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Effects of Economic Activities on Stock Market Prices: Case of Borsa Istanbul Sustainability Index¹ 60

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Abstract

For over a century, the rapidly increasing trend of industrialization has led to the excessive use of natural resources. In the field of economics, many studies are being conducted to ensure the sustainability of growth and development for this reason. In the capital markets, various indexes have been created that are based on companies meeting certain criteria and demonstrate their commitment to sustainability. Being included in these indexes provides firms with both prestige and the opportunity to use alternative green financial instruments. Certainly, stock markets are influenced by macroeconomic and political developments. The explanatory power of economic variables in determining stock market price movements has been extensively investigated and generally substantiated in many empirical works. This study examines the impact of nominal and real economic variables' (inflation and industrial production index, respectively) convergence inside

the Borsa Istanbul Sustainability Index for the period January 2015-April 2025 with Fourier-based methodologies due to the structural changes in the Turkish economy. The cointegration test result indicates that the null hypothesis of cointegration is not rejected. So, it confirms that there is a long-term positive and significance relationship between the BIST Sustainability Index, the industrial production index, and inflation rates. These results are important for risk diversification among investors who are considering sustainability sensitivities.

Keywords: Borsa Istanbul Sustainability Index, Inflation, Industrial Production Index, Fourier Cointegration.

JEL Codes: E44, G12, O16

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1. Introduction

For quite some time, sustainable development has come to the mostly important topic of both international and local policy agendas. The term of "Sustainable Development", is basically refers to development that satisfies the demands of us without jeopardizing the ability of next generations to fulfill their own demands (Goldin and Winters, 1995:1). These demands are differing around the world as about the air and water pollution, climate, poverty, energy, or urbanization.

There are several debates about the natural scarcity and the pollution effects of industrialization and population growth. The "Our Common World", published by the United Nations World Commission on Environment and Development, is commonly accepted as the start of a sustainable economy (Mebratu, 1998: 496). According to the report, the idea of sustainable development does entail constraints on natural resources imposed by current social structures and technological advancements, as well as the biosphere's capacity to absorb the consequences of human activity. Sustainable development can only be achieved if population size and growth match the ecosystem's changing productive capacity. Rapidly rising populations can strain resources and slow living standards. Therefore, sustainable development is not a situation but a process (WCED, 1987: 16).

The business world started to give excessive emphasis to environmental problems after Stockholm Conferences in the 1970s. The emphasis began with pollution prevention but has since evolved to include organizing self-regulation processes and integrating sustainability into business practices. Agenda 21, which was prepared at the Rio Summit held by the United Nations in 1992, is an important starting point for collaboration between ecologists/environmental groups and the business world. With the post-Rio period, the internalized environmental discussion has come to be a central part of corporate governance (Redclift, 2005: 216).

As interest in the concept of sustainability grows, numerous related terms have emerged in the literature. The increased focus on sustainability is not solely due to the environmental agendas of the government; companies, consumers, and investors are also placing greater importance on the subject. One of the key concepts related to sustainable development is corporate social responsibility. Companies are not solely focused on maximizing profit and outcome; besides these, they are also giving importance to environmental and social issues, too. The supporters of sustainability idea criticize the profit-origin actions that are widely accepted in neoclassical firm theory. According to them, companies must address both environmental and social responsibility burdens in addition to their economic priorities (Ebner and Baumgartner, 2006:3). The term corporate social responsibility is used interchangeably with Economic, Social, and Governance (ESG). This term is considerations into corporate management and investor's portfolio decisions.

