INTERNATIONAL RESEARCH AND REVIEWS IN ECONOMICS AND ADMINISTRATIVE SCIENCES

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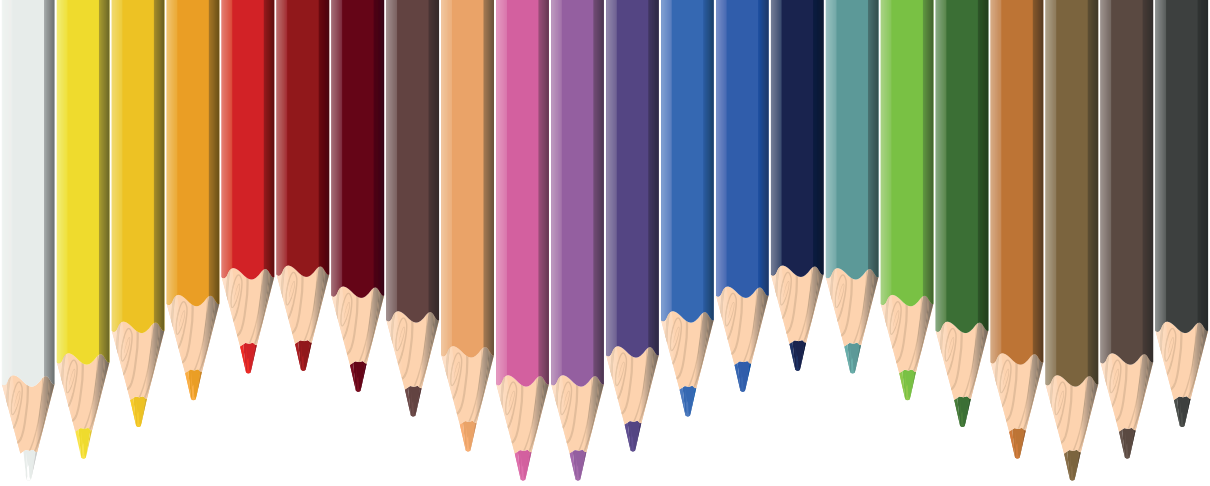

Chapter 2

MARKET EFFICIENCY IN THE WEAK FORM: ANALYSIS OF BORSA ISTANBUL TRANSPORTATION INDEX

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INTRODUCTION

Stock markets have gained significant prominence in recent years, mostly due to their role in providing capital, particularly for companies based in developing nations. These stock exchanges possess substantial financial resources in the form of various corporations and also regarded as a viable investment instrument for individuals seeking to optimize their savings. It is inherent for investors to seek higher returns on their assets. From this perspective, accurately determining asset prices is of utmost importance in calculating gains. The substantial growth in financial flows directed towards developing nations has prompted questions regarding the efficiency of these markets. Researchers in fields of finance and economics are particularly interested in the interaction amongst capital markets and economic growth. Numerous studies have established a positive correlation between the advancement of financial markets and economic growth. Carp (2012) asserts that stock markets are vital to the world economy and that their influence on economic growth can be transferred to the real sector through a number of channels, such as the generation of liquidity, market capitalization, risk allocation, and distribution. The stock markets play a crucial role in the economy by facilitating market liquidity, generating funds through promoting saving, diversifying the ownership of capital to foster societal expansion, and serving as an economic indicator. Due to transportation industry being one of the most crucial drivers of economic growth (Şahan and Tuna, 2021), it is essential for companies in this sector to benefit from the tools of capital markets. Transportation sector has witnessed advancements due to the expansion of global economies, the adoption of performance-driven strategies by firms, and advancements in communication and information technologies (Baygül, 2020). To sustain these advancements and stay competitive in the market, transport firms require attracting investments and generating funds now more than ever. Therefore, it is vital for their stock prices to exhibit market efficiency to encourage individuals to invest in their stocks without the fear of being consistently out-played.

