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TEST OF ARBITRAGE PRICING THEORY ON STOCK INDICES: AN EMPIRICAL STUDY ON BIST100

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Abstract:
The Arbitrage Pricing Theory (APT), based on arbitrage theory, emphasizes that a market can rebalance itself After the occurrence of an arbitrage opportunity. This capability of financial markets confirms the Arbitrage Pricing Theory. This study tests the validity of APT on the Istanbul Stock Exchange between the period of January 2009 and March 2020 on BIST100. Purposing to determine the relationship between security returns and other macroeconomic factor, it will serve as a compass for other emerging countries. With stock return factor as independent variable, this study uses a Vector Error Correction Model (from the VAR family model) with five macro-economic factors: GDP, interest rate, inflation rate, exchange rate and the countries' production indexes. The resulting model depicts a negative Error Correction Term (ECT) which indicates the validity of the model in the Turkish stock exchange.

***Keywords**: Arbitrage Pricing Theory, Capital Asset Pricing Model, Error Correction Model*

***JEL classification**: G12*

1. Introduction

The Arbitrage Pricing Model (APM) is one of the theories developed to measure the effectiveness of investment decision. Stephen Ross initialized APM (1976) as an alternative to the Capital Asset Pricing Model (CAPM). APM is a linear function modeling that attempts to explain the returns on financial assets by a series of factors, taking into account systematic risks. The goal of both models is to determine the expected rate of return of an asset.

In the Arbitrage Pricing Theory (APT), it is accepted that the return on a security is formed by the factors in the sector and the market, and that there is a positive correlation between return and risk. These factors are variables such as gross national product, inflation, interest rate, exchange rate etc. As the number of securities increases, the non-systematic risk will decrease, but the systematic risk will not change. The return of a security can be explained as the sum of the risks carried by the security by considering the risk-free interest rate and variable factors.

The definition of APT with formulas and its identification with the factors used in the theory are two separate issues. This is because the theory for a particular stock or asset cannot fully explain the different factors to an investor. In practice and in theory, a stock may show different sensitivity to various factors. For example, the stock price of a successful firm in the energy sector may be very sensitive to crude oil and natural gas prices, while the stock of a personal care firm may be relatively less sensitive to the price of oil.

APT has left the assessment of the factors that may be effective for a particular stock to the investor or analyst. Some of the difficulties that investors may face in determining these factors are:

- The determination of each of the factors affecting a particular stock,
- Determining the expected returns for each of these factors,
- Determining the sensitivity of stocks to each of these factors.

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Vol. 75, issue 1 Year 2023
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2. Research Problem

Identifying and quantifying each of the factors affecting a stock is no trivial matter, and is one of the reasons CAPM remains the dominant theory to describe the relationship between a stock's risk and return.

Upon the numerous advances and advantages of APT over CAPM, studies on this theory are few as compared to those on CAPM. This is partially due the complexity of the theory; most times, APT appears to be difficult and takes time to be analyzed by investors. Consequently, this study attempts to analyze APT in a simplified yet profound manner to better understand the theory and explore the relationship that exists between stock and several other macroeconomic factors.

3. Objectives of the Study

This study tries to bring a new approach to APT testing by addressing several macroeconomic factors. Using a Vector Auto Regressive (VAR) model, the objectives of the study are as follow:

1. To determine whether AFT can be tested in the economies of developing countries.
2. Exploring the extent to which macroeconomic factors affect securities returns in emerging economies.
3. Identify the nature of the relationship between the macroeconomic factor and stock returns in developing countries.

4. Significance of the Study

This study can be a contributing factor to extend the pool of research on AFT for a large number of financial practitioners and researchers; moreover, it can promote to building a general understanding and awareness of the key features of AFT. The specific significance of the study is as follows:

1. Determining whether AFT is valid in the economy of developing countries;
2. Investigating the extent of the effect of macroeconomic factors on stock yields in emerging economies;
3. Determining and defining the relationship between macroeconomic factors and stock returns in developing countries.

5. Literature Review

The first empirical study of AFT was conducted by Brennan (1971). Brennan concluded that the two risk factors must represent a return as opposed to a single CAPM factor. However, the first published study on AFT was done by Gehr (1975) as a similar version of the factor analysis approach. No further AFT studies were conducted until Ross and Roll (1980) conducted their own empirical research.

Roll and Ross (1980) first checked to see if there were multiple systemic risk factors affecting the rate of return on assets as the theory suggested. The study examined 1,260 stocks that were traded on New York and the U.S. Stock Exchange between July 3, 1962, and December 31, 1972. The tests performed consist of two stages. In the first stage, the expected rates of return and element betas were estimated using the rates of return of the assets, and in the second stage, the estimated values obtained in the first stage were used to control the arbitrage pricing equation (Çelik & Kurtaran, 2016, p. 348).

