table 18 reports the estimation results of the AR(1)-GARCH(1,1)-in-mean model. Each row of the table shows the results for each index, with values of the estimated coefficients of mean and variance equations and the p-values in the parenthesis. Suppose the p-value of the estimated coefficient of the lagged term in the mean equation is less than 0.05. In that case, the null hypothesis of no serial correlation is rejected, indicating persisting serial correlation of index returns. Suppose the p-value of the estimated coefficient of the GARCH term in the variance equation (column GARCH(-1)) is less than 0.05. In that case, the null hypothesis of constant variance structure is rejected, indicating that the variance structure changes.

For the levels of the first ten indexes, the autoregressive parameter is statistically significant, but for the last five indexes, it is not. This implies that since the autocorrelation coefficients for most indexes are statistically significant, past log returns provide relevant information regarding future changes in series. Moreover, in the variance equation, the GARCH parameter is statistically significant for all indexes, which means that past volatility affects current levels of variance. In conclusion, the weak form of the efficient market hypothesis is not supported.

The AR(1)-GARCH(1,1)-In-Mean model results are consistent with prior literature. AR(1)-GARCH(1,1)-In-Mean model is estimated by Müslümov, Aras & Kurtuluş (2003) using ISE 100 index from 1991 to 2001, where the autoregressive structure, as well as the GARCH term, is statistically significant. Therefore, according to AR(1)-GARCH(1,1)-In-Mean model estimators, there is no evidence supporting the weak-form market efficiency in the Turkish stock market. The results are also consistent with the autocorrelation results of the Ljung-Box Q statistic.

To examine the evolving efficiency, the appendix reports the estimation results of the AR(1)-GARCH(1,1)-in-mean model in the two sub-periods of the sample of each series of log returns. For the indexes FTSE Turkey Price Index and FTSE Turkey Total Return Index, the sample is the smallest relative to the samples of other indexes and, hence, the AR(1)-GARCH(1,1)-in-mean model cannot be estimated for the sub-periods. The autoregressive parameter in each sub-period is statistically significant for the levels of the first eight indexes, but it is not for the last five indexes. This result is consistent with the autoregressive parameters in full samples and implies that past log returns provide relevant information regarding future changes in series. Moreover, in the variance equation of all sub-periods, the GARCH parameter is statistically significant for all indexes, which means that past volatility affects current levels of variance, similar to the results of the total sample analysis. In conclusion, no index seems to change towards efficiency because the weak form of the efficient market hypothesis is not supported, given autocorrelation and GARCH parameters.

I checked the robustness of our results by running the test for the before and after 2008 global crisis subperiods, and the results remained largely unchanged. All models also indicate persistent volatility of the weekly returns. These results provide mixed support to earlier results in the literature. Müslümov et al. (2003) used ISE 100 index from 1991 to 2001 and found that both the autoregressive structure as well as the GARCH term were statistically significant, indicating the lack of weak-form efficiency for the chosen market benchmark.

Trend Regression

An alternative approach to test the efficiency of the market is by using trend regression. This will help us better understand the evolutionary character of efficiency in the market. To achieve this, we use the following approach, in the spirit of Auer (2016). Firstly, we define the following model:

$$Q_t = \alpha + \beta_i T + \epsilon_i$$

Where Q_t is the q-statistic for lag_i of the Ljung-box test, where i= 1 to 40, and T is a time variable, which takes the value from 1 to 30, from the year 1989 to 2018, respectively, if the null hypothesis that $\beta_i = 0$ is rejected at 5%, then this would imply that there is a trend in the evolution of the efficiency of TEM, either in a positive or negative direction. Thus, there is evolving market efficiency.

To reinforce the validity of the analysis, the same process was used, but instead of the q-statistic, the variance ratio was used. To be more precise, the model is:

$$VR_i = \alpha + \beta_i T + \epsilon_i$$

Where VR_i is the LOMAC variance ratio for q_i, where i= 2 or 4 or 8 or 16, and T is a time variable, which takes the value from 1 to 31 from the year 1989 to 2018, respectively. Similarly, if the null is rejected, then there is a trend in the evolution of market efficiency.

The detailed results can be found in the Appendix. Looking at the values of the q-statistics, the analysis revealed that for the lags from 3 to 30 (out of 40 and lag 37), there is a positive and statistically significant time trend coefficient. This suggests that every year the efficiency of the Turkish Equity Market deteriorates. One could take a different point of view and say that with the addition of more data, it became more and more clear every year that the Turkish Equity Market is not weak-form efficient. We believe that it is a combination of the two.

A similar picture can be painted by looking at the results of the LOMAC Variance Ratio test. This revealed that for all q-periods, there is a statistically significant time trend with a low positive coefficient, suggesting that every year the efficiency of the Turkish Equity Market deteriorates. This result is in line with previous findings. However, the regression found no time trend in q-periods two and four.

Discussions

A potential explanation for the lack of efficiency in the Turkish market can be traced to the characteristics common to emerging markets. For example, the microstructure of the Turkish market, the lack of liquidity, and the nature of traders.

It is well-documented that liquid markets are more likely to be efficient than those with thinner trading volumes (Revest, 1999). Moreover, the existence of multiple market makers tends to stimulate competition and improve market liquidity, which can improve efficiency (Huang & Stoll, 1996). Over the period, the liquidity of the Turkish market was not exceptionally high, and the number of market makers was limited. This is reflected in the relatively high bid-ask spreads, as well as the levels of the trading volume. The lack of liquidity is also evident in the recent suspension of trading in the aftermath of the two devastating earthquakes, a closure that lasted for a whole trading week. Other particularities of the Turkish market over the period include the daily lunch break to trading, which takes place every day, as well as the fact that the BIST lacks a parallel upstairs market that operates in the first 30min of trading and is reserved only for the wholesale market. This two-trading-session structure, with a midday break, is quite different to developed markets, where there is continuous trading throughout the day, a practice which was replaced at the end of 2019.

The inefficiency results also indicate that the size of the market influences efficiency. The literature has shown that small markets are typically less efficient than larger ones (Jennengren & Krosvold, 1984). Given the initially small size of the Turkish market, this can be another reason for inefficacy persisting in the early years. However, the inefficiency should disappear over time and as the market becomes more extensive.

However, it needs to be mentioned that over time, the market cap, liquidity, and volume of transactions have increased significantly, especially after the Istanbul Stock Exchange (ISE) merger and the Istanbul Gold Exchange (IGE) in 2013. According to the latest data, there are approximately 5,000 listed securities, with an average trading volume of 5 billion USD, as of 1/8/2022 (RBCITS 2023). Moreover, the amount of foreign investment in the BIST has increased dramatically in recent years, making the Turkish stock market one of the most vibrant emerging markets. In particular, as of 2020, “the BIST was ranked 22nd and 31st in the world in terms of transaction volume and market capitalisation, respectively. At that time, foreign investors and mutual funds from developed markets owned 61% of free-floating shares” (RE, p.2) (Kadiroglu, 2021). These significant changes in the fundamental characteristics of the stock market can explain why we have found evidence of evolving market efficiency since the stock market microstructure in the early 1990s is entirely different to those in the 2010s.

Another reason for the lack of efficiency in the Turkish market can be the nature of the traders. The key pillars of EMH lie in the importance of information; agents have to get access to all available information and must also be able to process it accordingly. If the data quality is poor, then the efficiency of the market will drop. Similarly, suppose the cognitive ability of the traders is low. In that case, it will be difficult for the market to operate efficiently, resulting in noise and increasing volatility, especially in periods of global macroeconomic instability. Looking at the literature, some authors recognised that the initial composition of the stock market participants was mostly speculators and short-term myopic investors (Aybar 1992). This means there were frequent incidences of overreaction, based on technical analysis, mainly overlooking the fundamentals. Moreover, some authors have found evidence of the volatility spillover, as the Turkish index had daily limiters initially set to 10% and later to 20% of the price. This implies that the volatility could spread over an extended period, leading to even less efficiency (Kyle, 1988), as higher volatility is linked to lower trading volume (Guner & Onder, 2002).

Lastly, other characteristics specific to the BIST might be responsible for the inefficiency in the market. For example, the tick size of the BIST is almost nine times larger than other exchanges (Yuksel 2000), which implies that the trading behaviour is impeded. Traders would think twice before entering a trade, which further increases volatility. The large tick size can further indicate informational asymmetries and signal that price resolution in the market is low.

Conclusions

The evidence on the efficiency of the Turkish stock market is mixed, with some authors suggesting that the markets are efficient, but most authors claim that they are inefficient. This chapter aims to clarify this by examining the efficiency of the Turkish markets, with the largest possible dataset over the most extensive period. In particular, data for 15 indices were collected over the period 1989-2019, which to the best of our knowledge, represents the most comprehensive dataset available for the Turkish stock market. Unlike in previous papers, which tend to opt-in for just one or a few equity indices, I subjected a broad range of indices to statistical testing. The advantages of this approach are three-fold: (1) the use of investable indices provides more credible information on index returns; (2) the indices for different market segments (e.g., market capitalisation segments) should be recognised and tested as the EMH should not necessary be supported in all market segments; (3) although the returns on all selected equity indices are highly correlated in time, the correlation varies over time, and the indices exhibit substantial heterogeneity, particularly during the volatile periods. The use of a wider range of indices appears to provide more robust evidence with respect to the EMH in the Turkish equity market so the empirical strategy applied here paid off.

To study EMH, we have used a variety of tests, all of which have been used in the literature but never all together in a single paper. This was done to increase the validity of the results to provide a definite answer to the topic of efficiency in the Turkish market. The methods used were autocorrelation tests using ADF, unit roots, and variance ratios. Moreover, we hypothesised that there might be evidence of evolving market efficiency as the period under consideration is extensive. In other words, the initial inefficiency that could be present in the Turkish stock market might disappear over time as the Turkish market becomes more developed. For this reason, we also used the GARCH-In-Mean model.

I managed to positively verify my working hypothesis, albeit not very strongly. The hypothesis states that, in the heterogeneous market, its relevant components might exhibit the properties of market efficiency. I have identified this component as that of the investible assets market. My result also added an additional and interesting explanation to the recent result of Abar (2022), who discovered the existence of a statistically significant causality from financial development to economic growth in Turkey. My findings suggest that this development might happen mainly due to the marked efficiency of the investible assets market. As such causality has also been found for a number of other countries (see, e.g. Dike, 2016), it can be conjectured that my findings might also be valid from a wider international perspective.

The choice of an equity index to test the EMH appears to matter. Although, as in the previous studies, the empirical evidence supporting the EMH in the Turkish equity market presented in this paper remains mixed, the MSCI Turkey Investable index and the MSCI indices for large, medium, and small capitalisation companies appear to support the EMH, at least in the context of tests I applied. As these indices are widely used for investment purposes and portfolio management (e.g., size-factor rotation strategies), the evidence derived from these indices behaviour is likely to be more credible, and the previous results in the literature could be biased by the index choice. Nevertheless, the difference between this and past studies may still be attributed to the different time spans and statistical methods used. The tests supporting the EMH tend to be based on indices with shorter time span, and hence could indicate the improvements in market efficiency in a more mature market development stage, but, as we point out in Chapter 4 of this thesis, the Turkish public equity market went through the turbulent period recently and was at the edge of being downgraded to the frontier market due to a number of investment restrictions, which appeared to negatively affect the drivers of market efficiency. The overall conclusion of this study is that the Turkish equity market appears to moderately deviate from the benchmark of efficiency, but the results tend to be sensitive to the sample period, the test choice, and the market index choice. A longer time series for investable indices accumulated over time will likely help to derive more credible information on the equity market efficiency in Turkey. The results are consistent with those of previous literature except for some of the results of the variance ratios.

The market's inefficiency can be attributed to various factors related to the Turkish stock market's microstructure, the traders' nature, and the amount of information. These points need to be addressed by policymakers seeking to improve the efficiency of the stock market. In principle, the regulators aim to reduce the volatility of the markets, as periods of extreme volatility are accompanied by a loss in investors' confidence and, in principle, leave small investors worse off (Inci, 2018).

As the MSCI size-caped indices are widely used for investment purposes and portfolio management (e.g., size-factor rotation strategies), the evidence of market efficiency might have important practical relevance, particularly in choosing the optimal investment strategy in line with the foundations of the efficient markets theory. Another novel feature of this chapter is the use of a longer sample period compared to other studies of Turkey's equity market. The maximum sample period in our study when it was drafted was 1988-2018, which is significantly longer than the samples used in other studies.

On the methodological side, my results indicate the relevance and, perhaps, some superiority of testing the necessary condition of market efficiency using the GARCH-M approach over the traditional autocorrelation and variance ratio approaches. The GARCH-M model tests both the effects of autocorrelation and autoregression in conditional variance simultaneously, giving complex and easily interpretable results. It also explicitly accounts for some forms of non-normality in data, that is, those caused by autoregression in the conditional variance. Its drawback is that it is difficult to account for long-term autocorrelation and, hence, calendar and seasonal effects. Therefore, it should be accompanied by other forms of statistical testing.

In terms of the policy makers, my findings suggest that the government might find it helpful to introduce more trading options for market participants. For example, they can introduce auction mechanisms during the closing period in the morning and afternoon sessions, thus increasing liquidity, reducing volatility, and increasing efficiency. Other mechanisms can be alternative order execution possibilities, further increasing liquidity and eagerness to trade. Moreover, governments can focus on improving the dissemination of market information and remove any barriers to information flow. Rules on releasing company information should be revised and enforced, as well as regulate the advisory services offered by intermediaries. Lastly, in an attempt to increase the sophistication of market participants, the regulators can look at emphasising the trading education and professional standards currently in place for Turkish agents. This can also be achieved with the greater participation of foreign investors, banks, and brokers.

This paper has concentrated on the informational efficiency of the Turkish stock market. Another area to explore would be to test for market efficiency across the different components of the BIST. For example, the financial sector, in particular the banking sector, is one of the largest in emerging markets, second after Russia in Europe. It is characterised by high liquidity, asset quality, and a relatively low level of leverage (Inci, 2018). For this reason, the efficiency of the markets might differ, so this is an area that could be explored further. Lastly, future work can also examine nonlinearities in stock market returns of other emerging markets to identify patterns similar to Turkey. Turkey has one of the most developed markets among the emerging ones, so lessons for other emerging markets can be drawn.

Appendix

Table 6: Ljung–Box Q Test Statistics for Turkish Equity Indices

Panel A: lags from 1 to 10

	1	2	3	4	5	6	7	8	9	10
MSCI Turkey Price Index	36.961 (0)	44.042 (0)	50.22 (0)	50.484 (0)	51.281 (0)	52.369 (0)	63.048 (0)	63.416 (0)	66.069 (0)	66.434 (0)
MSCI Turkey Total Return Index	36.88 (0)	43.837 (0)	49.816 (0)	50.107 (0)	50.837 (0)	51.959 (0)	62.597 (0)	62.975 (0)	65.564 (0)	65.936 (0)
FTSE Turkey Price Index	17.581 (0)	19.832 (0)	22.881 (0)	22.894 (0)	26.671 (0)	26.869 (0)	32.363 (0)	33.203 (0)	33.418 (0)	34.685 (0)
FTSE Turkey Total Return Index	17.16 (0)	19.262 (0)	22.118 (0)	22.124 (0)	25.64 (0)	25.814 (0)	31.5 (0)	32.3 (0)	32.496 (0)	33.778 (0)
BIST 100 Price Index	74.043 (0)	92.686 (0)	100.79 (0)	100.9 (0)	101.78 (0)	102.41 (0)	109.47 (0)	109.78 (0)	110.79 (0)	113.62 (0)
BIST 100 Total Return Index	80.482 (0)	96.994 (0)	104.81 (0)	104.9 (0)	105.37 (0)	108.16 (0)	116.26 (0)	117.02 (0)	117.19 (0)	119.61 (0)
S&P/IFCID Turkey Price Index	26.028 (0)	31.404 (0)	39.199 (0)	39.306 (0)	39.854 (0)	42.076 (0)	53.577 (0)	54.073 (0)	57.019 (0)	57.234 (0)
S&P TURKEY BMI Price Index	26.391 (0)	32.933 (0)	40.262 (0)	40.544 (0)	41.686 (0)	42.726 (0)	52.018 (0)	52.471 (0)	56.042 (0)	56.728 (0)
Turkey DataStream Price Index	71.573 (0)	84.297 (0)	91.433 (0)	91.435 (0)	92.144 (0)	94.595 (0)	103.33 (0)	103.75 (0)	104.36 (0)	107.3 (0)
Turkey DataStream Total Return Index	66.946 (0)	79.438 (0)	86.343 (0)	86.349 (0)	86.896 (0)	90.001 (0)	99.458 (0)	99.752 (0)	100.61 (0)	104.34 (0)
MSCI Turkey (Large-Cap) Price Index	0.0789 (0.779)	2.2256 (0.329)	7.4632 (0.059)	7.4632 (0.113)	7.4674 (0.188)	7.991 (0.239)	23.811 (0.001)	23.812 (0.002)	24.868 (0.003)	30.937 (0.001)

MSCI Turkey (Mid-Cap) Price Index	0.5511 (0.458)	6.5511 (0.038)	10.675 (0.014)	11.436 (0.022)	11.544 (0.042)	11.547 (0.073)	23.637 (0.001)	23.715 (0.003)	23.808 (0.005)	29.419 (0.001)
MSCI Turkey (Small Cap) Price Index	3.2028 (0.074)	12.052 (0.002)	16.342 (0.001)	20.375 (0)	21.86 (0.001)	21.862 (0.001)	30.108 (0)	30.298 (0)	30.556 (0)	32.685 (0)
MSCI Turkey (Small and Mid-Cap) Price Index	1.8933 (0.169)	10.496 (0.005)	14.615 (0.002)	17.184 (0.002)	17.349 (0.004)	17.349 (0.008)	28.009 (0)	28.233 (0)	28.271 (0.001)	32.542 (0)
MSCI Turkey (Investable Market)	0.0007 (0.979)	2.8705 (0.238)	7.014 (0.071)	7.1981 (0.126)	7.2122 (0.205)	7.338 (0.291)	22.815 (0.002)	22.854 (0.004)	23.149 (0.006)	29.304 (0.001)

Panel B: lags from 11 to 20

	11	12	13	14	15	16	17	18	19	20
MSCI Turkey Price Index	66.793	68.643	71.344	74.209	74.724	75.13	75.855	76.046	77.747	77.747
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
MSCI Turkey Total Return Index	66.264	68.092	70.935	73.88	74.439	74.84	75.614	75.796	77.575	77.575
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
FTSE Turkey Price Index	34.817	36.511	40.267	40.432	40.437	40.44	40.575	44.222	44.779	44.788
	(0)	(0)	(0)	(0)	(0)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
FTSE Turkey Total Return Index	33.946	35.678	39.704	39.916	39.93	39.93	40.099	43.577	44.074	44.08
	(0)	(0)	(0)	(0)	(0)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
BIST 100 Price Index	113.92	114.21	119.11	121.06	121.56	121.61	125.31	125.33	125.54	125.62
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
BIST 100 Total Return Index	119.82	121.14	126.71	129.01	129.2	129.22	132.36	132.49	133.71	133.9
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
S&P/IFCID Turkey Price Index	58.016	60.004	63.974	67.835	68.768	68.796	69.902	69.926	70.965	70.987
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
S&P TURKEY BMI Price Index	57.142	58.541	61.278	65.15	65.62	65.754	67.115	67.127	68.378	68.378
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Turkey DataStream Price Index	107.49	108.15	113.53	115.41	115.43	115.61	117.11	117.15	118.44	118.64
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Turkey DataStream Total Return Index	104.45	105.37	110.86	112.77	112.77	113.23	114.39	114.5	116.12	116.27
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)

MSCI Turkey (Large Cap) Price Index	32.323 (0.001)	32.477 (0.001)	32.784 (0.002)	35.783 (0.001)	36.369 (0.002)	36.457 (0.002)	38.736 (0.002)	39.366 (0.003)	42.758 (0.001)	43.81 (0.002)
MSCI Turkey (Middle Cap) Price Index	31.298 (0.001)	31.299 (0.002)	37.204 (0)	38.169 (0)	38.317 (0.001)	38.595 (0.001)	39.505 (0.002)	40.577 (0.002)	41.34 (0.002)	41.483 (0.003)
MSCI Turkey (Small Cap) Price Index	33.888 (0)	33.894 (0.001)	36.875 (0)	38.721 (0)	40.816 (0)	42.484 (0)	42.803 (0.001)	43.164 (0.001)	43.166 (0.001)	43.639 (0.002)
MSCI Turkey (Small and Mid-Cap) Price Index	34.108 (0)	34.113 (0.001)	38.484 (0)	39.895 (0)	40.956 (0)	41.818 (0)	42.348 (0.001)	42.936 (0.001)	43.157 (0.001)	43.364 (0.002)
MSCI Turkey (Investable Market)	30.982 (0.00)	31.078 (0.002)	32.117 (0.002)	34.829 (0.002)	35.809 (0.002)	36.05 (0.003)	37.874 (0.003)	38.25 (0.004)	39.434 (0.004)	40.573 (0.004)

Table 7: Augmented Dickey-Fuller Test Statistic for Turkish Equity Indexes

Index	constant	constant and trend
MSCI Turkey Price Index	-29.76 (0)	-29.75 (0)
MSCI Turkey Total Return Index	-29.77 (0)	-29.76 (0)
FTSE Turkey Price Index	-23.77 (0)	-23.81 (0)
FTSE Turkey Total Return Index	-23.80 (0)	-23.84 (0)
BIST 100 Price Index	-31.98 (0)	-31.97 (0)
BIST 100 Total Return Index	-31.62 (0)	-31.62 (0)
S&P/IFCI D Turkey Price Index	-30.27 (0)	-30.26 (0)
S&P TURKEY BMI Price Index	-30.55 (0)	-30.54 (0)
Turkey DataStream Price Index	-32.09 (0)	-32.08 (0)
Turkey DataStream Total Return Index	-31.46 (0)	-31.46 (0)
MSCI Turkey (Large-Cap) Price Index	-35.56 (0)	-35.56 (0)
MSCI Turkey (Mid-Cap) Price Index	-34.59 (0)	-34.59 (0)
MSCI Turkey (Small Capitalisation) Price Index	-22.44 (0)	-22.44 (0)
MSCI Turkey (Small and Mid-Cap) Price Index	-22.60 (0)	-22.60 (0)
MSCI Turkey (Investable Market)	-35.26 (0)	-35.27 (0)

Table 8: Phillips-Perron Test Statistic for Turkish Equity Indexes

Index	constant	constant and trend
MSCI Turkey Price Index	-29.85 (0)	-29.84 (0)
MSCI Turkey Total Return Index	-29.84 (0)	-29.83 (0)
FTSE Turkey Price Index	-24.06 (0)	-24.07 (0)
FTSE Turkey Total Return Index	-24.07 (0)	-24.08 (0)
BIST 100 Price Index	-32.33 (0)	-32.32 (0)
BIST 100 Total Return Index	-31.84 (0)	-31.83 (0)
S&P/IFCI D Turkey Price Index	-30.47 (0)	-30.45 (0)
S&P TURKEY BMI Price Index	-30.73 (0)	-30.72 (0)
Turkey DataStream Price Index	-32.23 (0)	-32.22 (0)
Turkey DataStream Total Return Index	-31.56 (0)	-31.55 (0)
MSCI Turkey (Large Cap) Price Index	-35.56 (0)	-35.56 (0)
MSCI Turkey (Mid-Cap) Price Index	-34.70 (0)	-34.70 (0)
MSCI Turkey (Small Cap) Price Index	-33.64 (0)	-33.65 (0)
MSCI Turkey (Small and Mid-Cap) Price Index	-34.11 (0)	-34.12 (0)
MSCI Turkey (Investable Market)	-35.28 (0)	-35.28 (0)