Before diving into market efficiency in more detail, we have to clarify the notion of random walk, and the random walk theory. The phrase "random walk" is first coined by Pearson (1905) to characterize the trajectory followed by an intoxicated individual, who moves in an erratic and unexpected manner. The random walk theory claims that fluctuations in asset prices occur in a random manner. Stock prices exhibit inherent volatility, rendering historical

prices unreliable for conducting future price predictions. The random walk hypothesis also suggests that the stock market is efficient and accurately incorporates all accessible information. Malkiel (1973) popularized the concept of random walk theory. As per the theory attempting to time or outperform the market, or employing fundamental or technical research to forecast stock prices is a futile endeavor that can result in subpar performance. Conversely, it is contended that investors would be more advantageous by purchasing and retaining a diversified index fund. Which became the key assumption of Efficient Market Hypothesis (EMH).

Despite facing criticism from proponents of alternative methods for predicting stock prices and achieving superior performance, random walk theory continues to be extensively embraced in the field of financial economics. By acknowledging the inherent unpredictability and efficiency of stock prices, investors can prioritize long-term strategic planning and refrain from impulsive decision-making driven by short-term market fluctuations. Random walk theory serves as a reminder to investors about the significance of maintaining discipline, patience, and concentration on their long-term investing objectives.

The notion of market efficiency has garnered significant interest from policymakers, investors, academicians, and financial professionals. The efficient market concept is derived from the EMH, which asserts that the present prices of assets completely include all the accessible information regarding the true worth of the asset (Fama, 1970). Essentially, this indicates that the returns on assets cannot be predicted, and as a result, investors cannot consistently gain higher returns from their investing plans. Conversely, in markets with inefficiency, it is possible to forecast the returns on assets by analyzing past fluctuations in prices. This implies that investors have the potential to achieve better performance than the whole market. Regulators and policymakers face a constant challenge in improving the speed of price discovery by enhancing the flow of market information. This requires focusing on frameworks for laws, regulations, and transparency. Scholars find the pursuit of inefficient marketplaces and strategies to capitalize on them to be a fertile and enticing area of research. The study of market efficiency has deep roots in the literature, stretching all the way through the works of Gibson (1889), Bachelier (1900), Mandelbrot (1963), Alexander (1964), Steiger (1964) and, among others (Sewell, 2011).

Fama (1965a) discovered the initial market efficiency and conducted the first empirical study on stock prices which exhibited characteristics of a random walk. Then, Fama (1965b) addressed the generalized version of random walk, while Samuelson (1965) contributed the notion of fair play to the field of financial economics. Samuelson (1965) also examined the concept of martingale, which is closely connected to random walk in the general form. After that, Roberts (1967) improved this concept and differentiated between weak and strong efficiency forms. Lastly, Fama (1970) categorized the EMH into three distinct types: strong form efficiency, semi-strong form efficiency, and weak form efficiency. Efficiency in the strong form refers to the condition when market prices effectively incorporate all available information, including insider knowledge, that is accessible to both the public and private individuals. Investors should not possess the ability to regularly surpass the performance of the market or earn returns that above the average in this particular situation. Both the efficiencies in the forms of semi-strong and weak are encompassed by the strong form efficiency. Prices are considered to be in semi-strong form when they accurately incorporate information that is readily accessible to the public, including dividend announcements, dividend/yield ratios, political and economic events, book value/market value ratios, and stock splits. Efficiency in the weak form indicates that prices accurately reflect information of all historical prices. Therefore, employing weak form efficiency to forecast future price fluctuations provides limited advantage. Put simply, previous fluctuations in price have no influence on current or future fluctuations in price. The utility of technical analysis is rendered ineffective when the weak form efficiency is upheld. Insufficient historical evidence exists for forecasting future price fluctuations under the weak form.

Based on Lo's (2005) adaptive markets hypothesis, recent research has shown that market efficiency is influenced by specific circumstances and is constantly changing. This means that abnormal returns can occur occasionally in response to shifts in market conditions. This has been supported by empirical evidence from studies conducted by Neely et al. (2009), Kim et al. (2011), and Lim and Brooks (2011). Therefore, rather than testing EMH on overall time period, this study aims to test the market efficiency of the BIST Transportation Index in the weak form during COVID-19 period to determine if investors in this area could predict the future values via technical analysis during this period and use the historical prices to outplay the market.