Here, the World Bank describes the term "sustainable finance" with ESG issues. According to the bank, sustainable finance is "the process of taking due account of ESG considerations when making investment decisions in the financial sector, leading to increased longer-term investments into sustainable economic activities and projects" (World Bank, 2021). The World Federation of Exchanges declared five principles for sustainable finance. Principle #4 expects exchanges to improve products and markets to support the scaling-up of sustainable finance (WFE, 2018). This means that sustainable themed indexes are supported by international organizations. Sustainability information offers insights into corporate management quality. Furthermore, it helps investors in predicting firm performance by presenting a broader viewpoint of the organization. For several investors, the proficient evaluation of sustainability.

vestors in predicting firm performance by presenting a broader viewpoint of the organization. For several investors, the proficient evaluation of sustainability considerations has become an essential component in determining the value of their investment. Consequently, investors are increasingly demanding corporations disclose their management of sustainability-related risks and opportunities and the sustainable effect of their activities on the real economy (SSE, 2024: 2).

The transparency shown by publicly traded companies in their sustainability efforts has become an important indicator of prestige alongside their current financial indicators. Therefore, being included in sustainability-themed indexes has become important for companies. However, a company's inclusion in a specific index is not the only important factor determining its pricing on the stock exchange markets. In addition to the company's internal dynamics, macroeconomic developments also have significant impacts on the market values of companies. Within financial theory, the impact of various macroeconomic data on firm values or, more generally, on stock market indexes has been a subject of discussion for a long time.

The early example of a sustainability index is the Domini 400, which was launched in 1990 for US mid and small-cap companies. After that, there were several sustainability-themed indexes created by developed markets. But for emerging markets, creating products and indexes is relatively new. Especially after the 2008 financial crisis, emerging markets have started to develop products focused on sustainability (IFC, 2011:15).

Borsa Istanbul published a sustainability guide for companies and launched the Sustainability Index in 2014, in line with the sustainability principles of the World Federation of Exchanges mentioned above. As of April 2025, there are 88 companies listed in the index with 190 billion USD market value, approximately. Figure 1 shows the sectoral breakdown of Borsa Istanbul Sustainability Index.

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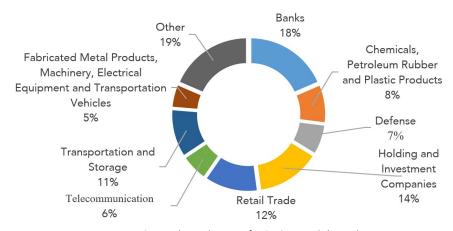


Figure 1. Sectoral Distribution of BIST Sustainability Index Source: https://www.borsaistanbul.com/en/index-detail/324/bist-sustainability, 31.05.2025

For the scope of this investigation is examining the economic convergences (both of nominal and real variables) among Borsa Istanbul Sustainability Index with monthly data from January 2015 until April 2025. Also, this study aims to investigate the explanatory power of these two groups of variables on stock market's sustainable-themed index value. These variables are the consumer price index, which represents the nominal economic variable, and the industrial production index, which represents the real economic variable. Because GDP data are available on a quarterly basis, their combination causes mismatched data problems related to inflation and exchange rates, as well as missing data points. So, the industrial production index is used instead of GDP.

Despite the presence of individual or corporate investors using sustainable investing strategies for ESG considerations, it remains uncertain if macroeconomic indexes influence the sustainability-sensitive stock market companies. There is no clear resolution to the issue. This research aims to examine the relationship between selected macroeconomic factors and Türkiye's sustainable stock market index. Although several empirical analyses examine the effects of key economic variables on exchanges, there is a lack of studies on the BIST-Sustainability Index, which is considered a sub-index, that utilize Fourier-based structural break analysis. This type of analysis provides insights to individual or corporate investors concerned with sustainability regarding the relationship between macroeconomic variables and price movements in the sustainability index.

The findings of the study indicate that real economic conditions and price stability, which refers to the nominal economic situation, are likely to affect positively the exchange market's value. This result is understandable because of the BIST Sustainability Index's sectoral breakdown. Approximately one-third of the index consists of banks and retail trade companies. These sectors actively participate in monetary policy actions, which naturally lead to inflation. Besides this, the production index is also important

for real economic sectors. Therefore, changes in policy or trends in the domestic and external economic situation are significant for stock market values.