Table 9: KPSS Test

Panel A: constant				
	LM-Statistic	**Asymptotic critical values**		
		1% level	5% level	10% level
MSCI Turkey Price Index	0.041446	0.739	0.463	0.347
MSCI Turkey Total Return Index	0.040813	0.739	0.463	0.347
FTSE Turkey Price Index	0.120563	0.739	0.463	0.347
FTSE Turkey Total Return Index	0.118118	0.739	0.463	0.347
BIST 100 Price Index	0.025738	0.739	0.463	0.347
BIST 100 Total Return Index	0.083751	0.739	0.463	0.347
S&P/IFCI D Turkey Price Index	0.036449	0.739	0.463	0.347
S&P TURKEY BMI Price Index	0.040042	0.739	0.463	0.347
Turkey DataStream Price Index	0.029655	0.739	0.463	0.347
Turkey DataStream Total Return Index	0.075585	0.739	0.463	0.347
MSCI Turkey (Large Capitalisation) Price Index	0.06227	0.739	0.463	0.347
MSCI Turkey (Middle Capitalisation) Price Index	0.08183	0.739	0.463	0.347
MSCI Turkey (Small Capitalisation) Price Index	0.084933	0.739	0.463	0.347
MSCI Turkey (Small and Medium Capitalisation) Price Index	0.101961	0.739	0.463	0.347
MSCI Turkey (Investable Market)	0.095933	0.739	0.463	0.347
Panel B: constant and trend				
		1% level	5% level	10% level
MSCI Turkey Price Index	0.042002	0.216	0.146	0.119
MSCI Turkey Total Return Index	0.042561	0.216	0.146	0.119
FTSE Turkey Price Index	0.030499	0.216	0.146	0.119
FTSE Turkey Total Return Index	0.0306	0.216	0.146	0.119
BIST 100 Price Index	0.025558	0.216	0.146	0.119
BIST 100 Total Return Index	0.046382	0.216	0.146	0.119
S&P/IFCI D Turkey Price Index	0.037041	0.216	0.146	0.119
S&P TURKEY BMI Price Index	0.040523	0.216	0.146	0.119
Turkey DataStream Price Index	0.029349	0.216	0.146	0.119
Turkey DataStream Total Return Index	0.04059	0.216	0.146	0.119
MSCI Turkey (Large Capitalisation) Price Index	0.034627	0.216	0.146	0.119
MSCI Turkey (Mid Capitalisation) Price Index	0.036589	0.216	0.146	0.119
MSCI Turkey (Small Capitalisation) Price Index	0.041004	0.216	0.146	0.119
MSCI Turkey (Small and Medium Capitalisation) Price Index	0.046706	0.216	0.146	0.119
MSCI Turkey (Investable Market)	0.035038	0.216	0.146	0.119

Table 10: Innovational Outlier Test

Panel A: constant

	Augmented Dickey-Fuller test statistic	**Asymptotic critical values**		
		1% level	5% level	10% level
MSCI Turkey Price Index	-30.548	-4.949133	-4.443649	-4.193627
MSCI Turkey Total Return Index	-30.556	-4.94913	-4.443649	-4.193627
FTSE Turkey Price Index	-24.299	-4.949133	-4.443649	-4.193627
FTSE Turkey Total Return Index	-24.345	-4.949133	-4.443649	-4.193627
BIST 100 Price Index	-32.592	-4.949133	-4.443649	-4.193627
BIST 100 Total Return Index	-32.220	-4.949133	-4.443649	-4.193627
S&P/IFCI D Turkey Price Index	-31.024	-4.949133	-4.443649	-4.193627
S&P TURKEY BMI Price Index	-31.485	-4.949133	-4.443649	-4.193627
Turkey DataStream Price Index	-32.720	-4.949133	-4.443649	-4.193627
Turkey DataStream Total Return Index	-32.079	-4.949133	-4.443649	-4.193627
MSCI Turkey (Large Capitalisation) Price Index	-36.025	-4.949133	-4.443649	-4.193627
MSCI Turkey (Middle Capitalisation) Price Index	-35.252	-4.949133	-4.443649	-4.193627
MSCI Turkey (Small Capitalisation) Price Index	-34.520	-4.949133	-4.443649	-4.193627
MSCI Turkey (Small and Medium Capitalisation) Price Index	-34.337	-4.949133	-4.443649	-4.193627
MSCI Turkey (Investable Market)	-35.895	-4.949133	-4.443649	-4.193627

Table 11: Wright (2000) rank scores (van der Waerden scores) -based test

Panel A: Wright (2000) rank scores (van der Waerden scores) -based test for the joint null hypothesis of random walk				
Index name	**Denning statistic**	**Sig.**	**Wald (Chi-Square)**	**sig.**
MSCI Turkey Price Index	14.84044	0	222.7907	0
MSCI Turkey Total Return Index	14.84033	0	222.8114	0
FTSE Turkey Price Index	12.33241	0	153.1629	0
FTSE Turkey Total Return Index	12.34315	0	153.4617	0
BIST 100 Price Index	16.23955	0	266.8478	0
BIST 100 Total Return Index	15.98858	0	260.1712	0
S&P/IFCI D Turkey Price Index	15.08274	0	229.1993	0
S&P TURKEY BMI Price Index	15.29349	0	235.2523	0
Turkey DataStream Price Index	16.02936	0	261.7749	0
Turkey DataStream Total Return Index	15.75329	0	252.1872	0
MSCI Turkey (Large Capitalisation) Price Index	18.31005	0	336.8583	0
MSCI Turkey (Middle Capitalisation) Price Index	18.11978	0	329.1581	0
MSCI Turkey (Small Capitalisation) Price Index	17.97588	0	323.6709	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	18.13557	0	329.6893	0
MSCI Turkey (Investable Market)	18.22557	0	333.2098	0

Panel B: Wright (2000) rank scores (van der Waerden scores) -based test for the null hypothesis of random walk								
Index name	**Sampling interval q (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**	**Sampling interval q (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**
MSCI Turkey Price Index	2	0.580919	-14.84044	0	4	0.322935	-12.81578	0
MSCI Turkey Total Return Index	2	0.580922	-14.84033	0	4	0.322765	-12.819	0
FTSE Turkey Price Index	2	0.554993	-12.33241	0	4	0.293966	-10.45857	0
FTSE Turkey Total Return Index	2	0.554024	-12.34315	0	4	0.291831	-10.47652	0
BIST 100 Price Index	2	0.59248	-16.23955	0	4	0.344714	-13.95798	0
BIST 100 Total Return Index	2	0.598272	-15.98858	0	4	0.339755	-14.04586	0
S&P/IFCI D Turkey Price Index	2	0.569941	-15.08274	0	4	0.315276	-12.83613	0
S&P TURKEY BMI Price Index	2	0.568125	-15.29349	0	4	0.318852	-12.89306	0

Turkey DataStream Price Index	2	0.597501	-16.02936	0	4	0.336084	-14.13289	0
Turkey DataStream Total Return Index	2	0.595003	-15.75329	0	4	0.337112	-13.78242	0
MSCI Turkey (Large Capitalisation) Price Index	2	0.481491	-18.31005	0	4	0.25938	-13.9796	0
MSCI Turkey (Middle Capitalisation) Price Index	2	0.486879	-18.11978	0	4	0.258178	-14.00228	0
MSCI Turkey (Small Capitalisation) Price Index	2	0.490954	-17.97588	0	4	0.259593	-13.97558	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	2	0.486432	-18.13557	0	4	0.257464	-14.01576	0
MSCI Turkey (Investable Market)	2	0.483883	-18.22557	0	4	0.256767	-14.02891	0
Panel B (cont'd)								
Index name	**Sampling interval (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**	**Sampling interval (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**
MSCI Turkey Price Index	8	0.168257	-9.957121	0	16	0.097634	-7.259569	0
MSCI Turkey Total Return Index	8	0.167786	-9.962756	0	16	0.097443	-7.2611	0
FTSE Turkey Price Index	8	0.139639	-8.060412	0	16	0.075976	-5.817592	0
FTSE Turkey Total Return Index	8	0.137046	-8.074174	0	16	0.07418	-5.821304	0
BIST 100 Price Index	8	0.1828	-11.00904	0	16	0.098191	-8.164297	0
BIST 100 Total Return Index	8	0.178823	-11.04868	0	16	0.098321	-8.152835	0
S&P/IFCI D Turkey Price Index	8	0.164763	-9.902809	0	16	0.09405	-7.218319	0
S&P TURKEY BMI Price Index	8	0.167971	-9.960552	0	16	0.093454	-7.293196	0
Turkey DataStream Price Index	8	0.175834	-11.09589	0	16	0.094522	-8.19235	0
Turkey DataStream Total Return Index	8	0.176897	-10.82355	0	16	0.095779	-7.990483	0
MSCI Turkey (Large Capitalisation) Price Index	8	0.136909	-10.30353	0	16	0.0757	-7.415242	0
MSCI Turkey (Middle Capitalisation) Price Index	8	0.139993	-10.26671	0	16	0.074453	-7.42525	0
MSCI Turkey (Small Capitalisation) Price Index	8	0.147666	-10.17511	0	16	0.08847	-7.312791	0

MSCI Turkey (Small and Medium Capitalisation) Price Index	8	0.143653	-10.22301	0	16	0.081651	-7.367503	0
MSCI Turkey (Investable Market)	8	0.13779	-10.293	0	16	0.07744	-7.40128	0

Table 12: Wright (2000) signs-based test

Panel A: Wright (2000) signs-based test for the joint null hypothesis of random walk				
Index name	**Chow-Denning statistic**	**Sig.**	**Wald (Chi-Square)**	**sig.**
MSCI Turkey Price Index	8.980042	0	84.6794	0
MSCI Turkey Total Return Index	9.318911	0	89.70491	0
FTSE Turkey Price Index	7.649891	0	61.21462	0
FTSE Turkey Total Return Index	7.87666	0	64.61951	0
BIST 100 Price Index	10.13809	0	107.8829	0
BIST 100 Total Return Index	10.40214	0	111.0382	0
S&P/IFCI D Turkey Price Index	9.352362	0	91.66304	0
S&P TURKEY BMI Price Index	9.205955	0	88.11838	0
Turkey DataStream Price Index	10.24492	0	109.7777	0
Turkey DataStream Total Return Index	10.00069	0	103.8325	0
MSCI Turkey (Large Capitalisation) Price Index	13.28127	0	178.1112	0
MSCI Turkey (Middle Capitalisation) Price Index	11.07244	0	123.1622	0
MSCI Turkey (Small Capitalisation) Price Index	12.26181	0	150.7172	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	12.26181	0	151.5243	0
MSCI Turkey (Investable Market)	12.37509	0	153.7166	0

Panel B: Wright (2000) signs-based test for the null hypothesis of random walk								
Index name	**Sampling interval (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**	**Sampling interval (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**
MSCI Turkey Price Index	2	0.746411	-8.980042	0	4	0.562201	-8.286851	0
MSCI Turkey Total Return Index	2	0.736842	-9.318911	0	4	0.557416	-8.377418	0
FTSE Turkey Price Index	2	0.723958	-7.649891	0	4	0.522135	-7.078666	0
FTSE Turkey Total Return Index	2	0.715405	-7.87666	0	4	0.510444	-7.242406	0
BIST 100 Price Index	2	0.745592	-10.13809	0	4	0.556045	-9.456487	0
BIST 100 Total Return Index	2	0.738636	-10.40214	0	4	0.563763	-9.280394	0
S&P/IFCI D Turkey Price Index	2	0.733333	-9.352362	0	4	0.541463	-8.595923	0
S&P TURKEY BMI Price Index	2	0.740032	-9.205955	0	4	0.560606	-8.31704	0

Turkey DataStream Price Index	2	0.742749	-10.24492	0	4	0.554855	-9.47587	0
Turkey DataStream Total Return Index	2	0.742895	-10.00069	0	4	0.562459	-9.097132	0
MSCI Turkey (Large Capitalisation) Price Index	2	0.623897	-13.28127	0	4	0.473136	-9.944847	0
MSCI Turkey (Middle Capitalisation) Price Index	2	0.686447	-11.07244	0	4	0.549318	-8.506856	0
MSCI Turkey (Small Capitalisation) Price Index	2	0.652767	-12.26181	0	4	0.489174	-9.642112	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	2	0.652767	-12.26181	0	4	0.510024	-9.248557	0
MSCI Turkey (Investable Market)	2	0.649559	-12.37509	0	4	0.492382	-9.581565	0
Panel B (cont'd)								
Index name	**Sampling interval (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**	**Sampling interval (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**
MSCI Turkey Price Index	8	0.452153	-6.558491	0	16	0.348485	-5.241462	0
MSCI Turkey Total Return Index	8	0.448963	-6.596677	0	16	0.352073	-5.212592	0
FTSE Turkey Price Index	8	0.388672	-5.727314	0	16	0.300456	-4.40428	0
FTSE Turkey Total Return Index	8	0.380548	-5.795859	0	16	0.289817	-4.465434	0
BIST 100 Price Index	8	0.44301	-7.503581	0	16	0.366341	-5.736669	0
BIST 100 Total Return Index	8	0.451073	-7.385637	0	16	0.370423	-5.692534	0
S&P/IFCI D Turkey Price Index	8	0.418293	-6.896886	0	16	0.305691	-5.532029	0
S&P TURKEY BMI Price Index	8	0.435008	-6.763742	0	16	0.324761	-5.432323	0
Turkey DataStream Price Index	8	0.439155	-7.550754	0	16	0.351828	-5.864361	0
Turkey DataStream Total Return Index	8	0.441837	-7.339664	0	16	0.349306	-5.7501	0
MSCI Turkey (Large Capitalisation) Price Index	8	0.381716	-7.381033	0	16	0.329391	-5.379997	0
MSCI Turkey (Middle Capitalisation) Price Index	8	0.468725	-6.342327	0	16	0.414796	-4.694832	0

MSCI Turkey (Small Capitalisation) Price Index	8	0.422213	-6.89758	0	16	0.369888	-5.055106	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	8	0.42903	-6.816207	0	16	0.368885	-5.063148	0
MSCI Turkey (Investable Market)	8	0.404571	-7.108193	0	16	0.335204	-5.333354	0

Table 13: Wild bootstrapped variance ratio test (Kim 2006)

	the joint null hypothesis of martingale	
Index name	**Chow-Denning statistic**	**Sig.**
MSCI Turkey Price Index	7.016297	0
MSCI Turkey Total Return Index	7.017506	0
FTSE Turkey Price Index	8.321651	0
FTSE Turkey Total Return Index	8.34209	0
BIST 100 Price Index	8.227783	0
BIST 100 Total Return Index	8.073758	0
S&P/IFCI D Turkey Price Index	7.276938	0
S&P TURKEY BMI Price Index	6.955043	0
Turkey DataStream Price Index	8.109636	0
Turkey DataStream Total Return Index	8.028237	0
MSCI Turkey (Large Capitalisation) Price Index	11.29161	0
MSCI Turkey (Middle Capitalisation) Price Index	10.50098	0
MSCI Turkey (Small Capitalisation) Price Index	9.521467	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	9.982349	0
MSCI Turkey (Investable Market)	10.78179	0

Index name	**Sampling interval q (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**	**Sampling interval q (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**
MSCI Turkey Price Index	2	0.558015	-7.016297	0	4	0.306177	-6.788886	0
MSCI Turkey Total Return Index	2	0.558294	-7.017506	0	4	0.306331	-6.792919	0
FTSE Turkey Price Index	2	0.556569	-8.321651	0	4	0.294296	-7.513056	0
FTSE Turkey Total Return Index	2	0.556474	-8.34209	0	4	0.294107	-7.528787	0
BIST 100 Price Index	2	0.5692	-8.227783	0	4	0.322508	-7.811028	0
BIST 100 Total Return Index	2	0.580135	-8.073758	0	4	0.321174	-7.919747	0
S&P/IFCI D Turkey Price Index	2	0.546833	-7.276938	0	4	0.296369	-6.926915	0
S&P TURKEY BMI Price Index	2	0.542997	-6.955043	0	4	0.297705	-6.59659	0
Turkey DataStream Price Index	2	0.578559	-8.109636	0	4	0.31864	-7.933661	0
Turkey DataStream Total Return Index	2	0.576479	-8.028237	0	4	0.318501	-7.817824	0
MSCI Turkey (Large Capitalisation) Price Index	2	0.474815	-11.29161	0	4	0.247103	-9.421484	0
MSCI Turkey (Middle Capitalisation) Price Index	2	0.475469	-10.50098	0	4	0.249233	-8.764349	0
MSCI Turkey (Small Capitalisation) Price Index	2	0.482258	-9.521467	0	4	0.24852	-8.234867	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	2	0.477111	-9.982349	0	4	0.248479	-8.448786	0
MSCI Turkey (Investable Market)	2	0.476154	-10.78179	0	4	0.246895	-9.024838	0

Index name	**Sampling interval q (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**	**Sampling interval q (weeks)**	**Variance ratio**	**z-Statistic**	**Sig.**
MSCI Turkey Price Index	8	0.148789	-6.208633	0	16	0.077727	-5.037837	0
MSCI Turkey Total Return Index	8	0.148733	-6.214791	0	16	0.07771	-5.043961	0
FTSE Turkey Price Index	8	0.142998	-6.065848	0	16	0.074422	-4.648398	0.001
FTSE Turkey Total Return Index	8	0.14284	-6.076289	0	16	0.074248	-4.654221	0
BIST 100 Price Index	8	0.157973	-7.088304	0	16	0.080121	-5.73765	0

BIST 100 Total Return Index	8	0.158864	-7.204015	0	16	0.082019	-5.808788	0
S&P/IFCI D Turkey Price Index	8	0.144397	-6.222094	0	16	0.074757	-4.993307	0
S&P TURKEY BMI Price Index	8	0.144713	-5.996487	0	16	0.075078	-4.860771	0
Turkey DataStream Price Index	8	0.156981	-7.180994	0	16	0.081292	-5.765644	0
Turkey DataStream Total Return Index	8	0.157353	-7.073331	0	16	0.081683	-5.679801	0
MSCI Turkey (Large Capitalisation) Price Index	8	0.124217	-7.619247	0	16	0.063152	-5.868879	0
MSCI Turkey (Middle Capitalisation) Price Index	8	0.127436	-7.128218	0	16	0.065424	-5.550836	0
MSCI Turkey (Small Capitalisation) Price Index	8	0.130697	-6.784218	0	16	0.068968	-5.39746	0
MSCI Turkey (Small and Medium Capitalisation) Price Index	8	0.129037	-6.912016	0	16	0.06743	-5.431588	0
MSCI Turkey (Investable Market)	8	0.124945	-7.314572	0	16	0.06415	-5.674149	0

Table 14: AR(1) - GARCH in mean (1,1)

	Mean Equation			**Variance Equation**		
Index name	**GARCH**	**C**	**index(-1)**	**C**	**RESID(-1)^2**	**GARCH(-1)**
MSCI Turkey Price Index	-0.594041(0.3579)	0.005235(0.0736)	0.176015(0)	0.000084(0.0189)	0.083097(0)	0.902274(0)
MSCI Turkey Total Return Index	-0.611529(0.3442)	0.005804(0.0479)	0.175166(0)	0.0000826(0.0196)	0.082619(0)	0.90305(0)
FTSE Turkey Price Index	-1.042592(0.4341)	0.006909(0.0904)	0.144366(0.0001)	0.000125(0.0452)	0.079182(0.0009)	0.88044(0)
FTSE Turkey Total Return Index	-0.988827(0.4567)	0.007367(0.0712)	0.142995(0.0001)	0.000121(0.0458)	0.078822(0.0009)	0.881973(0)
BIST 100 Price Index	-0.843775(0.1217)	0.006227(0.0256)	0.217137(0)	0.0000916(0.0103)	0.093085(0)	0.895179(0)
BIST 100 Total Return Index	-0.403049(0.4258)	0.003996(0.0946)	0.223007(0)	0.0000582(0.0182)	0.101528(0)	0.894948(0)
S&P/IFCI D Turkey Price Index	-0.752335(0.2402)	0.006095(0.0399)	0.151308(0)	0.0000818(0.0216)	0.082162(0)	0.905475(0)
S&P TURKEY BMI Price Index	-0.870958(0.1709)	0.006593(0.0223)	0.157381(0)	0.0000916(0.015)	0.086173(0)	0.899835(0)
Turkey DataStream Price Index	-0.516447(0.3537)	0.003559(0.1697)	0.219016(0)	0.0000735(0.0126)	0.089664(0)	0.900301(0)
Turkey DataStream Total Return Index	-0.53818(0.3403)	0.005223(0.0541)	0.210149(0)	0.0000899(0.0089)	0.096646(0)	0.891915(0)
MSCI Turkey (Large Capitalisation) Price Index	0.312851(0.6431)	0.001235(0.6346)	-0.010664(0.7052)	0.0000464(0.0482)	0.077047(0)	0.913776(0)
MSCI Turkey (Middle Capitalisation) Price Index	0.220482(0.7643)	0.002998(0.2004)	0.025238(0.3569)	0.0000451(0.0283)	0.071671(0)	0.916888(0)
MSCI Turkey (Small Capitalisation) Price Index	0.235284(0.7518)	0.003447(0.1188)	0.033335(0.2191)	0.000041(0.0296)	0.071559(0)	0.91799(0)
MSCI Turkey (Small and Medium Capitalisation) Price Index	0.206556(0.7827)	0.003542(0.1097)	0.033327(0.2205)	0.0000441(0.0266)	0.074095(0)	0.914257(0)
MSCI Turkey (Investable Market)	0.478931(0.525)	0.001716(0.4922)	0.001761(0.9499)	0.0000483(0.0367)	0.076404(0)	0.912074(0)

Table 15: Evolving efficiency of Turkish stock market

Evolving efficiency of MSCI Turkey Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			**Variance Equation**			
Index name	**GARCH**	**C**	**index(-1)**	**C**	**RESID(-1)^2**	**GARCH (-1)**	**observations**
1994-2006	-0.852437(0.3928)	0.008519(0.2113)	0.203464(0)	0.000347(0.044)	0.093611(0.0013)	0.859759 (0)	655
2007-2018	-1.109053(0.4924)	0.005683(0.2118)	0.142987(0.0007)	0.0000904(0.1196)	0.075838(0.0045)	0.894894 (0)	562

Evolving efficiency of MSCI Turkey Total Return Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			**Variance Equation**			
Index name	**GARCH**	**C**	**index(-1)**	**C**	**RESID(-1)^2**	**GARCH (-1)**	**observations**
1994-2006	-0.836466(0.4022)	0.008691(0.2027)	0.20073(0)	0.000346(0.0445)	0.093032(0.0014)	0.860417 (0)	655
2007-2018	-1.055074(0.5087)	0.006152(0.1734)	0.145492(0.0005)	0.0000867(0.1228)	0.076075(0.0043)	0.89608(0)	592