LITERATURE REVIEW

In essence, the investigations conducted on market efficiency have examined whether the prices of securities display a random walk or in other words are their patterns predictable or not. As discussed in the above section, the asset prices in a market has to exhibit a random walk in order to be considered in any form of efficiency. Since this theory is one of the cornerstones of the study of finance, one can find its application on almost any market around the world.

Although the market efficiency concept has been extensively researched in various financial markets including bond markets (Hall and Miles, 1992; Hotchkiss and Ronen, 2002), credit default swaps markets (Imbierowicz and Cserna, 2008; Kiesel et al., 2016), exchange rates (Frankel and Mussa, 1980; Charles et al., 2012), and commodities (Kaminsky and Kumar, 1990; Smith, 2002; Charles and Darné, 2009; Kristoufek and Vosvrda, 2013; Bouri, 2014; Memon et al., 2022) main focus on the reviewed literature will be studies testing EMH on stock markets.

Market Efficiency in International Stock Markets

International stock markets have been extensively tested for EMH since the inception of this concept. The literature on this subject is perhaps most established on United States (US) stock markets followed second by European markets. Early researchers such as Granger and Morgenstern (1963) discovered that the price series of New York Stock Exchange (NYSE) stocks exhibit random-walk behavior in the short run, as confirmed by spectral analysis. However, they observed that this theory does not hold for long-term movements. Narayan (2006) tested the EMH on NYSE between 1964 and 2003 and concluded that the weak form efficiency upholds on the market. Lim (2007) tested various stock markets and ranked them in terms of whether they possess market efficiency or not. The study concluded that the US stock market possessed market efficiency and ranked number one amongst other countries in terms of the market efficiency scale developed by the author. Anagnostidis et al. (2016) tested the impact of 2008 global financial crisis upon the efficiencies of stock markets in the Eurozone consisting of stock exchanges of twelve European nations. Their findings suggest that from 2004 to 2008 the Eurozone stock markets followed random walk and sustained market

efficiency in the weak form. However, during the 2008 -2014 period (post-crisis era) they concluded that due to the adverse effects of crisis such as herding behavior and financial panic the EMH is disrupted where the markets turned to inefficiency. Similarly in terms of post crisis results, Younas and Mehmood (2018) conducted market efficiency tests on another major US stock market, National Association of Securities Dealers Automated Quotations (NASDAQ). Their study encompassed the period between 2007 and 2017, which concluded in rejection of the EMH.

Regarding the emerging markets, in Squalli's (2006) study, the weak form efficiency of the Dubai Financial Market (DFM) and the Abu Dhabi Securities Market (ADSM) in the United Arab Emirates is analyzed. Both exchanges are relatively recent, having been established around the year 2000. The findings from their testing regularly demonstrate that a majority of the economic sectors in the DFM and ADSM exhibit inefficiency. Kim et al. (2014) examine the stock markets in Asia and Australasia, specifically Australia, China, Bangladesh, India, Japan, South Korea, New Zealand, Pakistan, Indonesia, Singapore, Malaysia, Sri Lanka, Taiwan, Hong Kong, and Thailand with meta analysis of variance ratio tests. This cluster of stock markets has heterogeneous attributes, demonstrating fluctuating levels of advancement and sophistication over the course of time. They discover a breach of the EMH in Asian and Australasian stock markets. In general, stock market inefficiency is more pronounced in nations with less established and heavily regulated stock markets. Significantly, they have also discovered that the efficiency of the stock market has increased with time.