Gültekin, Dhrymes and Friend (1984) criticized the results of Roll and Ross in their work. In the study, they argued that AFT-related tests should cover all assets available in the capital market and that not including them in the control process for any reason would lead to serious errors. In their work, they focused on various methods to check the validity of AFT. In the tests they used, they examined the stability of the risk factors that explain the rates of return and whether there was any relationship between the number of financial assets included in the research and the number of elements obtained from the element analysis method. It was found that the findings obtained were different from those required by AFT.

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

There is also a great deal of skepticism about AFT's testing methods. Cheng (1996), Chen, and others (1986) emphasize the importance of the number of independent variables involved in regression. Furthermore, Cheng (1996) notes that when a researcher tests AFT, one factor may be important in multivariate analysis and not again when testing in a univariate model later. A multiple collinearity between economic variables constitutes another disadvantage of this approach (Paavola, 2006).
French and Fama (1993, 1996) created a 3-factor model that captures three specific factors that influence expected return. Under the same assumptions, Zhongzhi et al. (2010) proposed a new model called the Dynamic Factor Pricing Model (DFPM). In this model, it uses both old and post-old factors and combines elements of price dynamics across assets over time.

Paavola (2006) has argued that it is natural for AFT to perform CAPM better in a statistical sense for two reasons: AFT allows for more than a single factor, and CAPM uses a single clearly defined factor.

Paavola (2006) found that the most disappointing feature of AFT is that it does not identify common factors (or even numbers). AFT is also not supported by the theoretical foundations of CAPM, which define the behavior of investors (Morel, 2001). Gilles and LeRoy (1990) noted that the AFT does not contain useful information about prices, does not contain any clear restrictions, and can be treated as a very general asset pricing model. This generality of theoretical AFT has become a major weakness for empirical AFT (Koutmos & others, 1993, pp. 119-126).

Akkum and Vuran (2005) analyzed various macroeconomic factors affecting the stock returns of companies in the Turkish capital market by using multiple regression analysis method with AFT. This effort was made between January 1999 and December 2002 on 20 companies that were continuously present in the Borsa İstanbul BIST30 index. In the analysis response, they found that the BIST30 index and sub-sector indices were effective in the stock returns and that AFT was valid.

Dhankar and Esq (2005) analyzed AFT in the Indian equity market using monthly and weekly returns for the period 1991-2002. It shows that AFT with multiple factors provides a better indicator of asset risk and return than CAPM, which uses beta as a single measure of risk.

6. Data Set and Research Method

In this study, the validity of the Arbitrage Pricing Model was tested in the stock markets of Turkiye, Istanbul Stock Exchange (BIST100)

Five key macroeconomic factors are used in addition to the share price to perform this test: inflation, exchange rate, interest rate, industrial index, Gross Domestic Product (GDP) and stock prices. Istanbul Stock Exchange (BIST100) was used in the study.

Stock Market Index

In this study, the stock market indices (BIST100) Istanbul Stock Exchange as the dependent factor.

Interest Rate

In this study, base interest rates received from the central bank of Turkiye was used as interest rate. This is the key ratios that central banks use as tools to enforce monetary policies.

Inflation Rate

The Consumer Price Index (CPI) is a general and popular tool for measuring people's spending in an economy. In this study, CPI was used as an inflation indicator.

Gross Domestic Product

GDP is the sum of the gross added value of all established producers in the economy, as well as product taxes and subsidies that are not included in the value of finished products. It is calculated without payment for the depreciation of manufactured assets or for the depletion and deterioration of natural resources. The GDP here is used as a measure of a country's growth.

Exchange rate

The exchange rate factor is the amount of 1 US Dollar of the Turkish Lira (TRY).

RevistaEconomică
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Vol. 75, issue 1 Year 2023
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Industrial Production Index

The industrial production index refers to industries belonging to sections 15-37 of the International Standard Industrial Classification (ISIC). It varies from manufacturing to recycling of products.

Monthly data for this study between January 2009 and March 2020 were collected mostly from the central bank of Turkiye. This period covers the period immediately after the great world economic crisis in 2008 and until the beginning of the new coronavirus outbreak in the world at the beginning of 2020. Data that were not available in monthly frequencies (high frequencies) were collected in annual frequencies (low frequencies), which were then converted into monthly frequencies. Secondary data were used in the study; data were collected from the central banks of the country concerned.