Evolving efficiency of BIST 100 Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			**Variance Equation**			
Index name	**GARCH**	**C**	**index(-1)**	**C**	**RESID(-1)^2**	**GARCH (-1)**	**observations**
1988-2003	-0.548229(0.5938)	0.00443(0.5936)	0.279207(0)	0.000833(0.0157)	0.102356(0.0003)	0.79999(0)	833
2004-2018	-1.044084(0.5203)	0.005028(0.3134)	0.163457(0.0001)	0.000207(0.003)	0.084329(0)	0.848597 (0)	755

Evolving efficiency of BIST 100 Total Return Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			**Variance Equation**			
Index name	**GARCH**	**C**	**index(-1)**	**C**	**RESID(-1)^2**	**GARCH (-1)**	**observations**
1988-2003	0.317958(0.7654)	-0.001937(0.8168)	0.281877(0)	0.000921(0.0148)	0.104139(0.0009)	0.784135 (0)	829
2004-2018	-1.200212(0.3619)	0.00673(0.0565)	0.144031(0.0001)	0.0000922(0.0419)	0.10276(0.0002)	0.868373 (0)	755

Evolving efficiency of S&P/IFCI D Turkey Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			**Variance Equation**			
Index name	**GARCH**	**C**	**index(-1)**	**C**	**RESID(-1)^2**	**GARCH (-1)**	**observations**
1995-2006	-1.297929(0.1825)	0.0118(0.0896)	0.173537(0)	0.000248(0.068)	0.089209(0.0012)	0.882832 (0)	599
2007-2019	-0.650188(0.6878)	0.004658(0.3373)	0.129895(0.0013)	0.000117(0.1089)	0.07272(0.004)	0.891665 (0)	631

Evolving efficiency of S&P TURKEY BMI Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			**Variance Equation**			

Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1995-2006	-1.369293(0.1304)	0.011547(0.0638)	0.165626(0)	0.000178(0.0855)	0.083142(0.001)	0.896958 (0)	600
2007-2019	-0.581551(0.7149)	0.00454(0.3327)	0.132992(0.001)	0.000114(0.1068)	0.074678(0.0036)	0.890372 (0)	631

Evolving efficiency of Turkey DataStream Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			Variance Equation			
Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1988-2003	0.02289(0.9825)	-0.001087(0.8864)	0.282221(0)	0.000401(0.0001)	0.089798(0)	0.859831 (0)	833
2004-2018	-0.772821(0.634)	0.003782(0.4224)	0.168575(0)	0.000178(0.0026)	0.082362(0)	0.856782 (0)	755

Evolving efficiency of Turkey DataStream Total Return Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			Variance Equation			
Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1988-2003	-0.295286(0.7996)	0.003372(0.6973)	0.261081(0)	0.000586(0.0001)	0.082004(0)	0.843212 (0)	833
2004-2018	-0.76938(0.6413)	0.004269(0.3585)	0.169241(0.0001)	0.000157(0.0038)	0.084661(0)	0.8633(0)	680

Evolving efficiency of MSCI Turkey (Large Capitalisation) Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			Variance Equation			
Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1994-2006	1.186663(0.3858)	-0.003701(0.6568)	-0.012461(0.7628)	0.000916(0.0386)	0.129006(0.0087)	0.727366 (0)	655
2007-2018	0.510847(0.752)	0.000276(0.9413)	-0.001955(0.9626)	0.000052(0.1465)	0.070892(0.0017)	0.90818(0)	562

Evolving efficiency of MSCI Turkey (Middle Capitalisation) Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			Variance Equation			
Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1994-2006	-0.090829(0.9339)	0.005664(0.2923)	0.029837(0.4427)	0.000251(0.0622)	0.110865(0.0025)	0.844527 (0)	655
2007-2018	0.977484(0.5853)	0.000575(0.872)	0.023568(0.5692)	0.0000521(0.0913)	0.055423(0.0047)	0.917456 (0)	592

Evolving efficiency of MSCI Turkey (Small Capitalisation) Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			Variance Equation			
Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1994-2006	-0.193112(0.8614)	0.006011(0.2072)	0.055326(0.1671)	0.000282(0.0388)	0.122833(0.0011)	0.820513 (0)	655
2007-2018	0.977484(0.5853)	0.000575(0.872)	0.023568(0.5692)	0.0000521(0.0913)	0.055423(0.0047)	0.917456 (0)	592

Evolving efficiency of MSCI Turkey (Small and Medium Capitalisation) Price Index

AR(1) - GARCH in mean (1,1)							
	Mean Equation			Variance Equation			
Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1994-2006	-0.145177(0.8929)	0.006027(0.2051)	0.047492(0.2256)	0.000238(0.0512)	0.117328(0.0014)	0.836433 (0)	655
2007-2018	1.097046(0.5342)	0.001081(0.745)	0.022961(0.5669)	0.0000442(0.1156)	0.059335(0.0045)	0.917383 (0)	592

Evolving efficiency of MSCI Turkey (Investable Market)

AR(1) - GARCH in mean (1,1)							
	Mean Equation			Variance Equation			
Index name	GARCH	C	index(-1)	C	RESID(-1)^2	GARCH (-1)	observations
1994-2006	0.779263(0.5452)	0.001008(0.8735)	0.00468(0.9077)	0.000424(0.0421)	0.116328(0.0043)	0.803333 (0)	655
2007-2018	0.758095(0.6477)	0.00046(0.8963)	0.005614(0.8916)	0.0000464(0.1363)	0.066672(0.002)	0.912534 (0)	592

Table 16: Trend Regression results for Serial-Correlation

Lags	Intercept		Time Variable	
	Coefficient	**P-values**	**Coefficient**	**P-values**
Lag 12	29.216	0.000	0.891	0.000
Lag 11	28.472	0.000	0.878	0.000
Lag 10	27.775	0.000	0.878	0.000
Lag 14	32.935	0.000	0.962	0.000
Lag 7	23.503	0.000	0.924	0.000
Lag 8	24.344	0.000	0.901	0.000
Lag 9	25.088	0.000	0.907	0.000
Lag 15	35.287	0.000	0.894	0.000
Lag 13	32.791	0.000	0.866	0.000
Lag 16	38.895	0.000	0.747	0.005
Lag21	44.217	0.000	0.808	0.006
Lag 22	48.885	0.000	0.757	0.008
Lag 23	51.248	0.000	0.733	0.009
Lag 29	56.902	0.000	0.695	0.013
Lag 25	53.537	0.000	0.710	0.015
Lag 24	53.055	0.000	0.705	0.016
Lag 28	55.642	0.000	0.680	0.018
Lag 30	58.850	0.000	0.680	0.019
Lag 27	55.139	0.000	0.686	0.019
Lag 26	54.693	0.000	0.687	0.020
Lag 17	42.147	0.000	0.640	0.021
Lag 6	25.386	0.000	0.495	0.028
Lag 19	44.417	0.000	0.617	0.031
Lag 18	43.432	0.000	0.608	0.033
Lag 20	44.926	0.000	0.605	0.034
Lag 5	24.756	0.000	0.473	0.037
Lag 37	67.303	0.000	0.618	0.041
Lag 4	24.495	0.000	0.456	0.045
Lag 3	23.821	0.000	0.461	0.046
Lag 36	66.993	0.000	0.587	0.054
Lag 38	68.256	0.000	0.584	0.056
Lag 31	62.527	0.000	0.553	0.069
Lag 32	64.223	0.000	0.525	0.087
Lag 35	66.544	0.000	0.507	0.092
Lag 34	65.643	0.000	0.510	0.098
Lag 33	65.071	0.000	0.508	0.099
Lag 1	18.003	0.000	0.251	0.117
Lag 2	22.724	0.000	0.329	0.118
Lag 39	73.307	0.000	0.406	0.180
Lag 40	73.576	0.000	0.403	0.181

Table 17: Trend Regression Results for Variance Ratio

Q2	*Coefficients*	*t Stat*	*P-value*
Intercept	0.295	6.811	0.000
T_Var	0.010	4.328	0.000

Q4	*Coefficients*	*t Stat*	*P-value*
Intercept	0.186	6.908	0.000
T_Var	0.005	3.127	0.004

Q8	*Coefficients*	*t Stat*	*P-value*
Intercept	0.086	8.385	0.000
T_Var	0.003	4.699	0.000

Q16	*Coefficients*	*t Stat*	*P-value*
Intercept	0.051	6.049	0.000
T_Var	0.001	2.714	0.011

Chapter 2: Biases in Computed Returns: The case of Borsa Istanbul

Introduction

Average returns across securities and portfolios are essential inputs for a very large proportion of studies in the field of Finance. The examples are abundant, including the most prominent ones in the areas of empirical asset pricing and corporate finance, where historical returns may be used as proxies for the cost of capital. As with many other sources of information, noise that is generated by market imperfections can distort the price data that are used in the calculations of returns. Examples of "noise" include market microstructure frictions, investor sentiment, and other behavioural factors (Chu et al., 2020; Schwartz, 2021). The presence of noise implies that there will be deviations in the price from the fundamental value of the asset into consideration.

This study is a novel attempt to examine the extent to which there is a size effect which is persistent in Turkish equity returns while correcting for the effects of noisy prices using the buy-and-hold method implemented by various authors in the past, such as Blume and Stambaugh (1983), Conrad and Kaul (1993), and Asparouhova et al. (2013). The size effect is related to the significant differences in the equity return across firms of different sizes. The stylised fact is that the average return in the lowest market-value decile tends to exceed the average returns of firms in the top decile even after risk adjustment (Alquist et al., 2018).

Van Dijk (2011) provides a comprehensive review of 30 years of research on the size effect on equity returns, starting with Banz (1981). Although the original studies focused exclusively on the U.S. market, the subsequent international evidence on the size premium is "remarkably consistent" (Van Dijk, 2011, p.3264,) and the size effects in other markets are considerable. Looking specifically at the Turkish market, there is only a study by Aksu and Onder (2003), which studies stock returns in the Istanbul Stock Exchange (ISE) during 1993–1997. Nevertheless, according to Van Dijk (2011), the reported extraordinarily large size effect of 3.4% per month might be attributed to inaccuracies in the data collection, as well as the methodology of the paper.

Our paper contributes towards understanding the time-varying efficiency of the Turkish equity market. Given the intrinsic noises in the data as well as the modest sample size and time span, we apply a relatively simple but well-established model to our data, virtually replicating the approach presented in Blume and Stambaugh (1983) for the US equities. The results of the size effect in the Turkish equity market for the overall sample period of 18 years are consistent with the estimates for developed markets but, as expected, becomes statistically insignificant from zero when the biases in computed returns are alleviated through calculating the buy-and-hold returns. It also appears that the magnitude of the size effect fluctuates significantly across subperiods in both rebalanced and buy-and-hold portfolios we constructed. Although it occasionally presented investors with attractive returns, these were nevertheless hard to time. As expected, a more rigorous risk-adjustment procedure applied to our results significantly decreases the magnitude of estimated excess returns.

We also present evidence of moderate impediments to trade and information governing in Turkey which, coupled with our empirical results, suggests that equity pricing in the Turkish stock market is likely to be only marginally less efficient than in developed markets. This result is consistent with Griffin et al. (2010), who find that without considering higher transaction and information costs in emerging markets, these markets appear to contradict the widely held notion that emerging markets are less efficient than developed markets. Our study complements the growing body of research that explores, from a comparative perspective, trading strategies across the world. The comparison is across all markets, developed and emerging.

The rest of the article proceeds as follows. Section 2 discusses historical developments in Turkish capital markets and stylised facts on the informational efficiency of the Turkish equity market. Section 3 presents a model of biases in computed return, and Section 4 describes the data and sample used. Section 5 presents empirical results. Section 7 provides further discussion of the results and concludes.

Historical Developments in Turkish Capital Markets and Stylised Facts on Informational Efficiency of the Turkish Equity Market.

The history of the organised Turkish capital market dates to the Ottoman Empire (Chambers, 2006). As the Ottoman Empire lagged behind Western countries in terms of introducing bank notes, the exchange activities predominantly involved the exchange of diverse value coins, precious stones, and alike. The first banknotes were issued in the 1840s. They were interest-bearing instruments used as money in the domestic market as well as an instrument used by investors (Tanor, 1999).

Following the Crimean War in 1866, the “Dersaadet Securities Exchange” was founded, the first marketplace for securities in Turkey. This was later renamed “the Istanbul Securities and Foreign Exchange Bourse" in 1929, just after the formation of the Turkish Republic. Despite challenging domestic and international events in the following decades, the exchange demonstrated positive dynamics with a growing number of listed equities and market capitalisation.

The market-oriented economic reforms in Turkey, which started in the early 1980s, gave a boost to the Turkish capital markets and facilitated developments in both the legislation and the institutions around it, enacting the "Capital Market Law" in 1981, leading to the 1985 inauguration of the “Istanbul Stock Exchange”. In 2013, the three key exchanges, the Istanbul Stock Exchange, the Istanbul Gold Exchange, and the Derivatives Exchange of Turkey, merged to establish “Borsa Istanbul”, the sole exchange entity in Turkey.

As the Turkish capital markets matured, one would expect that the price formation in the equity market would be increasingly consistent with the (EMH). The bulk of traditional empirical studies examines the evidence of a weak-form efficient market in the absolute sense, ignoring the evolution of the degree of market efficiency across the period into consideration. The growing evidence of time-varying weak-form market efficiency, particularly in emerging markets, led to increasing recognition of changing degrees of informational efficiency (Lim & Brooks, 2011). One conciliatory approach between traditional theories of EMH and the time-varying option of the EMH is proposed by behavioural finance and is known as the adaptive markets hypothesis (AMH) (Lo 2004, 2005). Based on the AMH, Market efficiency is a quality that changes continuously over time and between markets rather than being an all-or-nothing situation.

The accumulated evidence concerning the informational efficiency of the Turkish equity market can be classified according to the statistical tests used to inspect it. Using both parametric and nonparametric methods, some early studies, such as Balaban (1995a, 1995b), need help finding evidence of efficiency. Nevertheless, Kawakatsu and Morey (1999) found evidence in favour of efficiency using a battery of econometric tests. They believe this is not the result of liberalisation, as the markets appeared rather efficient before the actual liberalisation.

Buguk and Brorsen (2003) also check the EMH, with their results indicating that all series studied follow a random walk, but a non-parametric test provides some evidence against efficiency. The empirical findings in Odabaşl and Akgiray (2004) find some evidence towards evolving efficiency, as they found a reduction in the informational inefficiency of the market. Another approach that has been used to test whether stock return series are serially uncorrelated and, hence, whether the market is weak-form efficient is the VR test (Lo & MacKinlay, 1988). Using methodological improvements to VR experiments, the findings in Smith (2009) provide evidence of weak-form efficiency for the Turkish market. Another statistical test that is popular among researchers in the weak-form EMH field is the unit root test. According to Ozdemir's (2008) research, the Turkish major equities index has a unit root, which is consistent with the market's weak-form efficiency. Aga and Kocaman (2008), using a smaller equity index of the 30 largest businesses, support the weak-form efficiency of ISE.

Al-Jafari (2013) employs unit root tests, runs tests and variance ratio tests, and his findings disprove the null hypothesis and thus efficiency. On the other hand, Gozbasi et al. (2014) used a nonlinear ESTAR unit root test (Kruse, 2011) on the Borsa Istanbul stock price supporting the EMH.

A useful paper which allows evaluating the informational efficiency of the Turkish equity market vis-à-vis other emerging markets is Griffin et al. (2010). The authors offer a framework for quantifying conventional market efficiency indicators across nations, including Turkey, in terms of returns to trading strategies and price deviations from the random walk model. In contrast to other papers, the authors also look at plausible interpretations of their results and their implications for the validity of efficiency measures that are likely to produce misleading inferences when comparing securities in emerging markets with significantly different levels of information production.

According to the results of Griffin et al. (2010), average weekly contrarian profits are about -16 basis points (statistically insignificant), while the returns are positive in 14 out of 17 emerging markets studied. The average returns for developed markets are positive, statistically significant, and marginally lower than in emerging markets. Similarly, looking at another trading strategy, the six-month return to earnings surprises month, in 65% of the developed markets in 85% of emerging portfolios with positive earnings surprises earn higher returns than those with unexpected negative earnings. The reported return for Turkey is almost 10% but lacks statistical significance, while the averages for developed and emerging markets are positive and significant, at about 4%. A similar finding can be found in the returns to a weekly rebalanced six-month momentum strategy. The returns are also statistically significant in both developed and emerging markets on average, with somewhat larger returns observed in the developed markets.

Griffin et al. (2010) also look at the volume and cost of information generated and transaction costs as potential causes of efficiency (or lack thereof). Lesmond, Ogden, and Trzcinka (1999) (LOT) estimated round-trip transaction costs, which are used to calculate the transaction costs, are not published individually for each nation. Even while the three biggest portfolios show that trading costs are roughly twice as high in developing markets as in established ones, it is still evident that round-trip transaction costs significantly decreased throughout the sample period.

The country-level results for LOT in 31 emerging markets are reported in Lesmond (2005) for 1993-2000. LOT for Turkey is estimated at 5.627%, marginally higher than a number of countries from the Europe group, such as Greece and Poland, and generally at a lower end compared to other emerging markets, where the median value is 6.9%. Turkey also looks competitive relative to other emerging markets based on other liquidity cost measures reported in Lesmond (2005).

For instance, Amihud's price impact measure, which is the absolute value of stock returns scaled by dollar volume, is also relatively small - 0.002% for Turkey versus 1.26% median value for emerging markets; Turnover predicts high (greater than 1% of the shares outstanding transacted per day) trading frequency. Roll's effective spread costs measure (Roll, 1984) indicates fairly low effective spread costs for Turkey - 3.2 for Turkey versus 2.53 median for emerging markets. Estimates for Turkey and emerging markets as a whole, however, show that trading strategies in emerging markets are still likely to provide much lower returns when transaction costs are taken into consideration.

Griffin et al. (2010) look at analyst coverage, the number of forecasts, and the frequency of analyst changes to quantify information collection and expenses. When it comes to the average proportion of enterprises in the market having analyst coverage, Turkey compares favourably to the averages for developed and emerging markets. Griffin et al. (2010) conclude that emerging markets are at least as efficient as developed markets but are still quite different in terms of transaction costs and information generation/cost measures, but to a lesser extent than most emerging markets. In terms of the Turkish equity market, it looks reasonably efficient in a large cross-section of countries across multiple dimensions.

The presented evidence on moderate impediments to trade and information governing in Turkey suggests that equity pricing in the Turkish stock market is likely to be only marginally less efficient than in developed markets.

Biases in Computed Return

Our basic model of biases in computed return follows closely the one in Blume and Stambaugh (1983). In the absence of transaction costs, the true price at time *t* of stock i, P_{it}, is the price of the stock in the market. In practice, it is a transaction price when to buy and sell orders would 'cross' on the floor. Usually, we concentrate on the closing price or the price realised in the last transaction that took place just before the market closed. The closing price, $\hat{P}_{it}$, can deviate from the true price, P_{it}, as recorded bid and ask prices could easily be lower or above the true price. This is the bid-ask effect, which is a characteristic of closing prices and could be formalised in one of two ways:

$$\hat{P}_{it} = [1 + \delta_{it}]P_{it},$$

or

$$\hat{P}_{it} = P_{it} + \varepsilon_{it}, \qquad (1)$$

where $E[\varepsilon_{it}] = 0$, an error $\delta_{it}$is independently distributed across t, and $\delta_{it}$is independent of P_{it}, for all t.

It has long been recognised that the bid-ask effect causes so-called "reversals" by generating negative first-order autocorrelation in recorded price changes for particular equities (Niederhoffer & Osborne, 1966). Blume and Stambaugh (1983) demonstrated that the bid-ask spread also biases the estimated rates of return for specific US stocks upward. This paper adopts the methodology of Blume and Stambaugh (1983) to reinspect the magnitude and direction of bias on the computed returns of Turkish equities.

Consider the true return for stock i for period t is defined, assuming no dividends:

$$r_{it} = \frac{P_{it}}{P_{it-1}} - 1 \qquad (2)$$

Substituting $\hat{P}_{it} = [1 + \delta_{it}]P_{it}$, into (2), we obtain the expression for the computed returns.

$$\hat{r}_{it} = \frac{\hat{P}_{it}}{\hat{P}_{it-1}} - 1 = \frac{[1+\delta_{it}]P_{it}}{[1+\delta_{it-1}]P_{it-1}} - 1 \qquad (3)$$

Combining (2) and (3) gives

$$\hat{r}_{it} = \frac{[1+\delta_{it}]}{[1+\delta_{it-1}]}[1 + r_{it}] - 1 \tag{4}$$

Taking expectations of both sides of (4) gives

$$E(\hat{r}_{it}) = E\left(\frac{[1+\delta_{it}]}{[1+\delta_{it-1}]}\right)[1 + E(r_{it})] - 1 \tag{5}$$

By Jensen's inequality, $E\left(\frac{[1+\delta_{it}]}{[1+\delta_{it-1}]}\right) > 1$. Hence, $E(\hat{r}_{it}) > E(r_{it})$.

Applying Taylor series approximation,

$$E(\hat{r}_{it}) \approx E(r_{it}) + \sigma^2(\delta_{it-1}) \tag{6}$$

where σ^2denotes the variance, which is a lower bound for the bias induced by the bid-ask effect, assuming at least the odd of δ_{it-1} is zero.

An additional source of the potential closing price deviation from the true price is 'nonsynchronous trading'. This describes the occurrence of the final transaction prior to the period's end (e.g., Fisher, 1966). Just like the bid-ask effect, the nonsynchronous trading is known to produce negative autocovariance in returns. Nevertheless, the magnitude of this bias appears to be negligible compared to the bid-ask bias under reasonable assumptions (Blume & Stambaugh, 1983).

The return on a rebalanced portfolio calculation is an arithmetic average of individual securities return, which implies rebalancing to equal weights each period. As a result, we can show that the computed return on the rebalanced portfolio is biased by the average of bid-ask biases in the individual returns.

$$E(\hat{r}_{RBt}) \approx E(r_{RBt}) + \overline{\sigma^2(\varepsilon_{\iota t}/P_{\iota t-1})} \tag{6}$$

where $= \sum r_{it}$ is the true rebalanced return, $\hat{r}_{RBt} = \sum \hat{r}_{it}$ is the computed return, a bar indicates an average over i, and $\sigma^2(\delta_{it-1})$ in (6) is rewritten using (1.2).

The buy-and-hold portfolio-forming strategy invests an equal amount in each of N securities at an initial time 0, but no further transactions are performed for the holding period.
The true return for the buy-and-hold portfolio is given by

$$r_{RBt} = \frac{\sum P_{it}}{\sum P_{it-1}} - 1 \tag{7}$$

and the computed buy-and-hold return is

$$\hat{r}_{BHt} = \frac{\sum \hat{P}_{it}}{\sum \hat{P}_{it-1}} - 1 = \frac{\sum P_{it} + \sum \varepsilon_{it}}{\sum P_{it-1} + \sum \varepsilon_{it-1}} - 1, \tag{8}$$

we can rewrite (8), using (9) as

$$\hat{r}_{BHt} = \frac{1 + r_{BHt} + \varepsilon_{it}/P_{it-1}}{1 + \varepsilon_{it}/P_{it-1}} - 1 \tag{9}$$

The approximation of expected $\hat{r}_{RBt}$in (11) using Taylor series yields

$$(\hat{r}_{BHt}) \approx E(r_{BHt}) + \sigma^2(\overline{\varepsilon_{it}}/\overline{P_{it-1}}) \tag{10}$$

The bid-ask bias for the buy-and-hold return is reduced by a diversification effect, as the security weights in the buy-and-hold portfolio are contemporaneously correlated with computed returns, unlike in the rebalanced portfolio.