For testing the EMH in China, researches mainly focused on the country's primary stock markets of Shanghai Stock Exchange and Shenzhen Stock Exchange. Laurence et al. (1997), Liu et al. (1997), Long et al. (1999), and Lima and Tabak (2004) have together concluded that the stock markets of Chinese demonstrate weak form efficiency. This is evidenced by the absence of linear serial correlations in their stock returns. These efficiency findings are unexpected considering the commonly held belief that the Chinese stock markets are predominantly speculative, influenced primarily by market rumors and individual investor attitudes. On the opposite side of the fence, Ma (2004), and Mookerjee and Yu (1999) have both concluded that the primary stock markets of China were inefficient due to the rejection of the existence of random walk in their autocorrelation based investigations. While

Groenewold et al. (2004) discover substantial linear serial correlations and, they warn that the observed predictability may be false due to thin trading causing return autocorrelations.

Market Efficiency in Borsa İstanbul (BIST)

Depending on the employed methods and sample periods the literature on market efficiency of BIST, which was named İstanbul Stock Exchange (ISE) historically, exhibit differing results. On one hand, Smith and Ryoo (2003) tested the EMH using variance ratio analysis on ISE between 1991 – 1998. Their results suggested that the marked exhibited a random walk, which resulted in weak efficiency. Buguk and Brorsen (2003) tested the composite index of ISE as well as its finance and industry sub-indices with unit root approach. Their study also confirmed the efficiency in the weak form both for the composite and industry specific indices. Özdemir (2008) also conducted market efficiency on ISE 100 Index with a combination of unit root and variance ratio analysis. The study concluded that between 1990 and 2005 ISE exhibited weak form market efficiency. Based on their analysis of the ISE 30 with random walk and hypersensitivity hypothesis, Karan and Kapusuzoglu (2010) concluded that the Turkish stock market fulfilled market efficiency in the weak form during 2003-2007 period. After analyzing the BIST 100 Index regarding the EMH, Gozbasi et al. (2014) suggest that BIST was weak form efficient during 2002-2012. Çağlı (2018) contributed to the subject by testing the efficiency of BIST with a sectoral approach. He employed unit root tests to analyze random walk properties of BIST 100, BIST Financial Index, BIST Service Index, and BIST Technology Index during 1988-2018. This study resulted in confirmation of market efficiency in the weak form for BIST and its three sector based sub-indices.

On the other hand, Balaban (1995) conducted one of the very first examinations of Turkish stock market by testing EMH on ISE composite index between 1988-1994 with regression approach. Findings of this study resulted in rejection of EMH for the market. Balaban and Kunter (1997) tested the Turkish stock market efficiency in the semi strong form via causality approach and incorporated the intrabank money market and foreigh exchange market data in their model. Their findings stated that stock market in Türkiye was interdependent with the above mentioned two other markets

and did not hold efficiency in the semi strong form. Demirer and Karan (2002) used three way variance analysis method to prove the existence of market anomaly for rejecting EMH on ISE. Ozer and Ertokatli (2010) employed unit root tests in conjunction with chaos theory to test the behavior of ISE 100 during 1997-2009. Their results stated that stock market of Türkiye was an inefficient one. There are two possible explanations for the lack of consensus: either different periods were used for different markets with different levels of development, or different methodologies with different degrees of restrictive assumptions were applied.

METHODOLOGY

Following the examples of studies discussed in previous section, this study employs unit root approach, which is one of the most widely used parametric method of determining whether a series is a random walk or not, on testing the market efficiency of BIST Transportation Index. One of the primary properties of a random walk process is that it must possess a unit root, in other words to be at the order of I(1). To this end, both Augmented Dickey-Fuller (ADF) unit root test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) stationarity tests were employed on this study. These two tests complement each other due to ADF testing for a unit root and KPSS testing for its exact opposite, stationarity (Kwiatkowski et al. 1992). The analysis of this study is conducted on Eviews 13 econometrical and statistical analysis software.

Augmented Dickey Fuller Test

The acquired test value in the ADF Unit Root Test is compared to its model using a constant and a trend formed out of;

$$\Delta y_t = \mu + \phi y_{t-1} + \sum_{j=1}^{p} \psi_i \Delta y_{t-j} + \varepsilon_t$$

Where μ is a vector of terms that are deterministic such as constant and trend. The autoregressive structure of the errors is approximated by the p-lagged

difference terms, $\Delta yt-j$, and the value of p is set such that the error term, εt, is serially uncorrelated. The null hypothesis assumes the series have unit root, in other words H_0 is $\phi \neq 0$. For determining the order of p lag selection Akaike Information Criterion (AIC) formulated by Akaike (1974) is employed. The AIC formulation is defined as:

$$AIC = 2k - 2\log(\hat{L})$$

Where $\hat{L}$ the maximized value of the likelihood function and k is the number of parameters estimated by the model.