Table 1: Macroeconomic Factors Used in Analysis

Variable	Indicator	Measurement		Source	Variable Type
Stock Market Index	Index Return	$\frac{P_t - P_{t-1}}{P_{t-1}}$	$Log(\frac{P_t}{P_{t-1}})$	Istanbul Stock Exchange Site	Dependent
Inflation	Consumer Price Index	$\frac{Tüfe_t - Tüfe_{t-1}}{Tüfe_{t-1}}$	$Log(\frac{Tüfe_t}{Tüfe_{t-1}})$	Central Bank of Turkiye	Independent
Interest Rate	Central Bank Interest/12Month	$\frac{IR_t}{12}$	$Log(\frac{IR_t}{12})$	Central Bank of Turkiye	Independent
Exchange rate	TRY / US Dollar	$\frac{EXR_t - EXR_{t-1}}{EXR_{t-1}}$	$Log(\frac{EXR_t}{EXR_{t-1}})$	Central Bank of Turkiye	Independent
Economic Growth	GDP	$\frac{GSYİH_t - GSYİH_{t-1}}{GSYİH_{t-1}}$	$Log(\frac{GSYİH_t}{GSYİH_{t-1}}$	Central Bank of Turkiye	Independent
Industrial Production Index	Net Production	$\frac{NPO_t - NPO_{t-1}}{NPO_{t-1}}$	$Log(\frac{NPO_t}{NPO_{t-1}})$	Central Bank of Turkiye	Independent

Source: Created by the author

Table 2: Abbreviation of Variables

Variable	Abbreviation
Stock Exchange Index	ENDX
Inflation	ENFL
Interest Rate	FAIZ
Exchange rate	DKUR
Economic Growth	GDP
Industrial Production Index	SUEN

Source: Created by the author

7. Methodology

This study uses a VAR family model (VECM) to explore the existence of a relationship between the variables. A Granger causality test was applied to determine the nature of the relationship.

The research model is determined as follows.

$$ENDX_{it} = \beta_0 + \beta_1 ENFL_{it} + \beta_2 FAİZ_{it} + \beta_3 DKUR_{it} + \beta_4 GSYİH_{it} + \beta_5 SÜEN_{it} + \varepsilon_{it} \quad (1)$$

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

In Equation 4.1.
R_{it}: return of the stock market index
β_0: Constant
β_1: Annual change in Inflation β its sensitivity to annual change
β2: Annual change in Interest Rate
β3: Annual change in Exchange rate
β_4: Annual change in GDP
β_5: Annual change in Production Index
$\mathcal{E}_{it}$: Error term

First, the stationarity test of the series was performed. Next, the Cointegration test was carried out to determine if there is a long-term relationship between the variables. However, correlation doesn't necessarily mean long-term relationship; for this purpose, Johansen Cointegration Test was performed. After the cointegration test was applied, Granger Causality test was also applied to determine the relationship direction of the variables. In the Granger causality test, the series is static. Log values of the variables were used to perform the cointegration. The null hypothesis for Johansen Cointegration test states that there is no cointegration. The output from this test is based on the Trace and Maximum Eigenvalue statistics.

However, if there is a cointegration relationship between non-stationary series, Granger causality test is performed on Vector Error Correction Model (VECM), not on the VAR (Şentürk & Akba, 2014, p. 7). In addition, in the case of cointegration of the variables, a VECM would be made to determine the exact relationship between the variables. This model creates both short-term and long-term relationship. The predicted VECM model is as follows:

$$\Delta \text{ENDX}_t = \alpha_0 + \sum_{i=0}^{P} \alpha_1 \text{ENDX}_{t-1} + \sum_{i=0}^{P} \alpha_2 \text{ENFL}_{t-1} + \sum_{i=0}^{P} \alpha_3 \text{FAİZ}_{t-1} + \sum_{i=0}^{P} \alpha_4 \text{DKUR}_{t-1} + \sum_{i=0}^{P} \alpha_5 \text{GSYİH}_{t-1} + \sum_{i=0}^{P} \alpha_6 \text{SÜEN}_{t-1} + \delta_1 \text{ENDX}_{t-1} + \delta_2 \text{INF}_{t-1} + \delta_3 \text{FAİZ}_{t-1} + \delta_4 \text{DKUR}_{t-1} + \delta_5 \text{GSYİH}_{t-1} + \delta_6 \text{SÜEN}_{t-1} + \varepsilon_1 \quad (2)$$

Here $\boldsymbol{\alpha}$ parameters represent short-term relationships, while $\boldsymbol{\delta}$ parameters represent long-term relationships.