The magnitude of the bias can be inferred when we combine (6) and (10), as follows:

$$E(\hat{r}_{RB} - \hat{r}_{BH}) \approx E(r_{RBt} - r_{BHt}) + \left[\overline{\sigma^2\left(\frac{\varepsilon_{it}}{P_{it-1}}\right)} - \sigma^2(\overline{\varepsilon_{it}}/\overline{P_{it-1}})\right] \tag{11}$$

The second term on the right-hand side of (11) is the difference in the bid-ask bias of two types of portfolios. We expect that $E(r_{RBt} - r_{BHt}) \leq 0$, since the buy-and-hold portfolio tends to have a larger expected weight for the stocks with higher expected returns than the rebalanced portfolio (Cheng & Deets, 1971). Furthermore, as the quantity of securities in the portfolio rises, the buy-and-hold bias (the second term in square brackets) becomes smaller. In light of this, the difference in bid-ask biases is comparable to the average bias for a single asset (or rebalanced portfolio). Hence, $E(\hat{r}_{RB} - \hat{r}_{BH})$ provides us with a lower bound for the average bid-ask bias for an individual security (Blume & Stambaugh, 1983).[3]

Data and Sample

The historical data for Turkish equities was obtained from Refinitiv Eikon Database. The required information for our study was available to a different extent for 227 Turkish-listed companies. Our study design requires a continuous history of closing daily stock prices for each year at a time. As shown in Table 1, the number of equities in our sample is steadily increasing starting from the beginning of the observation period (31 January 1997) at an average rate of 3% per year. The number of companies per year ranges from 108 in 1997 to 225 in 2020. The mean market capitalisation in the sample, in $US terms, increased almost 20-fold between 1997 and 2020, with a mean annual growth of 22%. Overall, our data covers over 85% of the Turkish equity market universe from 2002 onwards, so the final sample is selected for 2002-2020.

The assignment of firms to portfolios follows the approach used in numerous other studies (see Reinganum, 1983; Blume & Stambaugh, 1983; Kothari and Warner, 2007, for review). Companies are ranked according to their common stock's average total market capitalisation value at the start of each fiscal year. Then they are divided into three portfolios with roughly equal numbers of securities in each. Three portfolios are produced as a result of this process for each of the 19 years from 2002 to 2020. From 144 in 2002 to 225 in 2020, there are companies in our sample at the beginning of each year.

We compute two sets of daily returns for each of the three portfolios for each year. Both return series presuppose that an equal sum is invested in each asset at the start of the year. The first series makes the buy-and-hold assumption that no adjustment will take place throughout the year. The second strategy -- known as a rebalanced strategy -- implies that investments in each stock are daily rebalanced to their initial equal proportions at closing prices.

[3] The approximation is best for large portfolios whose securities have identical expected true returns (Blume and Stambaugh, 1983).

Table 18: Market Capitalization of companies in the sample ($US 000.000)

year	N of firms	mean	sd	min	p25	Median	p75	max
1997	108	39.74	77.39	.08	5.24	13.27	38.37	887.37
1998	108	52.44	145.48	.13	4.72	12.16	37.42	1820.22
1999	120	70.1	220.02	.26	4.45	11.97	35.19	3616.59
2000	123	137.42	378.73	.05	8.46	25.62	80.4	4392.39
2001	144	61.65	178.04	.06	3.53	10.22	33.93	2991.7
2002	144	92.54	291.33	.01	4.66	13.66	47.55	4034.91
2003	149	257.65	636.49	.01	19.43	47.08	164.2	6295.05
2004	151	427.87	1089.57	.75	30.87	69.35	242.86	10340.63
2005	157	640.5	1676.86	1.69	46.97	111.28	362.29	17724.97
2006	161	840.63	2103.88	1.44	64.53	153.39	513.89	19754.94
2007	170	1093.09	2841.39	1.33	74.22	180.24	610.35	27490.24
2008	176	957.5	2484.88	1.19	56.98	165.39	528.62	24496.79
2009	177	840.81	2254.89	1.28	48.11	136.21	407.17	19978.03
2010	177	1347.49	3363.53	2.25	88.98	243.18	736.97	27831.86
2011	188	1251.61	2951.6	2.77	95.82	261	739.85	22896.52
2012	192	1191.22	2788.57	3.41	86.2	235.95	653.94	22087.95
2013	199	1345.62	3150.24	2.3	87.2	247.72	755.43	25580.64
2014	208	1112.76	2560.75	2.28	76.17	201.8	627.85	18593.31
2015	213	967.37	2172.04	3.53	64.35	184.2	596.62	19267.71
2016	215	850.39	1854.63	3.07	67.69	168.44	545.91	13495.77
2017	212	920.62	1977.88	3.88	81.46	192.58	603.71	13377.35
2018	218	736.94	1616.31	3.08	60.29	154.6	473.78	13835.82
2019	222	637.29	1382.07	4.77	51.71	130.34	410.8	24433.09
2020	225	791.53	2188.26	6.48	101.45	214.22	556.6	50433.45

Table 2 shows the descriptive statistics for the returns on three portfolios we constructed. As expected, both sets of returns and their volatility tend to be lower for the portfolios of larger companies. The returns on the buy-and-hold portfolio are significantly skewed towards positive return, while the rebalanced portfolio returns are moderately negatively skewed. Both sets of returns are characterised by a very high positive kurtosis, indicating the presence of an increased number of return outliers and return distributions with "fat tails". Volatile and leptokurtic returns, particularly for small companies, are typical in all emerging markets and have been shown to favour the use of a buy-and-hold portfolio strategy (Estrada, 2009).

Table 19: Buy-and-hold and Rebalanced Portfolios Return Distribution (% daily returns).

	Buy-and-hold portfolio				Rebalanced Portfolio			
	Mean (%)	*Sd(%)*	*Sk.*	*Kurt.*	*Mean (%)*	*Sd(%)*	*Sk.*	*Kurt.*
Small	0.26	5.34	24.33	1036.18	0.12	2.09	-0.93	11.65
Medium	0.15	3.39	12.19	436.92	0.07	2.13	-0.84	10.87
Large	0.14	3.76	18.53	631.70	0.06	2.17	-0.40	9.25

A Re-Examination of the Size Effect

The differences between the average daily returns on the portfolio with the smallest firms and the portfolio with the largest firms, where portfolios were typically formed as rebalanced portfolios, are frequently used to define the size effect that has been the subject of numerous prior studies (Van Dijk, 2011). Using this method, the size effect was, on average, found to be 0.1 per cent every day in the U.S. markets.

We demonstrated in Section 3 that the cross-sectional average of the individual security biases causes an upward bias in the cross-sectional mean returns to equal-weighted (EW) portfolios. This suggests that comparing the mean returns of equal-weighted portfolios may need to be more accurate. The upward bias will be stronger for the portfolio holding noisier securities if portfolios are built by sorting on a variable correlated with noise variance. The difference in mean returns between portfolios will be skewed.

The gap between returns for rebalanced and buy-and-hold portfolios is also skewed if the bias's degree varies across firms of various sizes. According to the theoretical model described in Part 2, buy-and-hold strategies would result in average returns with reduced bid-ask bias.

Our empirical findings in Table 3 are completely compatible with a bid-ask bias and a strong size effect. The numerical difference is greater for the portfolios of smaller firms, even though the average (computed) daily rebalanced return is always lower than the average daily buy-and-hold return, indicating that the term $E(r_{RBt} - r_{BHt})$ in (11) outweighs the second term constructed to capture the bias (see Panel A and B of Table 3). In line with our assumptions of a more considerable bias favouring smaller firms, the differences between the two techniques have decreased as firm size has increased. The average difference between the daily returns of the rebalanced and buy-and-hold portfolios for the total period for the large-firm portfolio is -

.09 per cent per day, but it is 58% higher for the small-firm portfolio, -.142 per cent per day (statistically significant).

In Panel D of Table 3, the average size effect is reported for the three sub-periods taken into consideration. In three of the five sub-periods, the size effect is more prominent in the buy-and-hold portfolio, but none of the estimates is statistically significant. The average size effect for the whole period using rebalanced portfolios is 0.0685 per cent per day (insignificant), or roughly half of the similarly estimated estimates for the US market. Furthermore, the size effect for the buy-and-hold portfolio is.121 per cent per day (insignificant) throughout the course of the time, which is 77% (not less!) greater than the rebalanced size effect. Overall, across the four subperiods we took into consideration, there currently needs to be proof of a strong size effect in either rebalanced or buy-and-hold portfolios.

As we suspect that our data is not satisfying well the assumptions of the t-test, we also employed the Wilcoxon rank-sum (Mann-Whitney) test. For both types of portfolios, the full sample difference between the return of small and large portfolios is positive and significant. Still, the probability that the return for the small-firm portfolio is more significant than returns for the large-firm portfolio do not differ significantly across rebalanced and buy-and-hold portfolios, amounting to 0.517% and 0.518%, respectively. Overall, we find some evidence for the existence of the size effect in the Turkish equity market. However, its magnitude is somewhat uncertain, and contrary to what we expected, it is potentially more significant in the buy-and-hold portfolio.

The summary statistics for the four subperiods presented in Table 2 suggest that the size effect fluctuates significantly across subperiods (see Panel D of Table 3), a result previously noted by many studies (e.g., Blume and Friend, 1974), Brown, Kleidon and Marsh, 1983, and Blume and Stambaugh, 1983). This is evident in both sets of results. Also, the size effect is only significant when we use the Wilcoxon rank-sum (Mann-Whitney) test. It is positive and significant only in the last subperiod for the rebalanced portfolio and positive and significant in the previous two subperiods for the buy-and-hold portfolio (see Panel D of Table 3). The pattern of returns for both types of portfolios is unstable across subperiods, as returns sometimes decline as one move from smallest to largest firms, but that pattern is reversed in other subperiods.

The Wilcoxon rank-sum (Mann-Whitney) test (unreported) does not alter our conclusions about the size effect by months, with insignificant t-statistics reported in Table 4). Unlike other studies, we do not find any evidence of January (or any other month) effect for the size effect. However, the average returns in January are higher for both rebalanced and buy-and-hold portfolios, with the nominal difference between the small and large stock portfolios remaining small. An exclusion of any month leaves the average size effect positive and significant over the remaining eleven months for both the rebalanced and the buy-and-hold portfolio. The exclusion of two months with the greatest size effect does not change our conclusions on the individual month's effect.

In addition, the difference between the size effects in the two portfolio types is computed for each of the twelve months. This “difference-in-difference” statistic is positive in 6 months and negative in the rest. Also, it is only significant in July and October with the opposing signs - negative in October and positive in July (see Table 4). The results are puzzling as a relatively constant difference is to be expected if the bid-ask phenomenon is stationary across months.
An important shortcoming of our analysis so far is that the constructed portfolio returns need to be adjusted for risk. Although the previous studies for the US market (e.g., Reinganum (1981, 1982, Blume and Stambaugh, 1983) find that the risk adjustment does not significantly change inferences about the size effect, the analysis of risk-adjusted returns in an emerging market, such as Turkey, is certainly warranted.

The simple accounting method for risk is to define excess returns as deviations from the Sharpe-Lintner version of the two-parameter model's implications. The difference between the returns on small and large portfolios (R_{St}- R_{Lt}) should only be explained by exposure to systematic risk or, in practice, to market return in excess of a risk-free rate ($R_{Mt} - R_{Ft}$). In the regression framework, we look at the following equation:

$$R_{St} - R_{Mt} = \alpha + \beta(R_{Mt} - R_{Ft}) + \varepsilon_t, \qquad (12)$$

where ε_t is an independent disturbance with zero expected value.

In the absence of arbitrage opportunities, the model in (12) implies that α=0, that is, the presence of zero excess return of small firms relative to large firms or, alternatively, the zero risk-adjusted size effect.

We provide estimates of α by regressing the difference in returns on the small and large firm portfolios on excess daily returns on the S&P500 index and use the US 1-month treasury rate as a risk-free interest rate. The reported t-statics are based on Newey-West consistent standard errors with two lags.

The results reported in Table 5 highlight the importance of adjusting our measure of the size effect for risk. Using the S & P500 index as a market proxy, the risk-adjusted size effect is comparable to the size effects reported in Tables 3 and 4 for both the rebalanced and the buy-and-hold portfolios. Moreover, the risk-adjusted size effect in the buy-and-hold portfolios often appears to be larger than the one in the rebalanced portfolio. Nevertheless, the risk-adjusted size effect for the overall period is 0.07% (1.8% per month) for rebalanced portfolios and a marginally insignificant 0.12% (3% per month) for the buy-and-hold portfolios. The 3% estimate is surprisingly close to the size effect reported in Aksu and Onder (2003), which studies stock returns in the Istanbul Stock Exchange (ISE) during 1993–1997; as we stated, our estimate lacks statistical significance, so it is effectively zero. The 1.8% for the rebalanced portfolio is consistent with the evidence of the developed market. The difference between the buy-and-hold and the rebalanced portfolio excess return for the whole period is consistent with the alleviation of bias in buy-and-hold portfolios.

To check the robustness of our results, we have done an alternative adjustment for risk using the BIS100 index US$ returns. The results reported in Table 6 and the tests for the entire sample are virtually identical for the S&P500 and BIS100 results. As suggested by Scholes and Williams (1977) and Dimson (1979), we also estimated (12) accounting for the potential effect of asynchronous trading by including betas with respect to lagged market returns. Including lags makes the buy-and-hold portfolio's size effect estimate even more statistically insignificant. The same applies to assessing the difference in the size effect of rebalanced and buy-and-hold portfolios; the difference is negative but insignificant. Hence, if we treat the buy-and-hold size effect as zero, the overall period evidence does support the presence of a more pronounced size effect in the rebalanced portfolios and alleviation of bias in the buy-and-hold portfolio, at least in the long run.

Discussion and conclusions

The remaining issue of this paper is how we can explain a larger magnitude of the size effect in the buy-and-hold portfolios relative to the rebalanced portfolios, which seems to be the case in some subperiods (see Table 4). Let us re-examine equation (11)

$$E(\hat{r}_{RB} - \hat{r}_{BH}) \approx E(r_{RBt} - r_{BHt}) + \left[\overline{\sigma^2\left(\frac{\varepsilon_{\iota t}}{P_{\iota t-1}}\right)} - \sigma^2(\overline{\varepsilon_{\iota t}}/\overline{P_{\iota t-1}})\right]$$

As we mentioned earlier, equation (11) defines a lower bound on the estimate of the size effect bias. $\sigma^2(\overline{\varepsilon_{\iota t}}/\overline{P_{\iota t-1}})$ is likely to be close to zero in sufficiently diversified portfolios, which is unlikely to be a major issue in our sample. It is more likely, though, that our results are driven by a large magnitude of the negative $E(r_{RBt} - r_{BHt})$ term. The historical developments in the Turkish equity market support this insight.

When the stock market is in a long-term, pronounced trend, the buy-and-hold rebalancing strategy often performs better than the rebalanced strategy. The buy-and-hold portfolio keeps more upside since it adjusts security weights in accordance with changes in security prices. Instead, the rebalanced portfolio has less upside potential because it continues to sell assets in an up-trending market and purchases stocks when they decline. The persistent cumulative return performance is likely to translate into persistent differences in daily returns.

The historical performance of the Turkish equity market clearly suggests the presence of prolonged trends. For example, in the last decade or so, The Turkish market, proxied by the annualised performance of the MSCI Turkey index, delivered -6.17% annual return over the 10-year period and -17.88% over the last three years (MSCI, 2021). Nevertheless, the index performance since 31 May 1994 is similar to the performance of MSCI Emerging Markets (6.77% versus 6.45%), suggesting a positive initial trend in the Turkish market changing into a negative one. Figure 1 provides further insights by depicting the cumulative performance of the benchmark BIS100 index during our sample period.

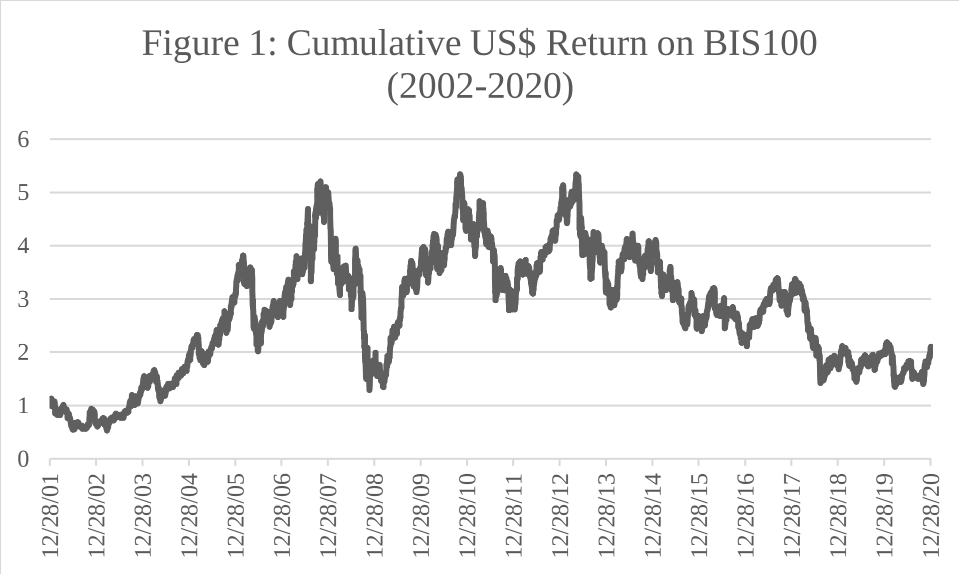


Figure 4: Cumulative US$ Return on BIS100 (2002-2020)

Overall, the size effect bias is of secondary importance in the calculation of portfolio returns of Turkish stocks. A well-diversified buy-and-hold portfolio of Turkish stocks delivers superior performance relative to the equally weighted portfolio. The potential extra gains in trading strategies exploiting the size effect are insignificant. The results are consistent with the conventional advice on equity investment strategies for emerging markets, which historically appeared more volatile and trending than developed markets (Estrada, 2009).

Although the potential returns from exploiting the size effect are moderate at best and volatile, their realisation in practice would be likely to be limited by transaction costs, illiquidity, and other market microstructure issues. Also, in practical terms, the overall (nominal) market capitalisation of small Turkish stocks is relatively low, leaving “little or no money on the table” for investors in the absence of derivative instruments.

Overall, we find some evidence supporting insights into biases in computed equity returns. The size effect calculated using a rebalanced portfolio is higher than the one in a buy-and-hold portfolio during the entire sample period, while the results for sub-periods/months tend to fluctuate significantly. Our results and literature review indicate that the Turkish equity market is relatively efficient compared to other emerging markets. Our results for the size effect in Turkey align with the existing evidence for the developed markets. However, our qualitative research of the Turkish market indicates that assessing the information environment is a challenging undertaking that should look at returns from a wider angle than just the information arbitrage component. It is necessary to conduct further research on the significance of the private and public information environments in global marketplaces.

Appendix

Table 20 Average daily percent returns for rebalanced versus buy-and-hold portfolios.[a]

	Panel A: Rebalanced Portfolio				Panel B: Buy-and-hold portfolio				Panel C: Rebalanced minus buy-and-hold			
	2002-06	2007-11	2012-2016	2017-20	2002-06	2007-11	2012-2016	2017-20	2002-06	2007-11	2012-2016	2017-20
	Average return (standard deviation)[b]								Average (difference (t-statistic)[c]			
Small	0.19	0.10	0.04	0.21	0.54	0.22	0.10	0.22	-0.145	-0.146	-0.092	-0.105
	(2.350)	(2.309)	(1.467)	(2.076)	(8.325)	(5.220)	(1.828)	(2.636)	(-2.886)	(-2.764)	(-2.034)	(-2.132)
Medium	0.15	0.06	0.02	0.12	0.28	0.19	0.01	0.16	-0.14	-0.102	-0.06	-0.054
	(2.408)	(2.313)	(1.506)	(2.142)	(3.606)	(4.532)	(1.995)	(2.624)	(-2.863)	(-2.55)	(-2.28)	(-1.841)
Large	0.13	0.04	0.02	0.05	0.30	0.22	0.02	0.04	-0.141	-0.102	-0.068	-0.105
	(2.508)	(2.376)	(1.624)	(1.975)	(4.592)	(4.960)	(1.882)	(2.222)	(-2.843)	(-2.446)	(-2.224)	(-2.132)
	Panel D: Average difference (t-statistic and the rank-sum test prob.)[c]											
Small-Large	0.06	0.058	0.018	0.154	0.234	-0.002	0.08	0.184				
	(0.6)	(0.6)	(0.3)	(1.7)	(0.85)	(0.00)	(1.1)	(1.7)				
The rank-sum test	(0.170)	(0.203)	(0.573)	(0.010)	(0.301)	(0.146)	(0.084)	(0.068)				

Note: [a] The reported statistics are derived from two series of daily returns for each year from 2002 through 2020 for each of three portfolios formed by market value at the beginning of the year. The first series are the daily returns for a specific year for a specific portfolio resulting from a daily rebalanced strategy, and the second series are the daily returns for a specific year for a specific portfolio resulting from a buy-and-hold strategy. Both strategies assume an equal amount invested in each security at the beginning of each year.
[b] The arithmetic averages of the daily returns for the years indicated for each size portfolio are shown. The numbers in parentheses are the standard deviations of the series.
[c] The indicated series of daily returns are differenced. The averages of these differences are given along with the t-values calculated on the basis of these differences, thus adjusting for any dependence between the original series.