Kwiatkowski Phillips Schmidt Shin Test

The null hypothesis of this test assumes stationarity and proposes H_0 is $\phi = 0$. This is due to the fact that KPSS uses a reverse hypothesis in its interpretation. Moreover, the bandwidth is automatically included in the KPSS computation using the Newey-West covariance estimator, so the lag time for the regression is not necessary (Newey and West, 1987). On its application the test statistic is computed by the formula below:

$$KPSS = \frac{\sum_{t=1}^{T} S_t^2}{s^2 T^2}$$

$$S_t = \sum_{i=1}^{T} \varepsilon_i$$

Where T is the effective sample size, s^2 is the Newey-West estimate of the long run variance and ε_i is the error term (Kwiatkowski et al. 1992).

Data

The data used on analysis consists of daily BIST Transportation Index closing prices published by BIST. Due to transportation, being one of the main sectors that directly contribute to Türkiye's economy, BIST created this sub index as

one of its 11 sector indices. Currently, the most important financial indicator of the transportation sector in Türkiye is the BIST Transportation Index (Akdağ et al., 2022). Index data has been gathered from Investing.com. The index has 10 firms as its components which have been given in Table 1.

Table 1. Components of BIST Transportation Index

Code	**Company**	**Operation Area**
BEYAZ	Beyaz Auto Fleet	Automotive Trading and After Sales Services
CLEBI	Çelebi Air Services	Airport Ground Services
DOCO	DO & CO	Airport Catering Services, International Catering Services, Restaurants
GSDDE	GSD Maritime	Maritime Transportation
GRSEL	GÜR-SEL Tourism	Land Transportation
PGSUS	Pegasus	Airline Transportation
RYSAS	Reysaş	Transportation and Logistics
TLMAN	Trabzon Port	Port Operations
TUREX	TUREKS	Automotive Rental, Personnel Transport, Construction Vehicles Rental
THYAO	Turkish Airlines	Transport, Communications, Storage, and Airline Transportation

Source: KAP, 2023

In order to test the EMH on BIST Transportation index during COVID-19 pandemic, the analyzed sample period is from 11 March 2020 to 1 December 2023. The starting point of the pandemic period is determined based on World Health Organization's (WHO) announcement of COVID-19 as a global pandemic on 11 March 2020. The line graph of BIST Transportation Index since the beginning of the pandemic is given at Figure 1.