If the variables are cointegrated, the long-term coefficients of each variable can be estimated by an error correction model as follows. The traditional VECM regression equation for cointegrated series is as follows.

$$\Delta \text{ENDX}_T = \gamma_0 + \sum_{i=0}^{p} \gamma_1 \Delta \text{ENDX}_{t-1} + \sum_{i=0}^{P} \varphi_i \text{ENFL}_{t-1} + \sum_{i=0}^{P} \varphi_i \text{FAİZ}_{t-1} + \sum_{i=0}^{P} \varphi_i \text{DKUR}_{t-1} + \sum_{i=0}^{P} \varphi_i \text{GSYİH}_{t-1} + \sum_{i=0}^{P} \varphi_i \text{SÜEN}_{t-1} + \mu \text{ECT}_{t-1} + u_i \quad (3)$$

In the above equation (15), **γ1** and **φ** i stand for short-term coefficients, Δ is the symbol for difference operator, **µ** is the order of delay, ui represent the residuals and ECTt-1 denotes the term for error correction.

As VECM was implemented, the error term correction was introduced. In the error-correcting model, the short-term dynamics of the variables are affected by deviation from equilibrium. The model

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

takes the difference of non-stationary variables and adds error-correction parameters between the descriptive variables to reflect the long-term adjustment to the balance. In the regression equation, it represents the delay value of the error term obtained from the cointegration equation called error correction term (Bozdağlıoğlu, 2007, p. 9). ECT (Error Correction Term) is the term for Error correction.

$$ECT_{t-1} = \delta_1 ENDX_{t-1} + \delta_2 ENFL_{t-1} + \delta_3 FAİZ_{t-1} + \delta_4 DKUR_{t-1} + \delta_5 GSYİH_{t-1} + \delta_6 SÜEN_{t-1} + \varepsilon_1 \quad (4)$$

In this equation, ECT shows the long-term relationship between variables. The ***u*** coefficient measures the speed at which stock returns come to equilibrium after a long-term deviation. The fact that the error correction coefficient is less than 1 indicates that the system is balanced, and the fact that it is negatively marked indicates that there is a movement towards balance in case of deviation from the balance. In other words, the error correction mechanism works (Bozkurt, 2007: 166).

8. Empirical Findings

8.1 Stationarity Test Results

Stationarity sis is a concept that refers to the fact that over time, series have a covariance due to a stationary variance and a level of delay. Time series with a stationary specificity (or no unit root) are series with a static mean and are series with variance and covariance. (Öner et al., 2018:118).

Most economic time series are not stationary, and this latter is obtained only at the first difference of level values or higher (Uwubanmwen and Obayagbona, 2012:10). An Augmented Dickey Fuller (ADF) test was used to analyze the presence of the unit root. In the ADF Unit Root Test, the H0 hypothesis states that the series has a unit root, while the H1 hypothesis states that the series is constant. The Akaike Information Criterion (AIC) Lag Length style was used to perform the test. The results are presented at levels and first difference, taking into account the intersection between variables and trends.

After the series were determined to be constant at the first difference, the cointegration method developed by Johansen (1988), and then Johansen and Juselius (1990) was used to examine whether there is a long-term equilibrium relationship within the series. Before the cointegration test is applied, it is necessary to determine the lag length of the models by creating unrestricted VAR (Vector Autoregressive) in the models. Akaike Information Criterion (AIC) was generally used to determine the Lag length.

The stationarity analysis of the macroeconomic factors of Turkiye in the data set is made and the results are shown in the tables below.

Table 3: ADF Unit Root Test Results

				LEVEL			
		INDEX	INTEREST	GDP	INFLATION	PRODUCTION (URETİM)	EXCHANGE R.(KUR)
Constant Term	t- Statistics	-10.7427	-2.0044	-1.4162	-4.9135	-2.9790	-10.8899
	Probability	0.0000	0.2848	0.5719	0.0001	0.0399	0.0000
		***	n0	n0	***	**	***
Constant Term & Trend	t- Statistics	-11.0034	-1.9942	-2.1588	-7.1692	-3.6165	-11.0816
	Probability	0.0000	0.5988	0.5072	0.0000	0.0327	0.0000
		***	n0	n0	***	**	***
				FIRST DIFFERENCE			
		d(INDEX)	d(INTEREST)	d(GDP)	d(INFLATION)	d(URETİM)	d(KUR)
Constant Term	t- Statistics	-7.1858	-4.1144	-4.3072	-6.7732	-3.2795	-7.0382
	Probability	0.0000	0.0013	0.0007	0.0000	0.0181	0.0000
		***	***	***	***	**	***
Constant Term & Trend	t- Statistics	-7.1787	-4.0514	-4.3749	-6.7424	-3.1952	-7.0178
	Probability	0.0000	0.0093	0.0036	0.0000	0.0905	0.0000
		***	***	***	***	*	***

Note: (*) shows 10%, (**) 5%, and (***) 1% indicates a level of significance.