Table 21: Average daily percent portfolio returns by month. 2002-2020

Panel A: Rebalanced Portfolio

	Jan	Feb	March	April	June	July	Aug	Sept	Oct	Nov	Nov	Dec
	Average return (standard deviation)[b]											
Small	0.17	0.08	0.10	0.34	-0.01	0.04	0.18	-0.02	0.19	0.13	0.14	0.22
	(1.970)	(1.896)	(2.791)	(1.786)	(2.284)	(1.996)	(1.858)	(2.276)	(1.710)	(2.165)	(2.199)	(1.751)
Medium	0.19	0.01	-0.01	0.30	-0.11	0.01	0.20	-0.13	0.18	0.06	0.10	0.18
	(2.036)	(1.874)	(2.740)	(1.749)	(2.235)	(1.994)	(1.940)	(2.370)	(1.798)	(2.280)	(2.332)	(1.812)
Large	0.17	-0.02	-0.02	0.24	-0.12	0.00	0.21	-0.15	0.11	0.07	0.09	0.13
	(2.076)	(1.880)	(2.667)	(1.811)	(2.175)	(2.079)	(2.028)	(2.291)	(1.920)	(2.339)	(2.511)	(1.897)
Average (difference (t-statistic)[c]												
Small-Large	0.028	0.008	0.147	0.043	0.154	0.025	-0.015	0.13	0.069	0.027	-0.019	0.04
	(0.2)	(0.05)	(0.8)	(0.3)	(1.1)	(0.2)	(-0.1)	(0.85)	(0.45)	(0.15)	(-0.1)	(0.25)

Panel B: Buy-and-hold portfolio

	Jan	Feb	March	April	June	July	Aug	Sept	Oct	Nov	Nov	Dec
	Average return (standard deviation)[b]											
Small	1.15	0.09	0.11	0.36	0.53	0.02	0.16	-0.02	0.56	0.08	0.07	0.15
	(10.34)	(1.962)	(2.754)	(1.979)	(12.29)	(2.145)	(1.853)	(2.408)	(3.133)	(5.008)	(2.344)	(2.088)
Medium	0.95	0.02	-0.05	0.27	-0.15	-0.00	0.25	-0.13	0.18	0.16	0.15	0.26
	(8.897)	(2.212)	(2.626)	(1.996)	(2.305)	(2.206)	(2.113)	(2.492)	(1.929)	(2.218)	(2.397)	(2.131)
Large	1.25	-0.04	-0.06	0.22	-0.10	0.09	0.19	-0.13	0.11	0.13	0.04	0.10
	(10.72)	(1.793)	(2.545)	(1.909)	(2.160)	(2.235)	(2.020)	(2.279)	(1.944)	(2.401)	(2.401)	(1.881)
Average (difference (t-statistic)[c]												
Small-Large	-0.002	0.036	0.132	0.088	0.521	-0.102	0.024	0.11	0.358	-0.032	-0.002	-0.017
	(0.00)	(0.15)	(0.75)	(0.55)	(1.05)	(-0.7)	(0.2)	(0.7)	(2.00)	(-0.15)	(0.00)	(-0.1)

Panel C: Rebalanced minus buy-and-hold

	Jan	Feb	March	April	June	July	Aug	Sept	Oct	Nov	Nov	Dec
	Average return (standard deviation)[b]											
Small	-0.98	-0.01	-0.01	-0.02	-0.54	0.02	0.02	-0.00	-0.38	0.05	0.08	0.07
	(9.968)	(0.571)	(0.624)	(0.916)	(11.55)	(0.882)	(0.673)	(0.974)	(2.569)	(4.373)	(1.102)	(1.144)
Medium	-0.76	-0.01	0.03	0.04	0.04	0.01	-0.05	0.00	0.01	-0.09	-0.05	-0.08
	(8.499)	(1.128)	(1.017)	(1.121)	(0.919)	(0.925)	(1.045)	(0.982)	(0.946)	(1.140)	(1.104)	(1.089)
Large	-1.07	0.01	0.04	0.02	-0.02	-0.08	0.03	-0.02	-0.00	-0.06	0.06	0.03
	(10.38)	(0.739)	(0.743)	(0.819)	(0.782)	(0.996)	(0.984)	(0.708)	(0.872)	(1.035)	(1.066)	(0.685)
Average (difference (t-statistic)[c]												
Small-Large	0.029	-0.029	0.017	-0.045	-0.366	0.127	-0.039	0.02	-0.289	0.058	-0.018	0.057
	(0.05)	(-0.45)	(0.3)	(-0.7)	(-0.8)	(2.15)	(-0.65)	(0.35)	(-2.5)	(0.3)	(-0.25)	(0.9)

Table 22: Sharpe-Lintner Excess Returns (S&P500): 2002-2020

	Jan	Feb	March	April	June	July	Aug	Sept	Oct	Nov	Nov	Dec
Panel A: Buy-and-hold (t statistic)												
Small-Large	-0.069	0.113	0.172	0.119	0.655	-0.072	-0.024	0.112	0.447	-0.035	0.004	0.039
	(-0.267)	(1.803)	(2.928)	(2.030)	(1.032)	(-0.947)	(-0.390)	(1.527)	(3.184)	(-0.156)	(0.056)	(0.563)
Panel B: Rebalanced (t statistic)												
Small-Large	-0.003	0.096	0.118	0.097	0.106	0.034	-0.034	0.124	0.066	0.060	0.038	0.085
	(-0.080)	(2.396)	(3.205)	(2.616)	(1.959)	(0.892)	(-0.902)	(2.699)	(1.830)	(1.452)	(0.950)	(2.313)
Panel C: Rebalanced minus Buy-and-hold (t statistic)												
	0.065	-0.017	-0.053	-0.022	-0.548	0.106	-0.010	0.011	-0.382	0.095	0.034	0.046
	(0.256)	(-0.390)	(-1.112)	(-0.441)	(-0.902)	(1.655)	(-0.171)	(0.225)	(-2.959)	(0.423)	(0.395)	(0.733)

	Panel D: Rebalanced Portfolio				Panel E: Buy-and-hold portfolio				Panel F: Rebalanced minus Buy-and-hold			
	2002-06	2007-11	2012-2016	2017-20	2002-06	2007-11	2012-2016	2017-20	2002-06	2007-11	2012-2016	2017-20
Small-Large	0.057	0.056	0.021	0.149	0.246	-0.005	0.094	0.172	-0.189	0.061	-0.073	-0.023
	(1.916)	(2.461)	(1.247)	(4.755)	(1.037)	(-0.102)	(2.730)	(2.854)	(-0.835)	(1.262)	(-2.436)	(-0.442)

Table 23: Sharpe-Lintner Excess Returns (BIS100US$): 2002-2020

	Jan	Feb	March	April	June	July	Aug	Sept	Oct	Nov	Nov	Dec
Panel A: Buy-and-hold (t statistic)												
Small-Large	-0.059	0.114	0.176	0.134	0.640	-0.070	-0.015	0.096	0.463	-0.044	0.020	0.052
	(-0.231)	(1.873)	(3.087)	(2.310)	(0.996)	(-1.061)	(-0.240)	(1.496)	(3.426)	(-0.184)	(0.233)	(0.767)
Panel B: Rebalanced (t statistic)												
Small-Large	0.014	0.091	0.120	0.118	0.098	0.034	-0.005	0.109	0.092	0.069	0.044	0.101
	(0.414)	(2.249)	(3.158)	(3.349)	(2.008)	(0.998)	(-0.143)	(2.941)	(3.077)	(1.842)	(1.263)	(3.129)
Panel C: Rebalanced minus Buy-and-hold (t statistic)												
	0.073	-0.023	-0.056	-0.016	-0.543	0.104	0.010	0.013	-0.372	0.112	0.023	0.049
	(0.297)	(-0.487)	(-1.246)	(-0.307)	(-0.882)	(1.591)	(0.182)	(0.238)	(-2.533)	(0.510)	(0.285)	(0.780)

	Panel D: Rebalanced Portfolio				Panel E: Buy-and-hold portfolio				Panel F: Rebalanced minus Buy-and-hold			
	2002-06	2007-11	2012-2016	2017-20	2002-06	2007-11	2012-2016	2017-20	2002-06	2007-11	2012-2016	2017-20
Small-Large	0.069	0.059	0.015	0.152	0.252	-0.007	0.085	0.172	-0.183	0.066	-0.070	-0.020
	(2.503)	(2.712)	(1.067)	(4.939)	(1.054)	(-0.127)	(2.528)	(2.865)	(-0.800)	(1.379)	(-2.311)	(-0.391)

Chapter 3: How meaningful is Turkish Country Beta? Lessons From a Partially Segmented Equity Market

Introduction

The Turkish Equity Market studied in this paper has been classified as an Emerging Market since 1989 by Morgan Stanley Capital International (MSCI). Nevertheless, the country's importance as an emerging market appears to be gradually shrinking in the recent decade, as the turbulent macroeconomic developments drove international investors away from an unpredictable economy. In its Market Classification Review for 2020 on June 23, MSCI announced that Turkey could be reclassified as a frontier or standalone market amid "accessibility concerns". According to MSCI, the Turkish equity market was "adversely impacted" by a series of bans on stock lending and short selling.[4] Turkey's weighting in the MSCI Emerging Markets index (MSCI EM) decreased to under 0.5% in June 2020, down from its long-term average of about 2%. According to MSCI (2020), the market developments in Turkey "severely restrict the ability of institutional investors to express active investment views and hedge portfolio risk". It was also argued that the reclassification of Turkey by MSCI could lead to about $5bn in total outflows from Turkish equities, including about $2-3bn from passive investment funds that automatically track the index (Pitel, 2020).

The MSCI EM is often used as a benchmark by active investment managers or tracked by passive investment funds, and these major market actors have limited or no room to deviate from the index weightings. Somewhat troubling, maintaining exposure to Turkey in the portfolios of the emerging markets fund managers started to require a large overweight position in 2020, something which the majority of these managers needed to be more comfortable with (Pitel, 2020). Importantly, it was also suggested that the frontier market investors started gaining Turkey exposure in their portfolios without a formal country reclassification decision by MSCI.

From the academic perspective, the aforementioned developments have implications for the integration of the Turkish equity market with the world market, its efficiency, and risk-factor exposures in the asset pricing models. Hence, we could view Turkey's market developments as an opportunity to test the robustness of the established theories and analytical frameworks.

[4] Liquidity of the Turkish equity market deteriorated significantly due to the imposition of short selling and stock lending bans in October 2019 and February 2020, respectively. This severely restricted the ability of institutional investors to "express active investment views and hedge portfolio risk" (MSCI, 2020).

One of the most important changes in the global financial market in the last decades has been a large increase in passive investing (e.g., French, 2008). Credit Suisse (2020) states that “the continued rise of passive and low-fee products reflects ongoing fee sensitivity from investors”. However, the superior average performance of index funds also played an important role (Pisani, 2019). Stambaugh (2014) shows that both the fraction of mutual funds that are actively managed (at a higher fee) and the active share of the portfolio of active equity mutual funds have been declining. Dimson, Marsh and Staunton (2017) also document a pronounced trend of “ditching active management” in favour of index funds and index ETFs in the US (2007-16). A particular rapid growth was observed in factor-based ETFs, with 75% of investment institutions using or actively evaluating “smart beta” strategies. In fact, factor investing is often regarded as a compromise between active and passive investing (Dimson, Marsh and Staunton, 2021). Although the observed positive trend in passive investment strategies is potentially fully compatible with the classic asset pricing theory, the changing market layout could lead to unintended market distortions, particularly in the smaller equity markets.

A paradigm for theoretically and empirically analysing investor competition in financial markets is developed by Haddad et al. in 2021. The authors contend that the significant rise in passive investment over the past few decades has resulted in significantly more inelastic aggregate demand curves for specific equities as a result of the stock market becoming too uncompetitive. It appears that the rise of passive investment management also puts pressure on active management by creating a ‘pull effect’ that actively managed funds need to follow. As the portfolio allocation is increasingly driven by the index weights, a potential reclassification of an asset by index providers leads to the portfolio rebalancing of both passive and active funds, as the latter are also benchmarked against established indexes (Raddatz et al., 2017).

Fichtner et al. (2021, p.4) argue that “by reclassifying individual countries, index providers effectively redraw the borders of markets. Moreover, index providers set out the criteria that decide “which countries are ‘investment-worthy’, thereby defining the hierarchy in global financial markets”. In fact, some of the US legal scholars argue that “the US investment industry should require index providers to register with the Securities and Exchange Commission and to solicit comments from the public through notice-and-comment periods when the providers add new rules or modify existing rules” (McCarthy, 2018It was stated that a nation reclassification by index providers demands a considerably more proactive involvement, even though the equity index inclusion of a firm is often more indirect and not targeted at individual companies (Petry at al., 2021). For instance, UBS bank predicted that once new entrants such as Saudi Arabia and China's domestic shares were added to global indexes, there would be a movement of around $121 billion in active and passive fund flows throughout the emerging market universe (Robertson & Lam, 2019).

Notably, the effect of country reclassification, and “downgrades” in particular, has not been extensively studied by the existing literature. The notable exception is the “index effect” literature focusing on the effects of changes to the composition of an index on the performance of firms whose stocks are added to or dropped from the index (see Afego (2017) for a comprehensive survey of the related literature). There are also studies which focus on alpha-maximizing responses to reclassifications for various investors (e.g., Davis, 2018; Burnham et al., 2018).

Ironically, the paper more closely related to what we are investigating is the undergraduate thesis submitted at Northwestern University by Dylan Cooney in 2018. The paper looks at the pairwise correlation between the components of the MSCI Emerging and Frontier Market Equity Indexes. The difference-in-difference regressions indicate a substantial decrease in the correlation of the return of a reclassified component (country) with other components from both indices (Cooney, 2018).

Evaluating a country's risk becomes a strategically significant challenge for international investors in a highly turbulent business climate. Investment managers are likely to increase the performance of their portfolios by determining the factors influencing country risk. From a policy standpoint, a greater comprehension of these causal links can enhance knowledge of the impact of monetary and fiscal policies and subsequent capital flows on market stability.
As we explain in more detail later, our results cast a shadow of doubt on the robustness of the country beta approach suggested by Harvey (1991) and utilised in many subsequent academic works and practical applications (e.g., capital budgeting) to measure country risk. Nevertheless, according to our results, the country beta appears to capture well the extent of equity market integration/segmentation, which becomes particularly visible when a country faces the possibility of reclassification by an index provider.

Harvey (1991) proposed the country beta approach, which measures country risk as the conditional sensitivity (or covariance) of nation returns to a proxy for global equity market

returns. Harvey and Zhou (1993) estimated country betas for 17 developed nations based on the impact of a capitalization-weighted global market portfolio using this method. Erb, Harvey, and Viskanta (1996) calculate nation betas as a function of country credit risk for twenty-one developed equities markets and twenty-six emerging equity markets. Gangemi et al. (2000) estimate Australia's national beta based on Australian macroeconomic indicators.
By creating an actual model of the Brazilian country risk, Andrade and Teles (2006) expand the beta country risk model. Ozdemir, Yildiz, and Otluoglu (2016) used a time-varying country beta model with various macroeconomic variables over 2004–2015 to examine Turkey's country risk. The authors assert that their analysis is the first to use a country beta approach to examine Turkey's country risk. In the context of a broad assessment of country risk, Sun et al. (2021) talk about country betas. While applying a novel multivariate stochastic volatility (SV) model to a group of emerging stock markets, Johansson (2009a) emphasises how acutely time-varying nation risk is typically represented by the beta relative to the market portfolio, is in emerging markets.

The time-varying character of systematic risk in the Greater China equities markets is examined by Johansson (2009b). As compared to the global market, the author claims that the Shanghai and Shenzhen markets typically have low average systematic risk, whereas the Hong Kong and Taiwan markets are more integrated and exhibit indicators of significant fluctuations in systematic risk over time. Notably, some of the papers mentioned above use daily equity return data allowing the authors to use more sophisticated methodologies than those employed in this paper.

This paper also contributes to the literature on the implications of partial segmentation of a market. Segmentation is defined as a situation in which “there are some equity flows that take place either in or out of a country, although these flows are limited because of explicit constraints on, or because of barriers to, international investment” (Karolyi and Stulz, 2003, p23). For several nations with explicit obstacles to foreign investment, there is conclusive empirical evidence of the disparity between global and local asset prices (e.g., Errunza and Losq, 1985; Hietala, 1989; Bailey & Jagtiani, 1994; Nivorozhkin & Castagneto-Gissey, 2016). The majority of the articles come to the conclusion that market segmentation has a considerable impact on the valuation of stocks and that the premium of shares made available to foreign investors changes over time.

The related literature uses the market model's coefficient of determination (R-squared) as a metric of the synchronicity of stock price movements to infer a variation in equity market integration. A model of the stock market synchronous behaviour of emerging markets was first put forth by Morck et al. (2000), who also stated that the R-squared values of emerging markets are larger than those of developed nations. Khandaker (2011) examined stock market data for eight emerging economies and three developed countries using country-level data and discovered evidence that the R-squared values of emerging economies are greater than those of developed economies.

This may result from investors' "herding" behaviour, which causes them to focus more on nations than specific equities when engaging in trading operations. As a result, Jin and Myers (2006) discover that countries with greater levels of opacity have higher R-squared statistics. However, the negative correlation between financial development and R-squared is only sometimes a direct result of aspects of corporate governance. The patterns seen in smaller or less established economies could be explained by increased macroeconomic risk or a lack of industry diversification.

Nivorozhkin and Castagneto-Gissey (2016) examined the fluctuation of R-squared measure across time in a single country to look for a possible impact of the 2014 economic and political sanctions placed on Russia rather than attempting to explain the cross-sectional variation in the degree of synchronicity. The findings show a significant difference in the level of the Russian stock market's integration with the rest of the world and a significant "decoupling" of the Russian market to the "low synchronicity" state indicative of the market's infancy. Similar to Nivorozhkin and Castagneto-Gissey (2016), this paper uses a univariate and multivariate asset pricing model framework to examine whether Turkish economic trends had an impact on the integration of the Turkish equity market with the rest of the world.

Lastly, Gabaix and Koijen (2021) demonstrate, theoretically and empirically, that, in contrast to the common viewpoint, the overall stock market is unexpectedly price-inelastic, with flows into and out of the market having a significant impact on prices and risk premia. The "inelastic markets hypothesis" is how the authors describe this occurrence. The conclusion that “the demand elasticity of the aggregate stock market appears to be a key parameter of interest in asset pricing and macro-finance, just like investors’ risk aversion, their elasticity of intertemporal substitution, and the micro elasticity of demand", should not perhaps come as a surprise in the "less-efficient" Turkish market context.

The rest of the article proceeds as follows. Section 2 presents data and samples. Section 3 presents and discusses empirical results, and Section 4 concludes.

Data

The monthly equity index returns data are obtained from the Refinitiv Eikon database. Initially, we considered five proxies to track the performance of the Turkish equity market and four proxies for the global equity market (see Table 1). The Global equity market proxies include the S&P500 index, the MSCI All Countries World index (which includes developed and emerging markets), the MSCI Emerging market index, and the MSCI Frontier market index. The Fama-French Monthly Factor Returns are obtained from Prof. French's Data Library (Kenneth R. French – Data Library, 2022). All return series are US$ discretely compounded returns, and Fama-French factors are expressed in terms of access returns.

Table 24: Equity Market Indexes

Index Name / Ticker	Index Description	Starting Date
BIST100 / XU100	A free float market capitalization-weighted index composed of 100 BIST Stars Market Segment companies. BIST Stars includes companies with market capitalisation in excess of TL 300 mil. BIST 100 index automatically covers BIST 30 and BIST 50 stocks.	1988m1
BIST50 / XU050	The index consists of 50 stocks selected among the stocks of companies traded on the National Market and the stocks of real estate investment trusts and venture capital investment trusts traded on the Collective Products Market. BIST 50 index automatically covers BIST 30 stocks.	2004m9
BIST30 / XU030	The index consists of 30 stocks selected among the stocks of companies traded on the National Market and the stocks of real estate investment trusts and venture capital investment trusts traded on the Collective Products Market.	200m9
BIST All Equity / XUTUM	The index consists of all stocks traded on Borsa Istanbul markets, except Investment Trusts.	1997m9
MSCI Turkey / dMITR00000GUS	The MSCI Turkey Index is designed to measure the performance of the large and mid-cap segments of the Turkish	2003m10

	market. With 11 constituents, the index covers about 85% of the equity universe in Turkey.	
S&P 500 / SPX	S&P500 equity market index	1988m1
MSCI ACW / dMIEF00000GUS	The MSCI ACW captures large and mid- cap representation across 23 Developed Markets (DM) and 25 Emerging Markets (EM) countries. The index covers approximately 85% of the global investable equity opportunity set.	1988m1
MSCI EM / dMIEF00000GUS	The MSCI Emerging Markets Index captures large and mid-cap representation across 25 Emerging Markets (EM) countries. The index covers approximately 85% of the free float-adjusted market capitalization in each country.	1988m1
MSCI FM / dMI7400000GUS	The MSCI Frontier Markets Index captures large and mid-cap representation across 28 Frontier Markets (FM) countries. The index covers about 85% of the free float-adjusted market capitalization in each country.	2013m3

Source: msci.com, borsaistanbul.com

Results and Discussion

Figure 1 illustrates the cumulative return on the selected equity indexes since 2013, when all index data became available. The poor performance of the Turkish economy is clearly reflected in a rather uniform decline of all Turkish equity indexes, which dropped in the range of 64-72% during the period. This also strongly contrasts with the performance of developed, emerging, and frontier equity market indices.

The descriptive statistics in Table 1 confirm the volatile nature of the Turkish equity market in absolute terms and relative to globally diversified indexes. Over a comparable period, the BIST 100 outperformed S&P 500 regarding average monthly returns (1.4% vs 0.81%). However, the volatility of monthly returns of the BIST100 was 3.6 times that of the S&P 500 (14.09% vs 4.16%), and the return distribution had more articulated “fat tails”.

The correlation among the selected Turkish equity indexes is in excess of 98%, as evident in Figure 1, so in the remainder of the paper, we will use the main Turkish equity index - BIST 100, which also has data for the most extended period.

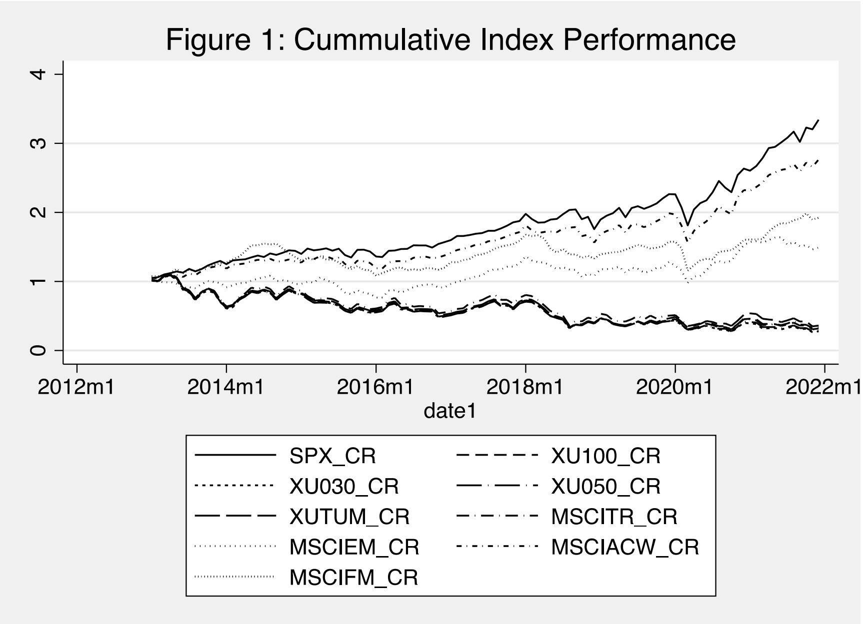


Figure 5: Cumulative Index Performance

Table 25: Descriptive Statistics for Equity Index Monthly Returns (%).

variable	N	mean	sd	p25	p50	p75	skewness	kurtosis
BIST 100	407	1.4	14.99	-8.27	0.95	8.51	0.79	5.8
BIST 30	206	0.45	10.7	-6.62	1.12	7.44	-0.07	3.32
BIST 50	206	0.45	10.49	-5.94	0.78	7.24	-0.13	3.35
BIST	290	0.86	13.05	-6.99	1.01	8.42	0.42	6.35
BIST All Shares	218	0.77	11.57	-5.18	0	5.93	2.37	21.64
S&P500	407	0.81	4.16	-1.7	1.19	3.44	-0.56	4.27
MSCI EM	138	0.57	5.05	-2.52	0.69	3.12	-0.18	3.62
MSCI ACW	407	0.78	4.34	-1.67	1.3	3.38	-0.61	4.62
MSCI FM	109	0.71	4.03	-1.12	1.2	3.1	-1.77	10.74

Source: Refinitiv Eikon and Author's calculations.