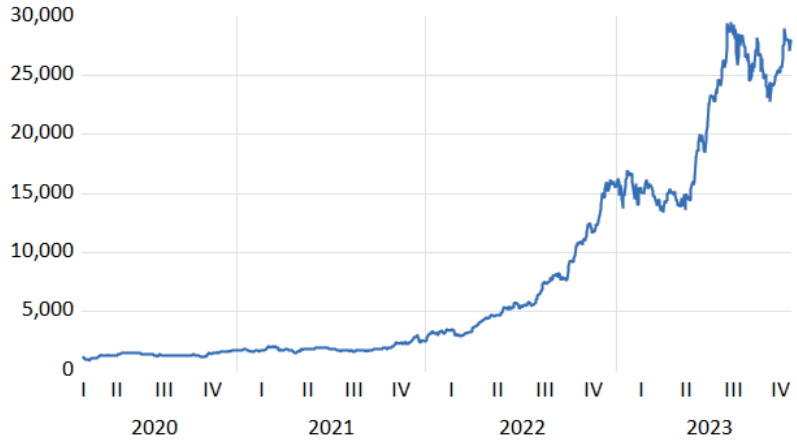

Figure 1. BIST Transportation Index

Source: Investing, 2023

Upon visual inspection of Figure 1, although staying relatively stable at the first two years of the pandemic, the increasing trend of the index can be easily identified for the COVID-19 period. Especially in the last two years, this upwards trend has reached exponential proportions. Perhaps one of the main reason for this could be the increasing inflation while having negative real interest rates in Türkiye during this period. In an economy where high inflation and negative real interest rate, investors could increase their demand for stock markets in order to protect their savings. In turn, this could cause the prices in the stock market to have an upwards trend. To start the analysis process firstly the index data has been converted into their natural logarithmic form. Then to acquire a better perspective on returns during that period, the series were converted into returns by the equation below:

$$R_t = log\left(\frac{P_t}{P_{t-1}}\right)$$

Where R_t is the index returns, while P_t represents the index price. Descriptive statistics for raw index prices and their returns are given at Table 2.

Table 2. Descriptive Statistics of BIST Transportation Index

	BIST TRAN	RETURNS(BIST TRAN)
Mean	7716.333	0.003435
Median	3008.250	0.001599
Maximum	29479.30	0.094503
Minimum	864.6100	-0.128430
Std. Dev.	8371.253	0.027474
Skewness	1.208850	0.000926
Kurtosis	3.143479	5.308609
Jarque-Bera	228.0352	206.9691
Probability	0.000000	0.000000
Observations	933	932

When Table 2 is inspected one of the first element which catches ones eye is the colossal discrepancy between maximum and minimum index values, where highest price point of the index were more than 34 times larger than its highest price point. This is also evident when we calculate the mean/standard deviation ratio of 92%. Also when the skewness and kurtosis values are inspected, we can state that the index series possess excess kurtosis and skewed to the right. When the statistics for returns are inspected, the index provided 0,01% daily returns on average to its investors during the pandemic. While it saw highest daily return at 9,45% while resulted in highest daily loss for 12,84%. The relative stability of index returns can be seen when we calculate its the mean/standard deviation ratio as 12,5%. Also when the skewness and kurtosis values of returns are inspected, we can state that the returns are not skewed while possessing excess kurtosis.

Findings and Discussion

Firstly, ADF unit root and KPSS stationarity tests have been conducted on the series natural logarithmic form in order to determine the unit root property of the random walk hypothesis of BIST Transportation Index. Lag length for ADF test is selected 0 based on AIC. Results of these tests are given at Table 3.

Table 4. ADF Unit Root and KPSS Stationarity Test Results

	ADF	**KPSS**
Test Statistics at level	−1.910321 (p: 0.64)	0.740222***
Test Statistics at 1st Difference	−30.67615^^^ (p: 0.00)	0.080581
1% critical value	−3.967926	0.216000
5% critical value	−3.414643	0.146000
10% critical value	−3.129473	0.119000

Note: *** indicates the KPSS null hypothesis of stationarity is rejected at the 1% level and ^^^ indicates the ADF null hypothesis of unit root is rejected at 1% level.

According to the ADF unit root test results, the provided test statistics is greater than critical values with the p-value of 0.64, we cannot reject the null hypothesis of H_0 is $\phi \neq 0$. Therefore conclude that the series have a unit root. Meanwhile according to the KPSS stationarity test results, the provided test statistics is greater than critical values, resulting in the rejection of null hypothesis H_0 is $\phi = 0$. Meaning the series are not stationary. After running the tests on the first differentiation of the series, this time ADF test rejects the existence of unit root while stationarity of the series cannot be rejected according to KPSS test. Meaning unit root can be removed by differentiating the series once, therefore the series possess one unit root. With results of both tests are in line with each other it is safe to state that BIST Transportation Index series possess unit root and are not stationarity. Meaning past shocks in the series are permanent and reflected in the current prices.