Source: Generated by the author

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

In the above table above, the unit root test results of macroeconomic variables for Turkiye are shown. At the level, in the constant and trend part, it was concluded that the variables interest rate and GDP have unit roots. The other variables, at 1% and 5% significance levels, do not have the problem of unit root. AT the first difference, it is established that in both cases (Constant and constant-trend) no variable has a unit root.

8.2 Findings

In order to determine the validity of the APT within the scope of the Turkish stock exchange (BIST100), a long-term relationship test between the variables is required.

Cointegration analysis was performed to reveal the relationship between the variables.

However, the lag length must be selected before proceeding to the cointegration test. The result of the lag length selection is displayed in the table below.

Table 4: Lag Length Selection

Delay	LogL	Lr	FPE	Aic	Sc	Hq
0	679.5004	Na	2.98e-13	-11.81580	-11.67179	-11.75735
1	1207.767	991.6589	5.29e-17	-20.45206	-19.44398	-20.04294
2	1299.615	162.7470	2.00e-17	-21.43184	-19.55970*	-20.67204*
3	1326.205	44.31774	2.38e-17	-21.26676	-18.53056	-20.15629
4	**1386.799**	**94.61147***	**1.59e-17***	**-21.69823***	**-18.09797**	**-20.23709**

** Shows the lag length selected by the criterion.*

Source: Generated by the author

Most information criteria show 4 as the optimal lag length.

The Johansen Cointegration test was performed to determine the existence of the final cointegration equation. The result of the test is described in the following table.

Table 5: Johansen Cointegration Test Results (Turkey)

Cointegration Test According to Trace Statistics

r	Eigenvalue	Track Statistics	Critical value	Probability**
Never*	0.324236	179.8815	95.75366	0.0000
Up to 1 *	0.296115	130.1088	69.81889	0.0000
Up to 2 *	0.245378	85.51396	47.85613	0.0000
Up to 3 *	0.173683	49.75861	29.79707	0.0001
Up to 4 *	0.116893	25.52999	15.49471	0.0011
Up to 5 *	0.073846	9.742766	3.841466	0.0018

Trace test shows 6 cointegration equations at level 0.05

Cointegration Test According to Maximum Eigenvalue Statistics

r	Eigenvalue	Mak. Ozdeğer Ist.	Critical Value	Probability**
None *	0.324236	49.77277	40.07757	0.0030
Up to 1 *	0.296115	44.59481	33.87687	0.0018
Up to 2 *	0.245378	35.75534	27.58434	0.0036
Up to 3 *	0.173683	24.22863	21.13162	0.0177
Up to 4 *	0.116893	15.78722	14.26460	0.0285
Up to 5 *	0.073846	9.742766	3.841466	0.0018

The Maximum Eigenvalue test shows 6 cointegration equations at level 0.05
* Indicates that at 0.05 significance level the null hypothesis can be rejected
** MacKinnon-Haug-Michelis (1999) p-values

Source: Generated by the author

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

Both Trace and Maximum Eigenvalue cointegration tests show the existence of 6 cointegration equations that are 5% meaningful. The existence of cointegration equations shows long-term relationships between variables. Granger causality test was performed to determine the direction of relationships.

Table 6: Granger Causality Test Results (Turkey)

H0: Granger is not the cause. **H1: Granger is the cause.**	**F-Statistics**	**Probability**	**Assessment**
Production>> Stock Market Index	1.36148	0.2515	H0 Accept
Stock Market Index>> Production	**3.97559**	**0.0046**	**H0 Refute**
Interest>> Stock Market Index	1.54368	0.1940	H0 Accept
Stock Market Index>> Interest	0.87050	0.4839	H0 Accept
Inflation>> Stock Market Index	0.81225	0.5197	H0 Accept
Stock Market Index>> Inflation	0.60432	0.6603	H0 Accept
GDP>> Stock Market Index	1.03292	0.3932	H0 Accept
Stock Market Index>> GDP	2.07753	0.0880	H0 Accept
Exchange rate>> Stock Market Index	0.44390	0.7767	H0 Accept
Stock Market Index>> Exchange Rate	1.51638	0.2018	H0 Accept

Source: Generated by the author

The results in the table above provide important information about the existence of a one-way causality relationship for Turkiye from the industrial production index to the stock market index.

VECM test was performed to further determine the relationship between the variables. Table 7 details the result.