To determine the Turkish country beta, β_{TR}, we estimate a series of rolling Global CAPM-style regressions:

$$R_{TR,t} - R_{f,t} = \beta_{TR}(R_{Gi,t} - R_{f,t}) + \varepsilon_t \qquad (1)$$

where $R_{TR,t}$ is a monthly US\$ return on BIST 100 index, $R_{Gi,t}$ is a monthly US\$ return on a global equity index i (e.g., MSCI ACW, MSCI EM, MSCI FM), and $R_{f,t}$ is a monthly time-series of the US risk-free interest rate (the yield on the one-month US Treasury bills) from the Prof. French's Data Library. We estimate regressions with Newey-West consistent standard errors with two lags. The Newey-West consistent standard errors are heteroskedasticity- and autocorrelation-consistent (HAC) standard errors (Newey & West, 1986). These robust estimates also subsume White's correction. Table 2 also reports the output of regressions estimated in the conventional Fama-MacBeth style (Fama & MacBeth, 1973). The betas are calculated in the 36-month rolling windows from February 1988 to December 2021 and then "averaged".

Table 26: Global Betas of the Turkish Equity Market (One-factor Models)

Panel A: 1988m2-2021m12

VARIABLES	(1)	(2)	(3)	(5)
S&P 500	0.593**			
	(0.239)			
MSCI ACW		1.029***		
		(0.239)		
MSCI EM			1.005***	
			(0.222)	
MSCI FM				0.575*
				(0.338)
Constant	0.282	0.211	0.0378	-0.441
	(0.323)	(0.249)	(0.212)	(0.323)
Observations	385	385	385	103

Panel B: 2000m1-202112

VARIABLES	(1)	(2)	(3)	(4)
S&P 500	1.041***			
	(0.222)			
MSCI ACW		1.200***		
		(0.223)		
MSCI EM			1.186***	
			(0.168)	
MSCI FM				0.575*
				(0.338)
Constant	0.217	-0.0856	0.0602	-0.441
	(0.285)	(0.253)	(0.178)	(0.323)
Observations	251	251	251	103

Newey-West FMB adj. Std. Err. using lags(2) are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2 reports our estimates of the Turkish market's global betas for the four global indices. Wirth the maximum observation period available to measure the Turkish equity market returns, the results reported in Table 2 (Panel A) could be clearer at first glance. The BIST 100 index is less risky than the global market benchmarks, riskier than an average emerging equity market, but less risky than an average frontier market. These interpretations are, of course, conditional on EM and FM portfolios being the efficient portfolios, which are generally considered to be combinations of the market portfolio and the risk-free rate. Nevertheless, it is possible that BIST100's contribution to the systematic risk of a globally diversified portfolio, such as S & P500 and MSCI ACW, is relatively small, while the opposite is valid for a less-diversified Emerging Markets Index. The idiosyncratic risk of Turkey could be better diversified in a more globally diversified portfolio. Nevertheless, it is hard to imagine a credible financial manager using the beta of 0.59 for the required return on equity in the cost of capital/discount rate calculations for a project in Turkey.

In Panel B of Table 2, we restrict our timeframe to the period of greater integration of the Turkish equity market. The first decade of 2000 was a historically best period for emerging markets in general, so one would expect to observe a greater degree of covariation between BIST 100 and global indices. The results in Panel B of Table 2 support our expectations. The betas with S&P 500 and MSCI ACW increase to a reasonable level expected from a market such as Turkey. Overall, in the long run, BIST100 appears to be exposed the most to the systematic risk factors proxied by its own asset class benchmark – MSCI Emerging Markets Index.

The frontier market index results will be revisited next when we look at the intertemporal behaviour of our regression coefficients in Figure 2.

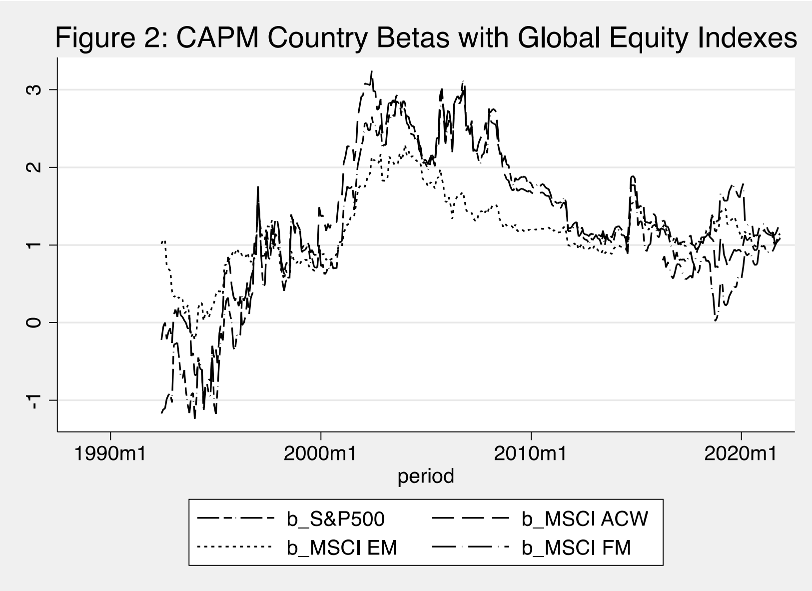


Figure 6: CAPM Country Betas with Global Equity Indexes

Figure 2 displays the market beta coefficients from the rolling window regressions. The Turkish market betas vary significantly over time which is also apparent from the very wide confidence intervals of beta coefficients in regression results reported in Table 2. For example, from the beginning of the 1990s, the Turkish market beta with respect to S&P 500 index ranged from effectively 0 throughout the 1990s to over three at its peak in October 2006. The beta with MSCI ACW picked at 3.3 in June 2002, in the aftermath of a major banking and economic crisis in Turkey. The MSCI EM betas remained lower relative to the S&P and MSCI ACW betas for an extended period, but both sets of betas declined significantly after the global financial crisis of 2008-09.

The pattern observed in Figure 2 is consistent with the conventional view of the degree of development and segmentation of the Turkish equity market over time. This is supported by the findings in Figure 3. Similar to betas, the coefficient of determination (R2) evolves in an inverse U-shape fashion. The synchronicity of a Turkish equity market index with global indexes varies significantly over time. At the pick, the MSCI EM index explained well more than 60 per cent of the variation in BIST 100.

Nevertheless, the period of the global financial crisis of 2008-9 is associated with a decrease in BIST 100 synchronicity with the global indexes. The Turkish market return integration (co-movement) with the rest of the world appears to decrease in recent years to the levels observed before the early 2000s. The R^2 pattern observed in Figure 3 is strikingly similar to the one reported for Russia by Nivorozhkin and Castagneto-Gissey (2016). Similar to the Russian equity market, the Turkish market appeared to emerge from a very segmented state in the early 1990s to becoming an integral part of international portfolio investment before the global financial crisis and following the decade of record economic growth for the emerging markets asset class. Subsequent adverse political and economic developments in both countries were reflected in the equity market dynamics, leading the equity markets to the state of greater partial segmentation.

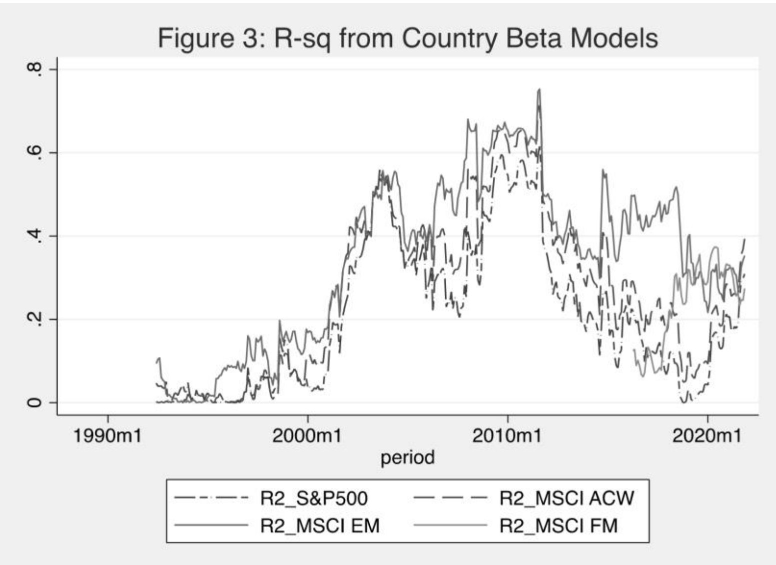


Figure 7: R-sq from Country Beta Models

The evidence of rising betas reported in Figure 2 contradicts the evidence of greater integration of the Turkish market with the global markets in the same period. Why would Turkey become "riskier", as evidenced by rising betas, during favourable economic environment periods? A plausible explanation for this apparent contradiction is perhaps the fact that the informativeness of beta is likely to be lower when the market is relatively segmented. In other words, the "plausible" values of market betas appear to be observed during the period of greater synchronicity across markets. The poor growth prospects, persistent macroeconomic disbalances and declining valuations have persistently contributed to an increasingly marginalised role of Turkish equities in global investment portfolios. Hence, the decrease in Turkish beta will likely reflect its decreasing marginal contribution to the risk of these "value-weighted" portfolios. Moreover, as emphasised by Damodaran (2021), the betas of small and underdeveloped equity markets are often characterised by "artificially" low betas with respect to value-weighted global benchmarks precisely because of these markets' small weight in the index.

Table 3 looks at the sensitivity of our beta estimates to a more sophisticated risk-adjustment procedure for the return series. Using the factor returns obtained from Prof. French's Data Library, we estimated a multifactor version of equation (1):

$$R_{TR,t} - R_{f,t} = \sum_{i=1}^{N}(R_{RFi,t} - R_{f,t}) + \varepsilon_t \qquad (2)$$

Where the returns on a single risk factor $R_{Gi,t}$ from equitation (1) are now proxied by multiple risk factors.

We selected a conventional set of risk factors from the asset pricing literature. FF_EM is a return on Fama-French Emerging Market Equity Index serving as a proxy for the market portfolio; the Emerging Market Size factor (SMB (Small Minus Big)) is the average return on the nine small stock portfolios minus the average return on the nine big stock portfolios for emerging markets; Emerging Market Value Factor (HML (High Minus Low)) is the average return on the two value portfolios minus the average return on the two growth portfolios for emerging markets; Emerging Market Momentum factor (WML) is the equal-weight average of the returns for the two winner portfolios for emerging markets minus the average of the returns for the two loser portfolios.

Somewhat unsurprisingly, the results depicted in Table 3 (Panel A) indicate a decrease of "long-term" Turkish market beta to less than 1 when the three-factor Fama-French model with and without momentum factor is fitted to the data. Nevertheless, Figure 4 shows that the relative magnitude of market betas from the alternative multifactor model specifications also fluctuates widely over time. Focusing on the period since 2000 in Panel B brings about more meaningful results. The market betas decrease in a multifactor setting, but their magnitude remains more significant than in Panel A. Moreover, BIST 100 is negatively and significantly related to the size factor for the emerging market benchmark, as one would expect as the largest (by market capitalisation) listed Turkish companies are included in the index. The Turkish equities also exhibited negative exposure to the momentum factor, as one would expect, given the index's cumulative performance during the period.

Table 27: Global Betas from a multifactor model

Panel A: 1989m7-2021m11

VARIABLES	(1)	(2)	(3)
FF EM	1.310***	0.863***	0.773***
	(0.244)	(0.112)	(0.105)
SMB		-0.105	-0.137
		(0.134)	(0.116)
HML		0.0344	0.0552
		(0.0869)	(0.0549)
WML			-0.115
			(0.0725)
Constant	0.0739	0.00932	0.0196
	(0.285)	(0.0480)	(0.0195)
Observations	389	389	383

Panel B: 2000m1-2021m12

VARIABLES	(1)	(2)	(3)
FF EM	1.147***	1.158***	1.025***
	(0.173)	(0.116)	(0.111)
SMB		-0.239**	-0.194**
		(0.0958)	(0.0821)
HML		-0.0134	-0.00351
		(0.0755)	(0.0580)
WML			-0.125*
			(0.0676)
Constant	-0.164	0.0253	0.0299
	(0.188)	(0.0736)	(0.0298)
Observations	251	251	251

Newey-West FMB adj. Std. Err. using lags(2) are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

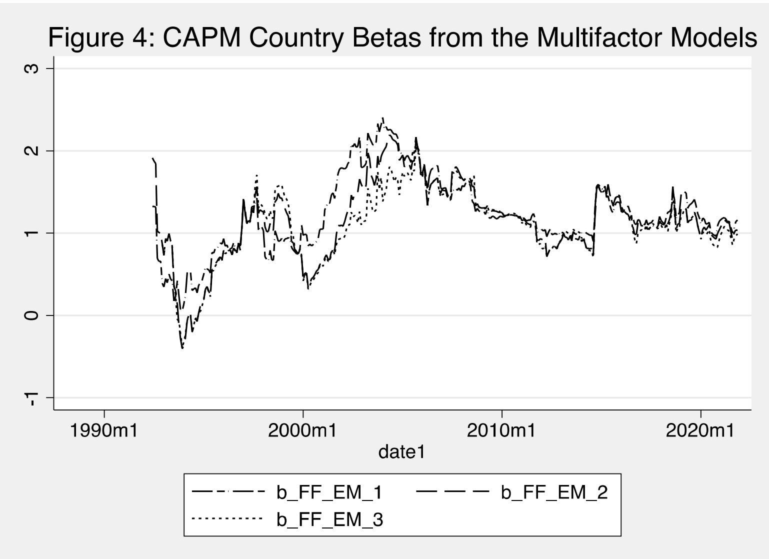


Figure 8: CAPM Country Betas from the Multifactor Models

The evidence so far indicates that market imperfections and the market microstructure features of the Turkish Equity market are likely to have a significant effect on the market betas we have observed so far.

This insight is further supported by the results presented in Figures 5 and 6, which are effectively truncated versions of Figures 2 and 3 and focus on 2015-21. As we mentioned in the introductory section, Turkey's importance as an emerging market has been gradually shrinking in recent years. The country's prolonged and turbulent macroeconomic developments negatively affected investors' sentiment and drove many away from an unpredictable economy. In its Market Classification Review for 2020, MSCI announced that Turkey could be reclassified as a frontier market or a standalone market amid "accessibility concerns". As of direct relevance for our study, the feasibility of maintaining exposure to Turkey in the portfolios of the emerging markets fund managers (and hence, the global portfolio managers) deteriorated significantly in 2020 (Pitel, 2020). In this environment, the frontier market investors already gained Turkey exposure in their portfolios without a formal reclassification decision by MSCI. Importantly, as part of the MSCI Frontier Market index, Turkey would be the largest or second largest market constituency in the index, as Turkey's market capitalisation is about the same as Vietnam's, which currently is the largest Frontier market. The effect of the potential reclassification of Turkey as a frontier market seems to be reflected in Figures 5 and 6. The beta with respect to MSCI FM reaches its historical maximum of 1.8 about a year before the MSCI Market Classification Review for 2020, after exceeding the betas concerning the MSCI EM index since the beginning of 2018. The dispersion across the alternative betas used remained high during 20018-20 and decreased substantially in the following periods when the risk of reclassification subsided.

As we know retrospectively, Turkey has yet to be reclassified by MSCI. Hence, the observed patterns of derived market betas indicate the critical role of institutional flows in the Turkish equity market. A sharp increase in the MSCI FM beta is related to investors adding Turkish equities to their portfolios. This is also supported by the historically high wedge between MSCI EM and MSCI FM betas at the time of the MSCI announcement.

Notably, the market betas are highly and positively correlated with R-squire statistics in the estimation period. At first glance, the higher synchronicity of BIST 100 with global benchmarks appears to be positively associated with the systematic risk exposure of BIST 100. A plausible explanation for this is that a reasonable degree of integration of the market is expected for the global betas to be informative. In the case of Turkey, the higher synchronicity periods produce "reasonable" beta values, as should be expected in the context of the Global CAPM, which, in its pure form, assumes that the markets are perfectly integrated with the rest of the world. The dominance of idiosyncratic (and imperfectly diversifiable) county risk in the state of relative market segmentation depresses valuations which eventually attracts portfolio investors, whose active positions drive up synchronicity and make global betas more informative. Although it is perfectly possible for the Turkish market to have a higher contribution to the risk of the frontier market portfolio relative to the emerging market portfolio, as in 2020, the trajectory of the betas suggests that the flow of funds across asset classes also appears to play a significant role. The dramatic fall of the beta with respect to the S&P 500 from about 1.5 in 2015 to nearly zero in 2018 and back to about one by the end of 2021, with the accompanying fall and rise of synchronicity providers, further supports this insight.

Overall, our results on the country beta cast a shadow of doubt on the robustness of the country beta approach suggested by Harvey (1991) and utilised in many subsequent academic works and practical applications (e.g., capital budgeting) to measure country risk. In fact, the issues with country betas and their ability to proxy country risk have been acknowledged in the literature.

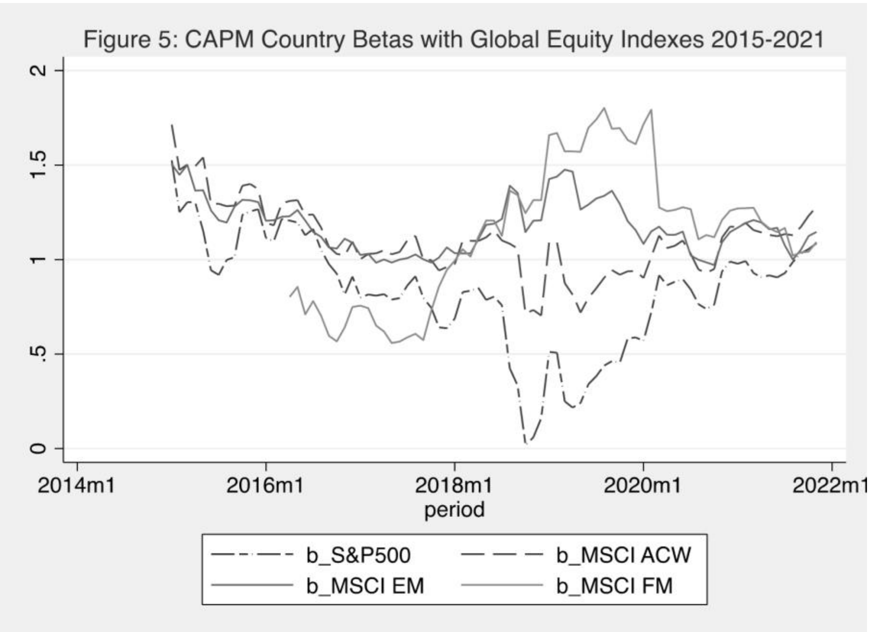


Figure 9: CAPM Country Betas with Global Equity Indexes 2015-2021

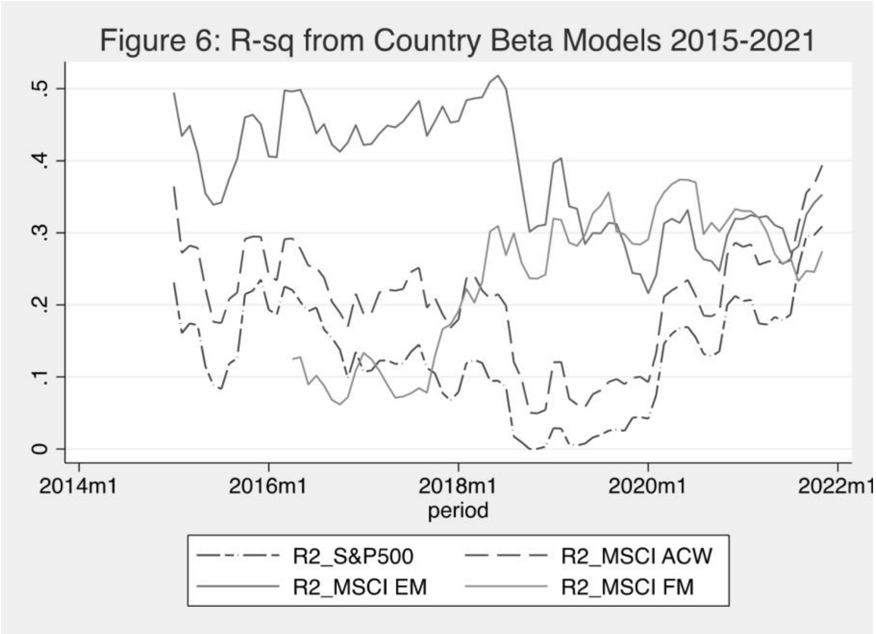


Figure 10: R-sq from Global Equity Indexes 2015-2021

The evolution of Turkish equity market beta concerning global benchmarks is not a meaningful proxy of country risk in a globally diversified portfolio when the degree of market integration varies significantly over time. The equity risk premium produced using Global CAPM for Turkey at the end of 2021 would look very low in the country with 20% yields on 1-year Treasury bonds, 5% sovereign US$ CDS spreads, and an unstable economic outlook.

Conclusions

This paper is a novel attempt to re-examine the time-varying efficiency of the Turkish equity market, particularly using an opportunity recently presented when Turkey faced the potential downgrade by MSCI from the emerging to the frontier market status.

Our results for Turkey appear to be consistent with the results for other emerging markets going through reversals in the degree of the market and the overall economic integration with the rest of the world (Nivorozhkin & Castagneto-Gissey, 2016). The decrease in the market betas of the Turkish market from the historical highs is unlikely to signal a reduction in exposure to systematic risk. It is more likely to be related to a prolonged decline in the market sentiment and a significant decrease in the degree of Turkish market integration.

Our results also appear to provide anecdotal support to "the inelastic markets hypothesis", implying that flows in and out of the market could significantly impact prices and risk premia (Gabaix & Koijen, 2021). It is unlikely that the riskiness of the Turkish market could be adequately captured in the conventional multifactor model framework. The explanatory power and the betas of the models appear to be affected by institutional investors' positions (or the lack of such). For example, the Turkish market beta with respect to MSCI FM reached its historical maximum about a year before the MSCI Market Classification Review for 2020 after exceeding the betas with respect to the MSCI EM index from the beginning of 2018. The dispersion across the two betas remained high during 20018-20 and decreased substantially in the following periods when the risk of reclassification subsided. Clearly, a higher beta with respect to the Frontier than with the Emerging market index is perhaps not a distorted reflection of the relative riskiness of the two asset classes but rather a reflection of the index informativeness. It is very likely that the institutional investor positions in the Turkish equity market fluctuated significantly during the studied sample period, and so did the informativeness of the return series. The interest in the Turkish market from the perspective of global portfolio diversification has been gradually decreasing due to a small and decreasing capitalisation weight of the Turkish market in the globally diversified portfolio and the lack of feasible investment strategies. All of the abovementioned factors impose limits on arbitrage strategies with negative consequences for market efficiency.

Our results clearly illustrate the likely effect of institutional investment flows on market betas. The evolution of Turkish equity market beta estimated with respect to global benchmarks and analysed in this paper does not appear to be a meaningful proxy of a country's risk in a globally diversified portfolio when the degree of market integration varies significantly over time.