Existence of unit root or non-stationarity of series is a prerequisite of random walk hypothesis, however it is not enough on its own to prove the series actually follow a random walk process. It is possible that a series has a unit root, yet it is not a random walk. For example an ARIMA(p, d, q) process is a random walk with $d = 1$ and $p > 0$ or $q > 0$ or both (Campbell et. al, 1997). With the ADF and KPSS tests we determined BIST Transportation Index fulfills the $d = 1$ assumption of unit root. However, we must make sure the series possess autoregressive or moving average or both properties to affirm it follows a random walk process. To reject nonzero autocorrelations the first-

differenced process of Δx_t is estimated on different orders of (p, q). The estimation that minimizes the AIC is the selection for the Δx_t process. Model comparison of the top 20 estimations with different (p, q) orders are given in Figure 2.

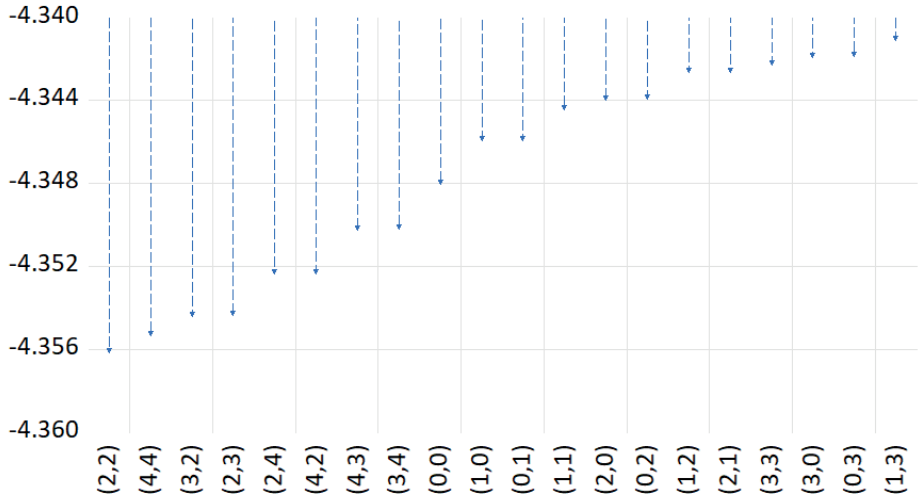

Figure 2. AIC Model Comparisons

According to AIC, the Δx_t process possesses the orders of $p = 2$ and $q = 2$. These findings point out to the existence of autoregressive and moving average properties of the series and affirm the $p > 0$ or $q > 0$ or both assumption of random walk.

CONCLUSION

The purpose of this study is analyzing the weak form efficiency of BIST Transportation Index, which is the primary indicator for stock prices of transportation companies in Türkiye, during COVID-19 pandemic. To assess the weak form of BIST Transportation sector efficiency, the daily closing prices of the index have been collected from investing.com. The sample period is selected from 11.03.2020 to 01.12.2023, consisting a total of 933 observations, in line with the announcement of COVID-19 as a global

pandemic by WHO. The analysis process includes ADF unit root test, KPSS stationarity test, and auto regressive moving average detection process.

The results of ADF unit root and KPSS stationarity tests suggested that BIST Transportation Index possesses a unit root and it is not stationary. These findings satisfied the non-stationarity aspect of the random walk hypothesis. However, in addition to not being stationary, a series has to possess autoregressive property or moving average property or both properties. To this end (p, d, q) order fitting process has been conducted based on AIC. The results indicated that best fit for Δx_t process of BIST Transportation Index has the order of ARIMA$(2,1,2)$, fulfilling the autoregressive assumption of random walk hypothesis.

Therefore, the tests employed in this study suggests that BIST Transportation Index has been moving as a random walk since the beginning of the COVID-19 pandemic, affirming the market efficiency in the weak form. In addition, individuals can safely invest in stocks of transportation sector in Türkiye without the fear of being consistently out-played. Meaning, current prices of BIST Transportation sector fully reflect its historical prices. In light of these findings, performing technical analysis for forecasting the prices to beat the market is a fruitless endeavor since the inception of COVID-19. Decision makers should direct their efforts into fundamental analysis when investing in stocks of transportation companies in Türkiye. Further studies could test the EMH on BIST Transportation Index before COVID-19 pandemic to compare their findings on our results to test the adaptive market hypothesis on this sector.

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