Table 7: Cointegration Equation

Cointegration Equation	**CointEq1**
ENDX (-1)	1.000000
SUEN (-1)	-0.578265
INTEREST (-1)	2.434985***
ENFL (-1)	-1.728662
GDP (-1)	0.153208
DKUR (-1)	0.724542
C	-0.006684
*, **, *, 1%, 5%, 10% respectively indicate the level of significance*	

Source: Generated by the author

In the long-term relationship between variables, only interest Rate has a significant coefficient. Therefore, it will have a positive effect on the interest index yield in the long run.

The short-term error correction model is shown below. As expected, the Error Correction Term (ECT) is negative. It determines the rate at which the series recovers from imbalance to equilibrium (Table 7).

Table 8: Short-Term Estimates (Cointegration Form)

Short Term Estimates (Cointegration Form)	
Bug Correction:	**D(STK_TR)**
CointEq1	-0.004659
D (ENDX (-1))	-0.756227***
D (ENDX (-2))	-0.633721***
D (ENDX (-3))	-0.310074***
D (SUEN (-1))	-0.177388

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

D (SUEN (-2))	0.150475
D (SUEN (-3))	-0.163614
D (INTEREST (-1))	0.025634
D (INTEREST (-2))	0.029669*
D (INTEREST (-3))	0.032948***
D (ENFL (-1))	0.125965
D (ENFL (-2))	0.175581
D (ENFL (-3))	0.051859
D (GDP (-1))	0.13012
D (GDP (-2))	1.620456***
D (GDP (-3))	-0.228901
D (DKUR (-1))	-0.211454
D (DKUR (-2))	-0.23343
D (DKUR (-3))	-0.202599
C	-0.000174
Diagnostic Tests	
Series correlation	No
Varying Variance (*p-value*)	0.000 (Yes)
Stationarity test (CUSUM)	Constant
Stationarity test (CUSUMSQ)	Constant
*, **, *, 1%, 5%, 10% respectively indicate the level of significance.*	

Source: *Generated by the author*

$$\begin{aligned} \Delta ENDX_t = & -0.00466ECT_{t-1} - 0.756227ENDX_{t-1} - 06337ENDX_{t-2} \\ & - 0.31001ENDX_{t-3} - 0.1774SÜEN_{t-1} + 0.1505SÜEN_{t-2} \\ & - 1636SÜEN_{t-3} + 0.0256FAİZ_{t-1} + 0.02967FAİZ_{t-2} \\ & + 0.0329FAİZ_{t-3} + 0.126ENFL_{t-1} + 0.1756ENFL_{t-2} \\ & + 0.0519ENFL_{t-3} + 0.1301GSYİH_{t-1} - 1.6205GSYİH_{t-2} \\ & - 0.2289GSYİH_{t-3} - 0.2115DKUR_{t-1} - 2334DKUR_{t-2} \\ & - 0.2056DKUR_{t-3} - 0.0001 \end{aligned} \tag{5}$$

The ECT in the model is negative; this implies that the model can adjust itself from previous deviations. In other words, BIST100 index can adjust itself from past deviation. However, the equilibrium velocity is 0.46%. Consequently, the model proves the validity of APT in the Turkish economy with the macroeconomic factors selected above.

9. Conclusions

APT is a theory that plays an important role in the financial sector. It helps investors make informed decisions and policymakers make better plans. This study tests the validity of APT on a developing country economy: Turkiye.

This study, first of all, highlights two popular asset pricing models: CAPM and APT. This not only provides an overview of the models, but also highlights a detailed analysis of the two models. It will be important to think of APT not as a substitute to CAPM, but as a complementary model. Both models have their drawbacks and advantages.

In the study, similar regression models were estimated by using the data for the period of January 2009-March 2020; a total of 6 variables were used for the predicted models. While the Istanbul stock market index (BIST100) was selected as the dependent variable, 5 macroeconomic factors (interest rate, exchange rate, inflation, industrial index and GDP) were determined as explanatory variables. Sometimes time series may face unit root problems. These can cause the series to become non-static during the time change. In this study, unit root test was performed to determine the stability of the series.

After the unit root tests, cointegration tests were performed. This will determine the linear relationship between descriptive variables. Cointegration is a phenomenon in which one predicting variable in a multiple regression model can be predicted linearly from others with significant accuracy. In other words, it is the emergence of high correlations between two or more independent variables in a multiple regression model. The cointegration test also helps determine the existence of a long-term relationship between variables. The results show the presence of 6 cointegration equations in different models.