References

- Abadir, K. M & Distaso, W. (2007): Testing joint hypotheses when one of the alternatives is one-sided. *Journal of Econometrics*, Vol 140(2), p. 695–718.
- Abar, H. (2022). An analysis of causal relationship between economic growth and financial development for Turkey: A MODWT—Granger causality test. *Economics and Business Review*, *8*(3), 59-81.
- Abdmoulah, W., (2010). Testing the evolving efficiency of Arab stock markets. *International Review of Financial Analysis*, *19*(1), pp.25-34.
- Afego, P.N., (2017). Effects of changes in stock index compositions: A literature survey. *International Review of Financial Analysis*, 52, pp.228-239.
- Aga, M. & Kocaman, B. (2011): Efficient Market Hypothesis and Emerging Capital Markets: Empirical Evidence from Istanbul Stock Exchange. *Journal of Financial Markets Research*, Vol 3, p. 44-57.
- Aga, M., & Kocaman, B. (2006). An empirical investigation of the relationship between inflation, P/E ratios and stock price behaviors using a new series called Index-20 for Istanbul Stock Exchange. *International Research Journal of Finance and Economics*, *6*(3), 133-165.
- Aga, M., and Kocaman, B., (2008). Efficient market hypothesis and emerging capital markets: empirical evidence from Istanbul stock exchange. *International Research Journal of Finance and Economics*, 13(1), 131-144.
- Aksu, M.H. and Onder, T., (2003). The size and book-to-market effects and their role as risk proxies in the Istanbul stock exchange. *Available at SSRN 250919*.
- Al-Jafari, M. K., (2013). The random walk behavior and weak-form efficiency of the Istanbul Stock Market 1997-2011: empirical evidence. *International Journal of Management*, 30(3), 169.
- Al-Loughani, N., Chappell, D., (1997). On the validity of the weak-form efficient markets hypothesis applied to the London Stock Exchange. *Appl. Finance. Econ*. 7, 173–176.
- Al-Nahlehb, M., Al-Zaubia, K. (2010). Financial Markets Efficiency: Empirical Evidence from some Middle East and North Africa Countries. International Research *Journal of Finance and Economics*, Vol. 49, p. 172–184.
- Alexeev, V., Tapon, F., (2011). Testing weak form efficiency on the Toronto Stock Exchange. *J. Empir. Financ*. 18, 661–691.

- Aloui, C., (2005). Long-range dependence in daily volatility on Tunisian stock market. *Economic Research Forum Working Paper* 40, 3–25.
- Alparslan, S. M. (1989). *Tests of weak form efficiency in Istanbul Stock Exchange*. Unpublished MBA Thesis, Bilkent University, Ankara, Turkey. [On-line]. Available: www.bilkent.edu.tr.
- Alquist, R., Israel, R. and Moskowitz, T., (2018). Fact, fiction, and the size effect. *The Journal of Portfolio Management*, 45(1), pp.34-61.
- Amihud, Y; H. Mendelson. (1986). “Asset pricing and the bid–ask spread.” *Journal of Financial Economics*, Vol. 17, No. 2, pp. 223–249
- Andrade, J. and Teles, V.K., (2006). An empirical model of the Brazilian country risk--an extension of the beta country risk model. *Applied Economics*, 38(11), pp.1271-1278.
- Antoniou, A., Ergul, N. & Holmes, P. (1997): Market efficiency, thin trading and non-linear behaviour: evidence from an emerging market. *European Financial Management*, Vol 3(2), p. 175-190.
- Arbel, A; P. Strebel. (1982). “The Neglected and Small Firm Effects”. *Financial Review*, Vol. 17, No. 4, pp. 201-218
- Asparouhova, E., Bessembinder, H. and Kalcheva, I., (2013). Noisy prices and inference regarding returns. *The Journal of Finance, 68*(2), pp.665-714.
- Aybar, C. B. (1992). *Descriptive analysis of stock return behavior in an emerging equity market: the case of Turkey*. The Ohio State University.
- Bailey, W. and Jagtiani, J., (1994). Foreign ownership restrictions and stock prices in the Thai capital market. *Journal of financial Economics*, 36(1), pp.57-87.
- Balaban E., Candemir B. Kunter K., (1996). "Istanbul Menkul Kiymetler Borsasi'nda Aylik Dalgalanma Tahmini," *Discussion Papers 9609*, Research and Monetary Policy Department, Central Bank of the Republic of Turkey.
- Balaban, E. (1995) Informational Efficiency of the Istanbul Securities Exchange and Some Rationale for Public Regulation. The Central Bank of the Republic of Turkey, *Discussion Paper No: 9502*, p.1-27.
- Balaban, E. (1995). Day of the week effects: New evidence from an emerging stock market. *Applied Economics Letters*, 2, 139–143.
- Balaban, E. & Kunter, K. (1999): A note on the efficiency of financial markets in a developing country. *Applied Economics Letters,* Vol 4(2), p. 109-112.

- Balkiz, O. (2003). Testing informational market efficiency on Kuala Lumpur stock exchange. *Jurnal Ekonomi Malaysia*, *37*(3), 3-20.
- Ball, R.; Brown, P. (1968). "An Empirical Evaluation of Accounting Income Numbers" *Journal of Accounting Research*, Vol. 6, No. 2, pp 159-178
- Banz, R. W. (1981). "The Relationship Between Return and Market Value of Common Stocks" *Journal of Financial Economics*, Vol. 9, No. 1, pp 3-18
- Basu, S. (1977). "Investment Performance of Common Stocks in Relation to Their Price- Earnings Ratios: A Test of the Efficient Market Hypothesis" *The Journal of Finance*, Vol. 32, No.3, pp 663-682
- Beechey, M., Gruen, D., Vickery, J., (2000). The Efficient Market Hypothesis: A Survey. *Research Discussion Paper No. 2000-01*. Reserve Bank of Australia.
- Benartzi, S.; R. Thaler. (1985). "Myopic Loss Aversion and The Equity Premium Puzzle" *The Quarterly Journal of Economics*, Vol.110, No.1, pp 73-92
- Bernard, V. L., Thomas, J. K., (1990). Evidence that stock prices do not fully reflect the implications of current earnings for future earnings, *Journal of Accounting and Economics*, Vol 13, pp. 305-340.
- Bernard, V. L.; J. K. Thomas. (1989). "Post-Earnings-Announcement Drift: Delayed Price Response or Risk Premium?" *Journal of Accounting Research*, Vol. 27, pp. 1-36.
- Birau, F. R., (2013). Emerging capital market efficiency: a comparative analysis of weak-form efficiency in Romania and Hungary in the context of the global financial crisis, *Al & Soc*, Springer.
- Black, F. (1986). "Noise". *Journal of Finance*. Vol.41, No.3, pp. 529-543
- Blavy, R. (2006). Public debt and productivity: the difficult quest for growth in Jamaica.
- Blume, M.E. and Friend, I., (1974). Risk, investment strategy and the long-run rates of return. *The Review of Economics and statistics*, pp.259-269. Blume, M.E. and Friend, I., 1974. Risk, investment strategy and the long-run rates of return. *The Review of Economics and statistics*, pp.259-269.
- Blume, M.E. and Stambaugh, R.F., (1983). Biases in computed returns: An application to the size effect. *Journal of Financial Economics*, *12*(3), pp.387-404.
- Bodie, Z.; A. Kane.; A.J. Marcus. (2007). *Essentials of investments*, 6th edition, McGraw- Hill / Irwin.
- Borges, M. (2010): Efficient market hypothesis in European stock markets. *The European Journal of Finance*, Vol 16(7), p. 711-726.

- Brealey, R. A.; S. C. Myers.; A. J. Marcus. (1999). *Fundamentals of Corporate Finance*, 2nd edition, McGraw-Hill.
- Brisset, Nicolas. (2017). Models as Speech Acts: The Telling Case of Financial Models. *Journal of Economic Methodology, 25*(1), 21-41. DOI : 10.1080/1350178X.2018.1419105
- Brown, P., Kleidon, A.W. and Marsh, T.A., (1983). New evidence on the nature of size-related anomalies in stock prices. *Journal of Financial Economics*, *12*(1), pp.33-56.
- Buguk, C., & Brorsen, B. W., (2003). Testing weak-form market efficiency: Evidence from the Istanbul Stock Exchange. *International review of financial analysis*, 12(5), 579-590.
- Burnham, T.C., Gakidis, H. and Wurgler, J., (2018). Investing in the presence of massive flows: The case of MSCI country reclassifications. *Financial Analysts Journal*, 74(1), pp.77-87.
- Burton G. M, (2003), The Efficient Market Hypothesis and Its Critics, *Journal of Economic Perspectives*—Volume 17, Number 1Pages 59–82.
- Butler, K. C., & Malaikah, S. J. (1992). Efficiency and inefficiency in thinly traded stock markets: Kuwait and Saudi Arabia. *Journal of Banking and Finance*, 16, 197–210.
- Campbell, J. Y.; R. J. Shiller. (1988). "Stock Prices, Earnings and Expected Dividends, *The Journal of Finance*, Vol. 43, No.3, pp 661-676
- Çelik, T. & Taş, O. (2007): Etkin Piyasa Hipotezi ve Gelişmekte Olan Hisse Senedi Piyasaları. *İTÜ Dergisi*, Vol 4(2), p. 11-22.
- Çevik, E. (2012): İstanbul Menkul Kıymetler Borsası'nda Etkin Piyasa Hipotezinin Uzun Hafıza Modelleri ile Analizi: Sektörel Bazda Bir İnceleme. *Journal of Yaşar University*, Vol 26(7), p. 4437-4454.
- Challe, Édouard. (2008). Valeur fondamentale et efficacité informationnelle. In Eric Brian and Christian Walter (eds), *Critique de la valeur fondamentale*, 25-54.
- Chambers, Nurgül. (2006). "The creation, development and operation of the Istanbul Stock Exchange." *Journal of Financial Analysis*. Published by the Istanbul Chamber of Certified Public Accountants.
- Charles, A., Darne, O. (2009). Variance ratio tests of random walk: an overview. *Journal of Economic Surveys*, Vol. 23, issue. 3, p. 503–527.

- Charron, Jacques-Olivier. (2016). Inefficient Debate. The EMH, the 'Remarkable Error' and a Question of Point of View. ResearchGate, January. DOI : 10.1515/ael-2015-0021
- Chaudhuri, K.,Wu, Y., (2003). Random walk versus breaking trend in stock prices: evidence from emerging markets. *J. Bank. Finance*. 27, 575–592.
- Cheung, K.-C., Coutts, J.A., (2001). A note on weak form market efficiency in security prices: evidence from the Hong Kong Stock Exchange. *Appl. Econ*. Lett. 8, 407–410.
- Cheung, Y. W., & Lai, K. S. (1993). A fractional cointegration analysis of purchasing power parity. *Journal of Business and Economics Statistics*, 11, 103–112.
- Chiş, D.M., (2012). Testing the martingale difference hypothesis in the European emerging unit-linked insurance markets. *Procedia Economics and Finance*, *3*, pp.49-54.
- Chordia, T, Asani S, and Avanidhar S., (2005) "An empirical analysis of stock and bond market liquidity." *The Review of Financial Studies* 18, no. 1 85-129.
- Chu, Y., Hirshleifer, D. and Ma, L., (2020). The causal effect of limits to arbitrage on asset pricing anomalies. *The Journal of Finance*, 75(5), pp.2631-2672.
- Conrad, J. and Kaul, G., (1993). Long-term market overreaction or biases in computed returns? *The Journal of Finance*, *48*(1), pp.39-63.
- Cooney, D., (2018). Public Equity Reclassification Events in Emerging and Frontier Market Indexes : An Investigation of MSCI Indexes in International Markets, Senior Thesis in Mathematical Methods in the Social Sciences submitted at Northwestern University (Advisor: Professor Robert Korajczyk). Available at https://tinyurl.com/yf3a794x .
- Cowles III (1944). "Stock Market Forecasting?" *Econometrica*, Vol.12, No. 3/4, pp. 206-214
- Cowles III, A. (1933). "Can Stock Market Forecasters Forecast?" *Econometrica*, Vol.1, No. 3, pp. 309-324
- D'ambrosio, U., & Brasil, S. P. (1980). Mathematics and society: Some historical considerations and pedagogical implications. *International Journal of Mathematical Educational in Science and Technology*, *11*(4), 479-488.
- Damodaran, A., (2021). *Equity Risk Premiums (ERP): Determinants, Estimation, and Implications – The 2021 Edition* (March 23, 2021). Available at SSRN: https://ssrn.com/abstract=3825823 or http://dx.doi.org/10.2139/ssrn.3825823

- Datastream International. (2023). Available: Refinitiv Workspace.
- De Bondt, W. F., & Thaler, R. H. (1987). Further evidence on investor overreaction and stock market seasonality. *The Journal of finance*, *42*(3), 557-581.
- De Long, B. J.; A. Shleifer.; L. H. Summers.; R. J. Waldman. (1990). "Noise Trader Risk in Financial Markets", *Journal of Political Economy*, Vol.98, No.4, pp. 703- 738
- De Moor, L., Van den Bossche, F., Verheyden, T. (2013). A tale of market efficiency. *HUB Research Paper Series*, Vol. 5.
- Degutis, A. and Novickytė L. (2014.) The Efficient Market Hypothesis: a critical review of literature and methodology, *Ekonomika* 2014 Vol. 93 (2):7-23.
- Demirer, R., & Karan, M. B. (2002). An investigation of the day-of-the-week effect on stock returns in Turkey. *Emerging Markets Finance & Trade*, 47-77.
- Dickey, D., & Fuller, W. (1979). Distributions of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 75, 427–431.
- Dickinson, J. P., & Muragu, K. (1994). Market efficiency in developing countries: A case study of the Nairobi Stock Exchange. *Journal of Business Finance & Accounting*, *21*(1), 133-150.
- Diebold, F. X., & Rudebusch, G. D. (1991). On the power of Dickey–Fuller tests against fractional alternatives. *Economics Letters*, 35, 155–160.
- Dimson, E., Marsh, P. and Staunton M., (2021). *Credit Suisse Global Investment Returns Yearbook 2021 – Summary Edition*, Credit Suisse Research Institute, March 2021.
- Dimson, E., Marsh, P., and Staunton M., (2017). Credit Suisse Global Investment Returns Yearbook 2017 - Slide Deck, Credit Suisse Research Institute, February 2017.
- Dimson, E., Mussavian, M. (2000). Market Efficiency. *The Current State of Business Disciplines*, Vol. 3, p. 959–970.
- Dimson, E.; M. Mussavian. (1998). "A Brief History of Market Efficiency". *European Financial Management*. Vol. 4, No. 1, pp. 91-103.
- Duman Atan, S., Özdemir, Z. & Atan, M. (2009): Hisse Senedi Piyasasında Zayıf Formda Etkinlik: İMKB Üzerine Ampirik Bir Araştırma. Dokuz Eylül Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, Vol 24(2), p. 33-48.
- Ekrem Tufan and Bahattin Hamarat, (2004) Do Cloudy Days Affect Stock Exchange Returns: Evidence from Istanbul Stock Exchange, *Journal of Naval Science and Engineering* Vol. 2, No.1, pp. 117-126.

- El-Erian, M. A., & Kumar, M. S. (1995). Emerging equity markets in Middle Eastern countries. *Staff Papers*, *42*(2), 313-343.
- Elliott, A., Rothenberg, T. J., & Stock, J. H. (1996). Efficient tests for an autoregressive unit root. *Econometrica,* 64, 813–836.
- Engle, R.F., and Granger, C.W. (1987), "Cointegration and error correction: Representation, estimation, and testing", *Econometrica* 55, 251-276.
- Erb, C.B., Harvey, C.R. and Viskanta, T.E., (1996). Political risk, economic risk, and financial risk. *Financial Analysts Journal*, 52(6), pp.29-46.
- Ergül, N. (2009): Ulusal Hisse Senetleri Piyasası'nda Etkinlik. Yönetim Bilimleri Dergisi, Vol 7(1), p. 101-117.
- Erol, C., F. Baklaci, H., Aydoğan, B., & Tunç, G. (2014). Performance comparison of Islamic (participation) banks and commercial banks in Turkish banking sector. *EuroMed Journal of Business*, *9*(2), 114-128.
- Errunza, V. and Losq, E., (1985). International asset pricing under mild segmentation: Theory and test. *The Journal of Finance*, 40(1), pp.105-124.
- Estrada, J., (2009). Black swans in emerging markets. *The Journal of Investing,* 18(2), 50-56.
- Fama, E (1991). "Efficient Capital Markets: II". *Journal of Finance*, Vol. 46, No. 5, pp. 1575-1617
- Fama, E, K. R. French. (1988). "Dividend Yields and Expected Stock Returns" *Journal of Financial Economics*, Vol.22, No.1, pp 3-25.
- Fama, E., (1965). "Random Walks in Stock Market Prices", *Selected Papers.* No.16, University of Chicago.
- Fama, E., (1965). "The Behavior of Stock-Market Prices." *The Journal of Business,* Vol. 38, No.1, pp. 34-105
- Fama, E., (1970). "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance,* Vol. 25, No. 2, pp. 383-417.
- Fama, E., (1998). Market efficiency, long-term returns, and behavioural finance, *Journal of Financial Economics* 49, 283–306.
- Fama, E., and K. French, (1988). Permanent and temporary components of stock prices, *Journal of Political Economy* 96, 246–273.
- Fama, Eugene F.; MacBeth, James D., (1973). "Risk, Return, and Equilibrium: Empirical Tests". *Journal of Political Economy*, 81(3), pp. 607–636.

- Fichtner, J., Heemskerk, E. and Petry, J., (2021). The new gatekeepers of financial claims: States, passive markets, and the growing power of index providers, forthcoming in
- Finnet (2000) Plus I; Retrieved October 30, 2019, from http://www.finnet.com.tr/f2000plus
- Fluck, Z., Malkiel, B., Quandt, R., (1997). The predictability of stock returns: a cross-sectional simulation, *Review of Economics and Statistics*, Vol. 79, No. 2, pp. 176-183;
- Foster, G., Olsen, C., Shevlin, T., (1984). Earnings release, anomalies, and the behavior of security returns, *The Accounting Review*, Vol. 59, No. 4;
- French, K.R., (2008). Presidential address: The cost of active investing. *The Journal of Finance*, 63(4), pp.1537-1573.
- Gabaix, Xavier and Koijen, Ralph S. J., (2021). In Search of the Origins of Financial Fluctuations: The Inelastic Markets Hypothesis (June 11, 2021). *Swiss Finance Institute Research Paper* No. 20-91, Available at http://dx.doi.org/10.2139/ssrn.3686935
- Gangemi, M.A., Brooks, R.D. and Faff, R.W., (2000). Modeling Australia's country risk: a country beta approach. *Journal of Economics and Business*, 52(3), pp.259-276.
- Geweke, J., & Porter-Hudak, S. (1983). The estimation and application of long memory time-series models. *Journal of Time Series Analysis*, 4, 221–238.
- Gozbasi, O., Kucukkaplan, I., & Nazlioglu, S., (2014). Re-examining the Turkish stock market efficiency: Evidence from nonlinear unit root tests. *Economic Modelling*, 38, 381-384.
- Graham Smith (2012) The changing and relative efficiency of European emerging stock markets, *The European Journal of Finance*, 18:8, 689-708
- Granger, C. & Morgenstern, O. (1962): Spectral Analysis of New York Stock Market Prices. *Econometric Research Program Research Memorandum* No. 45, 1-31.
- Grieb, T. A., & Reyes, M. G. (1999). Random walk tests for Latin American equity indexes and individual firms. *Journal of Financial Research*, 22, 371–383.
- Grossman, S. J., & Stiglitz, J. E. (1980). On the impossibility of informationally efficient markets. *The American Economic Review*, 70(3), 393-408.
- Guerrien, B. and Ozgur Gun, (2011) Efficient Market Hypothesis: What are we talking about? *Real-world economics review*, issue no. 56.
- Güner, N. and Önder, Z., (2002). Information and volatility: Evidence from an emerging market. *Emerging Markets Finance & Trade*, pp.26-46.

- Haddad, V., Huebner, P. and Loualiche, E., (2021). How Competitive is the Stock Market? Theory, Evidence from Portfolios, and Implications for the Rise of Passive Investing (April 7, 2021). Available at http://dx.doi.org/10.2139/ssrn.3821263
- Harrison, J. M., & Kreps, D. M. (1979). Martingales and arbitrage in multiperiod securities markets. *Journal of Economic Theory*, 20(3), 381-408. http://dx.doi.org/10.1016/0022-0531(79)90043-7
- Harvey, C. (1993). *Portfolio investment using emerging markets and conditioning information*. Washington, DC: World Bank. Working paper.
- Harvey, C.R. and Zhou, G., (1993). International asset pricing with alternative distributional specifications. *Journal of Empirical Finance*, 1(1), pp.107-131.
- Harvey, C.R., (1991). The world price of covariance risk. *The Journal of Finance*, 46(1), pp.111-157.
- Harvey, D.I., Leybourne, S.J., Xiao, B., (2008). A Powerful Test for Linearity When the Order of Integration is Unknown. Studies in Nonlinear Dynamics & Econometrics, 12. Berkeley Electronic Press 1–24.
- Hasanov, M., Omay, T., (2007). Are the transition stock markets efficient? Evidence from nonlinear unit root tests. (Online) *Cent. Bank Rev*. (ISSN: 1305-8800) 7, 1–12.
- Hasanov, M., Omay, T., (2008). Nonlinearities in emerging stock markets: evidence from Europe's two largest emerging markets. *Appl. Econ*. 40, 2645–2658.
- Hietala, P.T., (1989). Asset pricing in partially segmented markets: Evidence from the Finnish market. *The Journal of Finance*, 44(3), pp.697-718.
- Hirshleifer, D., Hsu, P. H., Li, D., (2013). Innovative efficiency and stock returns, *Journal of Financial Economics*, Vol. 107, pp. 632–654;
- Hoque, H., Kim, J. & Pyun, C. (2007): A comparison of variance ratio tests of random walk: A case of Asian emerging stock markets. *International Review of Economics and Finance*, Vol 16, p. 488-502.
- Hsieh, D.A., (1991). Chaos and nonlinear dynamics: application to financial markets. *J. Finance*. 46, 1839–1877.
- Huang, R.D. and Stoll, H.R., (1996). Dealer versus auction markets: A paired comparison of execution costs on NASDAQ and the NYSE. *Journal of Financial economics*, *41*(3), pp.313-357.
- Huber, P. (1997). Stock market returns in thin markets: Evidence from the Vienna Stock Exchange. *Applied Financial Economics*, 7, 493–498.

- Inci, A.C., (2018). Financials sector intraday volatility characteristics in the emerging Turkish economy. *Eurasian Economic Review*, 8, pp.215-229.
- Jagric, T. Boris Podobnik, and Marko Kolanovic (2005) Does the Efficient Market Hypothesis Hold? Evidence from Six Transition Economies, *Eastern European Economics*, 43:4, 79-103.
- Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of finance*, *48*(1), 65-91.
- Jennengren L. and Krosvold, P., (1975), *The random character of Norwegian Swedish market prices*, in E. Elton and M. Gruber eds., International Capital Markets (North-Holland, Amsterdam), 37-54
- Jin, L. and Myers, S.C., (2006). R2 around the world: New theory and new tests. *Journal of financial Economics,* 79(2), pp.257-292.
- Johansen, S. (1988), "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control*, 231-254.
- Johansson, A.C., (2009a). An analysis of dynamic risk in the Greater China equity markets. *Journal of Chinese Economic and Business Studies,* 7(3), pp.299-320.
- Johansson, A.C., (2009b). Stochastic volatility and time-varying country risk in emerging markets. *The European Journal of Finance*, 15(3), pp.337-363.
- Kadioglu, E., (2021). Intraday analysis of regulation change in microstructure: evidence from an emerging market. *International Journal of Emerging Markets*, (ahead-of-print).
- Kahneman, D., & Tversky, A. (1979). *On the interpretation of intuitive probability:* A reply to Jonathan Cohen.
- Kan, D. & O'Callaghan, B. (2007): Examination of the efficient market hypothesis-the case of post-crisis Asia Pacific countries. *Journal of Asian Economics*, Vol 18, p. 294-313.
- Kapetanios, G., Shin, Y. & Snell, A. (2003): Testing for a unit root in the nonlinear STAR framework. *Journal of Econometrics,* Vol 112(2), p. 359–379.
- Kapusuzoglu, A. (2013) Testing Weak Form Market Efficiency on the Istanbul Stock Exchange (ISE), *Int.J.Buss.Mgt.Eco.Res.,* Vol 4(2) ,700-705
- Karacaer, S., Kapusuzoğlu, A. & Bozkurt, F. (2010): From the Anomalies of the Days of the Week Point of View Testing of the Validity of Efficient Market Hypothesis:

Evidence from Istanbul Stock Exchange. *Banking and Finance Letters*, Vol 2(1), p. 215-221.