The presence of long-term relationships can indicate possible short-term relationships between variables. Then the Granger Causality test was performed to determine the type of these relationships. With the presence of cointegration equations, further analyzes were made with the Vector Error Correction Model (VECM). Different cointegration equations were determined with VECM and an Error Correction Term (ECT) was created. The expected result is that all ECTs are negative.

After the presence both long- and short-term relationships among the variables, the resulting ECT coefficient is negative and meets the expectation: -0.004659 (0.47%). This figure depicts the speed at which BIST100 can readjust itself after discrepancies occurred in the market.

While this study helped to identify investment opportunities in the stock markets of Turkiye, it also aimed to reveal the existing relationships between various macroeconomic factors. Based on the findings of this study, it can be concluded that there may be less risk when investing Turkiye, and that any investor is unlikely to receive abnormal returns on their investments on the long run.

References

- Akkum, T., & Vuran B. (2005). Analysis of Macroeconomic Factors Affecting Stock Returns in the Turkish Capital Market with Arbitrage Pricing Model. *Journal of Economics Business and Finance*, 20 (233): 28-45.
- Bozdağlıoğlu, U., E., Y. (2007). Türkiye'nin İthalat ve İhracatının Eşbütünleşme Yöntemi İle Analizi (1990-2007). *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 9(3), 213-224.
- Brennan, M., J. (1971). Capital Market Equilibrium with Divergent Borrowing and Lending Rate. *Journal of Financial and Quantitative Analysis.* V. 7. p:1197-1205
- Brown, R. L., & James, D., Jonathan, M. E. (1975). Techniques for Testing the Constancy of Regression Relationships over Time. *Journal of the Royal Statistical Society*, 37(2), 149-192.
- Chen, N.F., Roll, R., & Ross, S.A. (1986). Economic Forces and the Stock Market. *Journal of Business*. Vol. 59
- Cheng, A.C.S. (1996). Economic Factors and Stock Markets: Empirical Evidence from the UK and the US. *International Journal of Finance & Economics*. Volume 1. Issue 4. https://doi.org/10.1002/(SICI)1099-1158(199610)1:4<287::AID-IJFE26>3.0.CO;2-Y
- Copeland, T. E., & Weston, J. F. (1988). *Financial Theory and Corporate Policy*. C. 3. Addison Wesley. Massachusetts. S.219.
- Copeland, T. E., & Weston, J. F. (1988). *Financial Theory and Corporate Policy*. 3. Ed. Addison-Wesley Publishing Company. Massachusetts.
- Copeland, T. E., & Weston, J. F. (1989). *Managerial Finance*. 8. Ed. Dryden Press. Chicago
- Çelik, M. K., & Kurtaran, A. T. (2016). Testing Arbitrage Pricing Theory with Factor Analysis at Borsa İstanbul: An Application for Bıst30 Index. *Journal of Management and Economics*, Volume: 14. Issue: 1. Doi: http://dx.doi.org/10.11611/JMER853

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

- Dhrymes, P., J., Irwin, F., Gultekin, N. B., Gultekin, M., N (1984). A Critical Reexamination of the Empirical Evidence on the Arbitrage Pricing Theory. *Journal of Finance*. Volume 39. Page: 323-346.
- Dhankar, P. & ESQ, M (2005). Arbitrage Perspective Theory and the Capital Asset Perspective Model Evidence from the Indian Stock Market. *Journal of Financial Management and Analysis*. 18(I): 2005:14-27
- Engle, R., F., & Granger, C., W., J. (1987). Cointegration and error correction: Representation., estimation and testing. *Econometrica*, 55, 251–76.
- Erdinç, A. (2014). Sermaye Piyası'nda Varlık Fiyatlama Teorileri. Sermaye Piyasası Teorisi-Arbitraj Fiyatlama Teorisi. *Derin Yayınları*. Basım: Eren Ofset. s.137- 178. Topkapı-İstanbul
- Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1), 3-56.
- Fama, E. F., & French, K. R. (1996). The CAPM is wanted, dead or alive. *The Journal of Finance*, 51(5), 1947-1958.
- Fama, E., Kenneth, F., & French, R. (2004). The Capital Asset Pricing Model: Theory and Evidence. *Journal of Economic Perspectives*.18 (3): 25-46.DOI: 10.1257/0895330042162430
- Fuller, R., J., & Farrell, J., L. (1987). *Modern Investment and Security Analysis*. Mc.Graw Hill Book Company. New York. S.472-473
- Gehr, A. (1975). Some Tests of the Arbitrage Pricing Theory. *Journal of Midwest Finance Association*. pp. 91–105.
- Gilles, C., & LeRoy, S.F. (1990). On the arbitrage pricing theory. https://doi.org/10.1007/BF01210561 *Econ Theory* 1 , 213–229
- Granger, C. W. J., Huang, B. & Yang, C. (2000). A bivariate causality between stock prices and exchange rates: Evidence from recent Asian flu. *The Quarterly Review of Economics and Finance*, 40, 337-354.
- Granger, C., & W., J. (1969). Investigating Causal Relations by Econometric Models and Cross spectral Methods. *Econometrica*, 37 (3), 424-38.
- Granger, C., & W., J. (1988). Some Recent Developments in a Concept of Causality. *Journal of Econometrics*. 39(1-2), 199–211.
- Karaman, K (2014). Arbitraj Fiyatlama Modeli – AFM. (Retrieved date: 11/03/2020) https://koraykaraman.com/blog/3614/Arbitraj-Fiyatlama-Modeli-AFM
- Karan, M. B. (2001). Yatırım Analizi ve Portföy Yönetimi. *HÜFAM Yayınları*, Yayın No:1, Ankara.
- Koutmos, G., Negakis, C., & Theodossiou, P. (1993). Stochastic Behaviour of the Athens Stock Exchange. *Applied Financial Economics*. 3:2, 119-126, DOI: 10.1080/758532830
- Markowitz, H. (1959). Portfolio Selection- Efficient Diversification of Investments. *New York. John Wilet & Sons*.
- Öner, H., İçellioğlu, C., Ş., & Öner, S. (2018). Volatilite Endeksi (VIX) İle Gelişmekted Olan Ülke Hisse Senedi Piyası Endeksleri Arasındaki Engel-Granger EşBütünleşme ve Granger Nedensellik Analizi. *Finansal Araştırmalar ve Çalışmalar Dergisi*. Cilt 10; S: 18. ISSN: 1309-1123, ss110-124
- Paavola, M. (2006). Tests of The Arbitrage Pricing Theory Using Macroeconomic Variables in The Russian Equity Market. (Bachelor's thesis, Lappeenranta University of Technology, Finland) Retrieved from: http://www.doria.fi/bitstream/handle/10024/30869/TMP.objres.246.pdf?
- Reilly, F., K., & Brown, K., C. (1997). *Investment Analysis and Portfolio Management*. C. 5. Dryden Press. FortWoth. S.298
- Roll, R., & Ross, S. A. (1980). An empirical investigation of the arbitrage pricing theory. *The journal of finance*, 35(5), 1073-1103.

Vol. 75, issue 1 Year 2023
DOI: 10.56043/reveco-2023-0001

- Ross, S., A. (1976). The Arbitrage Theory of Capital Asset Pricing. Journal of Economic Theory. *Department of Economics and Finance*, University of Pennsylvania. 13, 341-360
- Seyidoğlu, H. (1994). Uluslararası Finans. *Güzen Yayınları*. İstanbul. s.63
- Şentürk, M., & Akbaş, Y., E. (2014). İşsizlik-Enflasyon Ve Ekonomik Büyüme Arasindaki Karşilikli İlişkinin Değerlendirilmesi: Türkiye Örneği. *Journal of Yasar Unıversity*. 9(34), 424-38
- Türkiye Cumhuriyet Merkez Bankası (2020). https://www.tcmb.gov.tr/wps/wcm/connect/TR/TCMB+TR/Main+Menu/Istatistikler/Enflasyon+V erileri
- Türkiye Sermaye Piyasası Aracı Kuruluşları Birliği (2006). Sermaye Piyasası Faaliyetleri İleri Düzey Lisansı Eğitimi: Finansal Yönetim. Temmuz 2005. (Çevrimiçi) http://www.tspakb.org.tr/docs/egitim_notlari/- finansal_yonetim_ileri.pdf , s.84
- Unvan, H. (1989). Finansal Varlıkları Fiyatlandırma Modeli ve Türkiye Üzerine Bir Deneme 1978-1986. *Sermaye Piyasası Yayınları*. Yayın No:11. Ankara. s.4
- Uzunoğlu, S., Ayhan, A., Nural, Y., & Kasırga, Y., A., A. (2008). *Temel Ekonomi*, 2.b., İstanbul
- Uwubanmwen, A., E., Obayagbona, J. (2012). Tests of The Arbıtrage Prıcıng Theory Usıng Macroeconomıc Varıables in the Nıgerıan Stock Market. Ethiopian Economics Association (EEA). Vol 21 No 1. eISSN: 1993-3681.
- Zhongzhi, L. H, Huh, S., Ankara Lee, B. (2010). Dynamic Factors and Asset Pricing. *Journal Of Financial and Quantitative Analysis*. Vol. 45. No. 3. pp. 707–737