- Karolyi, G.A. and Stulz, R.M., (2003). Are financial assets priced locally or globally?. *Handbook of the Economics of Finance*, 1, pp.975-1020.
- Kasman A. and Torun E., (2007) Long Memory in the Turkish Stock Market Return and Volatility, *Central Bank Review* 2 13-27.
- Kasman, A. & Kırkulak, B. (2007): Türk Hisse Senedi Piyasası Etkin mi? Yapısal Kırılmalı Birim Kök Testlerinin Uygulanması. *İktisat İşletme ve Finans*, p. 68-78.
- Kavussanos, M.G., Dockery, E., (1996). Testing the efficient market hypothesis using panel data, with application to the Athens stock market. *Appl. Econ. Lett*. 3, 121–123.
- Kawakatsu, H., Morey, M.R., (1999). An empirical examination of financial liberalization and the efficiency of emerging market stock prices. *Journal of Financial Research* 22(4), 385-411.
- Keynes, John Maynard, (1936), *The General Theory of Employment*, Interest and Money. London: Macmillan
- Khandaker, S., (2011). R Squared Measure of Stock Synchronicity. *International Review of Business Research Papers*, 7(1), pp.165-175.
- Kiliç, Y. and Mehmet B, (2016) The Efficient Market Hypothesis: Evidence from Turkey, *International Journal of Academic Research in Business and Social Sciences*, Vol. 6, No. 10.
- Kim, J. H., Shamsuddin, A. (2008). Are Asian stock markets efficient? Evidence from new multiple variance ratio tests. *Journal of Empirical Finance*, Vol. 15, p. 518–532.
- Kim, M., Nelson, C. & Startz, R. (1991): Mean Reversion in Stock Prices? A Reappraisal of the Empirical Evidence. *The Review of Economic Studies*, Vol 58(3), p. 515-528.
- Konak, F., Seker, Y., (2014). The Efficiency of Developed Markets: Empirical Evidence from FTSE 100", *Journal of Advanced Management Science*, Vol. 2, No. 1;
- Kondak, N. E. (1997). "The Efficient Market Hypothesis Revisited: Some Evidence from the Istanbul Stock Exchange." *Capital Board of Turkey*. No.83
- Kruse, R. (2011): A new unit root test against ESTAR based on a class of modified statistics. *Statistical Papers*, Vol 52(1), p. 71–85.

- Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., & Shen, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*, 54, 159–178.
- Kyle, A.S. (1988): “Trading halts and price limits”, *Review of Futures Markets*, 10, 136-175.
- Lagoarde-Segot, T., & Lucey, B. M. (2008). Efficiency in emerging markets—Evidence from the MENA region. *Journal of International Financial Markets, Institutions and Money*, *18*(1), 94-105.

- Lagoarde-Segot, T., & Lucey, B. M. (2008). Efficiency in emerging markets—Evidence from the MENA region. *Journal of International Financial Markets, Institutions and Money*, *18*(1), 94-105.

- Lakonishok, J.; A. Shleifer.; R. Vishny. (1994). “Contrarian Investment, Extrapolation, and Risk” *Journal of Finance*, Vol. 49. No. 5, pp. 1541-1578
- Leroy, S. F.; R. D. Porter. (1981). “The Present Value Relation: Tests Based on Implied Variance Bounds” *Econometrica*, Vol.49, No.3, pp 555-574.
- LeRoy, Stephen F. (1989). Efficient Capital Markets and Martingales. *Journal of Economic Literature*, 27(4): 1583-1621.
- Lesmond, D. A., J. P. Ogden, and C. A. Trzcinka. (1999). A New Estimate of Transaction Costs. *Review of Financial Studies* 12:1113–41.
- Lim, K. P., and Brooks, R. (2011). The evolution of stock market efficiency over time: A survey of the empirical literature. *Journal of Economic Surveys*, 25(1), 69-108.
- Lim, K.P. and Luo, W., (2012). The weak-form efficiency of Asian stock markets: New evidence from generalized spectral Martingale test. *Applied Economics Letters*, *19*(10), pp.905-908.
- Lim, K.P., Brooks, R., (2011). The evolution of stock market efficiency over time: a survey of the empirical literature. *J. Econ. Surv*. 25, 69–108.
- Lim, K.P., Liew, V.K.S., (2007). Nonlinear mean reversion in stock prices: evidence from Asian markets. *Appl. Finance. Econ*. Lett. 3, 25–29.
- Liu, C. Y., & He, J. (1991). A variance-ratio test of random walks in foreign exchange rates. *Journal of Finance*, 46, 773–785.
- Liu, C. Y., Song, S. H., & Romilley, P. (1997). Are Chinese stock markets efficient? A cointegration and causality analysis. Applied Economic Letters, 4, 511–515.

- Ljung, G.M. and Box, G.E., (1978). On a measure of lack of fit in time series models. *Biometrika*, *65*(2), pp.297-303.
- Lo, A. W. (2004). The adaptive markets hypothesis. *The Journal of Portfolio Management*, *30*(5), 15-29.
- Lo, A.W. (2004) The adaptive markets hypothesis: market efficiency from an evolutionary perspective. *Journal of Portfolio Management*
- Lo, A.W. (2005) Reconciling efficient markets with behavioral finance: the adaptive markets hypothesis. *Journal of Investment Consulting* 7(2): 21–44.
- Lo, A.W. and A.C. MacKinlay, (1999). *A Non-Random Walk Down Wall Street* (Princeton University Press, Princeton).
- Lo, A.W. and A.C. MacKinlay,(1988). Stock Market Prices Do Not Follow Random Walks: Evidence from a Simple Specification Test. *The Review of Financial Studies*, Vol 1(1), p. 41-66.
- Lo, A.W. and A.C. MacKinlay,(1989) The size and power of the variance ratio test in finite samples: A Monte Carlo investigation. *Journal of Econometrics*, Vol 40(2), p. 203-238.
- Lo, A.W. and MacKinlay, A.C., (1988). Stock market prices do not follow random walks: evidence from a simple specification test. *Review of Financial Studies* 1: 41–66.
- Lumsdaine, R. & Papell, D. (1997): Multiple Trend Breaks and the Unit-Root Hypothesis. *The Review of Economics and Statistics*, Vol 79(2), p. 212-218.
- Luukkonen, R., Saikkonen, P. & Teräsvirta, T. (1988): Testing linearity against smooth transition autoregressive models. *Biometrika*, Vol 75(3), p. 491–499.
- Malkiel, B.G., (2011). The efficient-market hypothesis and the financial crisis. Rethinking Finance: Perspectives on the Crisis (*Proceedings of a Conference*). Russel Sage Foundation.
- Malkiel, B.G., (1973). *A Random Walk Down Wall Street* (W.W. Norton & Co., New York).
- Malkiel, B.G., (2003). The efficient market hypothesis and its critics, *Journal of Economic Perspectives* 17, 59–82.
- Malkiel, B.G., (2005). “Reflections on the Efficient Market Hypothesis: 30 Years Later” *The Financial Review* 40 (2005) 1-9.
- Marsh, P., (1979). Equity Rights Issues and the Efficiency of the UK Stock Market, *The Journal of Finance*, Vol. 34, No. 4, pp. 839-862.

- Marshall, B., Visaltanachoti, N. (2010). The other January effect: evidence against market efficiency? *Journal of Banking & Finance*, Vol. 34, issue. 10, p. 2413–2424.
- McCarthy, J.I., (2018). Benchmarking the World: A Proposal for Regulatory Oversight of Stock Market Index Providers. *Vanderbilt Journal of Transnational Law*, 51, pp. 1191-1240.
- McMillan, D.G., (2003) Non-linear predictability of UK stock market returns. Oxf. *Bull. Econ. Stat*. 65, 557–573.
- McMillan, D.G., (2005). Non-linear dynamics in international stock market returns. *Rev. Finance. Econ*. 14, 81–91.
- Michael, P., Nobay, A. R. & Peel, D. A. (1997): Transactions costs and nonlinear adjustment in real exchange rates; An empirical investigation. *Journal of Political Economy*, Vol 105(4), p. 862–879.
- Mobarek, A. and Angelo F, (2014) The prospects of BRIC countries: Testing weak-form market efficiency, *Research in International Business and Finance* 30 217– 232.
- Mobarek, A., & Keasey, K. (2000). Weak-form market efficiency of an emerging Market: Evidence from Dhaka Stock Market of Bangladesh. In *ENBS Conference held on Oslo* (pp. 1-30).
- Morck, R., Yeung, B. and Yu, W., (2000). The information content of stock markets: why do emerging markets have synchronous stock price movements?. *Journal of financial economics*, 58(1-2), pp.215-260.
- MSCI (2020) *MSCI Turkey IMI 25/50 index*. Available at: https://www.msci.com/documents/10199/2a599370-f52b-aad6-adb0-29e366bb9d4d (Accessed: March 28, 2023).
- MSCI, (2020). MSCI global market accessibility review. June 2020.
- MSCI, (2021). MSCI Turkey Index (USD) *Factsheet* (February 26, 2021).
- Munir, Q., Mansur, K., (2009). Is Malaysian stock market efficient? Evidence from threshold unit root tests. *Econ. Bull*. 29, 1359–1370.
- Muradoglu, G. (1991) "Factors influencing the stock demand of individual investors in Turkey", in: *Proceedings Izmir Iktisat Kongresi* 3, 1-17.
- Muradoglu, G. and Unal, M. (1994) Weak form of efficiency in the thinly traded Turkish stock exchange. *The Middle East Business and Economic Review*, 6, 37-44.
- Muradoglu, G., & Oktay, F. T. (1993). Calendar anomalies at Istanbul stock exchange. *Hacettepe University Faculty of Business Administration Journal*, *11*, 41-62.

- Muradoglu, Y. & Metin, K. (1996): Efficiency of the Turkish Stock Exchange with respect to monetary variables: A cointegration analysis. *European Journal of Operational Research*, Vol 90, p. 566-576.
- Müslümov, A., Aras, G. & Kurtuluş, B. (2003): Evolving Market Efficiency in Istanbul Stock Exchange. *Istanbul Technical University Selected Articles*, p. 1-19.
- Narayan, P., Narayan, S., Popp, S. & Ahmed, H. (2015): Is the efficient market hypothesis day-of-the-week dependent? Evidence from the banking sector. *Applied Economics*, Vol 47(23), p. 2359-2378.
- Narayan, P.K., (2005). Are the Australian and New Zealand stock prices nonlinear with a unit root? *Appl. Econ*. 37, 2161–2166.
- Narayan, P.K., (2006). The behaviour of US stock prices: evidence from a threshold autoregressive model. *Math. Comput. Simul*. 71, 103–108.
- Narayan, P.K., (2008). Do shocks to G7 stock prices have a permanent effect? Evidence from panel unit root tests with structural change. *Math. Comput. Simul*. 77, 369–373.
- Narayan, P.K., Smyth, R., (2004). Is South Korea's stock market efficient? *Appl. Econ. Lett*. 11, 707–710.
- Narayan, P.K., Smyth, R., (2005). Are OECD stock prices characterized by a random walk? Evidence from sequential trend break and panel data models. *Appl. Finance. Econ.* 15, 547–556.
- Newey, W.K. and West, K.D., (1986). A simple, positive semi-definite, heteroskedasticity and autocorrelationconsistent covariance matrix.
- Niederhoffer, V., & Osborne, M. (1966). Market making and reversal on the stock exchange. *Journal of the American Statistical Association*, 61, 897–916.
- Nivorozhkin, E. and Castagneto-Gissey, G., (2016). Russian stock market in the aftermath of the Ukrainian crisis. *Russian Journal of Economics*, 2(1), pp.23-40.
- Oktay Tas & Salim Dursunoglu, (2005). "Testing Random Walk Hypothesis For Istanbul Stock Exchange," International Trade and Finance Association Conference Papers 1035, *International Trade and Finance Association*.
- Önkal, D., & Muradoglu, G. (1996). Effects of task format on probabilistic forecasting of stock prices. *International Journal of Forecasting*, *12*(1), 9-24.
- Onur Gozbasi, Ilhan Kucukkaplan and Saban Nazlioglu. (2014). “Re-examining the Turkish stock market efficiency: Evidence from nonlinear unit root tests” *Economic Modelling* 38 381–384.

- Ooi, J.T. and Dung, D.D., (2019). Finding superior returns in green portfolios: Evidence from Singapore REITs. *Journal of Sustainable Real Estate*, *11*(1), pp.191-215.
- Osborne, M.F. (1959) "Brownian motion in the stock market", *Operations Research*, Vol. 7, No. 2, pp.145-173.
- Ozdemir, A.K., Yildiz, M.E. and Otluoglu, E., (2015). Time-varying country beta approach in modelling country risk of turkey. *Journal of Business Economics and Finance*, 4(4).
- Ozdemir, Z.A., (2008). Efficient market hypothesis: evidence from a small open economy. *Applied Economics* 40: 633–641.
- Ozer, G., Ertokatli, C., (2010). Chaotic processes of common stock index returns: an empirical examination on Istanbul Stock Exchange (ISE) market. *Afr. J. Bus. Manag*. 4, 1140–1148.
- Özmen, T., (1997), "Observed Anomalies in World Stock Markets and a Study on Istanbul Stock Exchange (in Turkish)" *Security Exchange Commission* Publishing, No: 61, Ankara.
- Panas, E. E. (1990). The behavior of Athens' stock prices. *Applied Economics*, 22, 715–727.
- Pasour, E.CV. (1989), "The Efficient-Market Hypothesis and Entrepreneurship," *Review of Austrian Economics* 3: 95-96.
- Petry, J., Fichtner, J. and Heemskerk, E., (2021). Steering capital: the growing private authority of index providers in the age of passive asset management. *Review of international political economy*, 28(1), pp.152-176.
- Pettit, R. R., Venkatesh P. C., (1995). Insider Trading and Long-Run Return Performance, *Financial Management* Nr. 24;
- Pisani, B., (2019). Active fund managers trail the S&P 500 for the ninth year in a row in triumph for indexing. CNBC.COM, Published on March 15, 2019, Updated March 15 2019..
- Pitel, L., (2020), Turkey faces threat of MSCI downgrade to 'frontier' market. F*inancial Times*, June 2020. Available at shorturl.at/dkAU5.
- Poterba, J. M., & Summers, L. H. (1988). Mean reversion in stock prices: Evidence and implications. *Journal of Financial Economics*, 22, 27–59.

- Raddatz, C., S., Schmukler, L. and Williams, T., (2017). International asset allocations and capital flows: The benchmark effect. *Journal of International Economics*, 108, pp. 413-430.
- Rapach, D. E. & Wohar, M. E. (2006): The out-of-sample forecasting performance of nonlinear models of real exchange rate behavior. *International Journal of Forecasting*, Vol 22(2), p. 341–361.
- RBCITS (2023) *Turkey - Profils du marché*, *RBCITS*. Available at: https://www.rbcits.com/fr/gmi/global-custody/market-profiles/market.page?dcr=templatedata%2Fglobalcustody%2Fmarketprofiles%2Fdata%2Fturkey (Accessed: March 28, 2023).
- Reinganum, M.R., (1982). A direct test of Roll's conjecture on the firm size effect. *The Journal of Finance*, *37*(1), pp.27-35.
- Revest, V, (1999), Structures de marché et évolutions des bourses de valeurs, *CREI, document de travail.*
- Roberts, H. (1959): Stock market patterns and financial analysis: Methodological suggestions. Journal of Finance, Vol 14(1), p. 1-10.
- Robertson, B. and Lam, E., (2019). UBS Sees $121 Billion of EM Flows Amid `Seismic' Index Shifts, BloombergQuint.com, Published on 11 Feb.
- Roll, R., (1984). A simple implicit measure of the effective bid-ask spread in an efficient market. *The Journal of finance*, 39(4), 1127-1139.
- Samuelson, P. (1965). Proof that properly anticipated prices fluctuate randomly. *Industrial Management* Review, 6, 41–49.
- Sarantis, N. (1999): Modelling non-linearities in real effective exchange rates. *Journal of International Money and Finance*, Vol 18(1), p. 27–45.
- Schwartz, R.A., (2021). A market microstructure view of the informational efficiency of security prices. *The Journal of Portfolio Management*, 47(8), pp.75-84.
- Schwert, G. W. (2003). *Anomalies and market efficiency*. In Constantinides, G. M., Harris, M., and Stulz, R. M., editors, Handbook of the Economics of Finance: Volume 1B, Financial Markets and Asset Pricing, volume 21 of Handbooks in Economics, chapter 15, pp. 937-972. Elsevier North-Holland, Amsterdam.
- Serkan S, Emre E Topaloglu E, Ilhan E, (2018) January Effect Revisited: Evidence from Borsa Istanbul and Bucharest Stock Exchange, *International Journal of Economics and Finance*; Vol. 10, No. 1;

- Sewell, M. (2011). *History of the efficient market hypothesis*. Research Note RN/11/04, University College London, London.
- Sewell, M. (2012). “The Efficient Market Hypothesis: Empirical Evidence” *International Journal of Statistics and Probability*; Vol. 1, No. 2; 2012, 164-178.
- Shiller, R. (1981). “Do Stock Prices Move Too Much To Be Justified By Subsequent in Dividends?” *The American Economic Review*, Vol.71, No.3, pp 421-436
- Shiller, R. (1989). *Market volatility*. Cambridge, MA: MIT Press.
- Shiller, R. (2000). *Irrational Exuberance*. Princeton: Princeton University Press.
- Shiller, R. (2003). From efficient markets theory to behavioural finance. *Journal of Economic Perspectives*, Vol. 17, issue. 1, p. 83–104.
- Shiller, R. Perron, P. (1985): Testing the random walk hypothesis: Power versus frequency of observation. *Economics Letters*, Vol 18(4), p. 381-386.
- Shively, P.A., (2003). The nonlinear dynamics of stock prices. *Q. Rev. Econ. Finance*. 43, 505–517.
- Shleifer, A. (2000). *Inefficient Markets: An Introduction to Behavioral Finance*. 1st edition, Oxford University Press, USA.
- Shostak, F. (1997) ‘In Defense of Fundamental Analysis: A Critique of the Efficient Market Hypothesis’, *Review of Austrian Economics* 10, no. 2: 27-45.
- Smith, G., & Ryoo, H. J. (2003). Variance ratio tests of the random walk hypothesis for European emerging stock markets. *The European Journal of Finance*, *9*(3), 290-300.
- Smith, G., (2009). Martingales in European emerging stock markets: size, liquidity and market quality. *European Journal of Finance* 15: 249–262.
- Sowell, F. (1990). The fractional unit root distribution. *Econometrica*, 58, 495–505.
- Sun, X., Feng, Q. and Li, J., (2021). Understanding country risk assessment: a historical review. *Applied Economics*, pp.1-13.
- Tanor, R., (1999). The Turkish Capital Market, Volume 1, *Parties, Garanti Investment Publications*, Special Edition, Beta Publishers, Istanbul.
- Taş, O. & Dursunoglu, S. (2005): Testing Random Walk Hypothesis for Istanbul Stock Exchange. *International Trade and Finance Association 15th International Conference*. Istanbul, p. 1-17.
- Taylor, M. P., Peel, D. A. & Sarno, L. (2001): Nonlinear mean-reversion in real exchange rates: toward a solution to the purchasing power parity puzzles. *International Economic Review*, p. 1015–1042.

- Teräsvirta, T. (1994). Specification, estimation, and evaluation of smooth transition autoregressive models. *Journal of the American Statistical Association*, Vol 89(425), p. 208–218.
- Thaler, R.H. (1999). The End of Behavioral Finance. *Financial Analysts Journal* 55 (6): 12-17.
- Thomas Delcey, (2019) Samuelson vs Fama on the Efficient Market Hypothesis: The Point of View of Expertise », *Œconomia* [En ligne], 9-1 | 2019, mis en ligne le 01 mars 2019, consulté le 28 mars 2023.
- Țițan, A. G. (2015). The efficient market hypothesis: Review of specialized literature and empirical research. *Procedia Economics and Finance*, *32*, 442-449.
- Toth, B., & Kertesz, J. (2006). Increasing market efficiency: Evolution of cross-correlations of stock returns. *Physica A*, 360(2), 505-515.
- Urrutia, J. L. (1995). Test of random walk and market efficiency for Latin American emerging equity markets. *Journal of Financial Research*, 18, 299–309.
- Van Dijk, M.A., (2011). Is size dead? A review of the size effect in equity returns. *Journal of Banking & Finance, 35*(12), pp.3263-3274.
- Vuillemey, Guillaume. (2013). Sur le statut épistémologique de l'hypothèse d'efficience des marchés. *Revue de philosophie économique*, *14*(2): 93-118.
- Walter, Christian. (2006). Les Martingales Sur Les Marchés Financiers, Une Convention Stochastique ? *Revue de Synthèse*, *127*(2): 379.
- Working, H. (1960). Note on the correlation of first differences of averages in a random chain. *Econometrica*, 28, 916–918.
- Wright, J. H. (2000). Alternative variance-ratio tests using ranks and signs. *Journal of Business and Economic Statistics*, 18, 1–9.
- Yalçın, K. (2010). "Market Rationality: Efficient Market Hypothesis versus Market Anomalies" *European Journal of Economic and Political Studies* Vol. 3 No. 2: 23-38.
- Yavuz, N. & Yilanci, V. (2012): Testing for nonlinearity in G7 macroeconomic time series. Romanian Journal of Economic Forecasting, Vol 3, p. 69–7.
- Yaz Gulnur Muradoglu and Kivilcim Metin, (1996) Efficiency of the Turkish Stock Exchange with respect to monetary variables: A cointegration analysis, European Journal of Operational Research 90 566-576.
- Yen, G., & Lee, C. F. (2008). Efficient market hypothesis (EMH): past, present and future. *Review of Pacific Basin Financial Markets and Policies*, *11*(02), 305-329.

- Yuksel, S. A. (2000). *Three essays on the microstructure of the Turkish stock market*. Michigan State University.
- Zeynel Abidin Ozdemir (2008) Efficient market hypothesis: evidence from a small open-economy, Applied Economics, 40:5, 633-641.
- Zychowicz E.J., M. Binbasioglu and N. Kazancioglu (1995), `The Behavior of Prices on the Istanbul Stock Exchange,' Journal of International Financial Markets, Vol. 5, No. 4, pp. 89±101.