The remainder of this paper is separated into five sections. Section I reviewed the literature, Section II describes data and methodology, Section III summarizes findings. Finally, Section IV and V presents a discussion and conclusion.

2. Literature Review

How macroeconomic factors affect stock markets is an important issue for not only policymakers and market practitioners but also a favourable research question among scholars. There are several studies about the relationship between macroeconomic variables and various stock market indexes. These analyses have shown different results according to the analysis period, countries or indexes covered, and variables that were used. This section gives a short summary about the relationship between economic variables and stock market indexes.

The pioneer studies about the linkage between macroeconomic variables and stock markets generally found a significant relationship. Fama (1981) explained the anomalous stock market return and inflation relationship for the post 1953 period and stated significance positively linkage for US Stock markets. Chen et al. (1986) tested the economic state variables' influence on asset pricing for US stock market for 1953-1983 period. They found a significant relation between stock returns and industrial production, the risk premium on corporate over government bonds, and inflation rates.

Humpe and Macmillan (2009), tested the cointegration between macroeconomic variables and stock market for US and Japan stock markets. They found that stock prices are positively related with industrial production and negatively related with consumer price index and long-term interest rates for US. But for Japanese, stock prices are influenced positively by industrial production only.

Subeniotis et al. (2011) investigated the relationship between stock market indexes and crucial macroeconomic variables with panel data analysis for EU-12 countries. Their results showed that a strong effect of market capitalization, industrial production and the economic sentiment indicator, while inflation was not statistically significant.

Ozcan (2012) analyzed the relationship between the BIST Industry Index (formerly ISE) and a set of macroeconomic variables for the period 2003–2010 monthly. The result of the cointegration test indicates a significant relationship between variables and moving together in the long run.

Bari and Adalı (2020) tested the relation between industrial production index, the consumer price index, the oil prices, foreign reserve in the Central Banks, the interest rates, the money supply, the exchange rates and BIST-100 index using Fourier cointegration test. Test results verify that absence of the long-run cointegration between BIST-CPI, BIST-Reserve, BIST-Oil, and BIST-Interest, respectively, is confirmed. On the other side, the long-run tie between BIST-Exchange and BIST-Money exists.

Studies on the Sustainability Indexes could distinguish two main groups. One group is focused on examining the relative performance of sustainability indexes with the benchmark indexes or others. Also, there are event studies about the firms that are listed or delisted in sustainability indexes. Lopez et al. (2007) examine the relationship between business performance and Corporate Social Responsibility with the selected group of Dow Jones Sustainability Index companies and Dow Jones Global Index for 1998-2004. Their results showed that differences in performance exist between firms that belong to the two indexes and that these differences are related to CSR practices. Oberndorfer et al. (2013) analyzed the effect of the inclusion of German corporations in the Dow Jones STOXX Sustainability Index and the Dow Jones Sustainability World Index on stock performance. Their results indicated that a German firm's inclusion in the indexes is a handicap for its market performance. Hawn et al. (2018) examine investor reactions to events of firms that are listed or delisted from Dow Jones Sustainability Index and showed that investors care little about the announcements. Karakaya and Kutlu (2022) tested the effect of volatility spillover between sustainability indexes, using E-GARCH models for the period of 2015-2019.

Their results showed that the impact of negative news has been more effective than positive news in the Borsa Istanbul, Dow Jones World and Dow Jones European sustainability indexes.

The second group of studies is focusing on the macroeconomic variables' effects on the sustainability indexes. But this kind of research question is rare. Drimbetas et al. (2010) analyzed the impact of macroeconomic variables on the Dow Jones Sustainability Index, using a GARCH model for the period of 1999-2008. Their findings show that crude oil returns have a negative effect, while the 10-year bond value has a positive effect. Kaur and Chaudhary (2021) investigated the relationship between Indian stock market index and macroeconomic variables for 2013-2020. Their findings shows that there is a long-term cointegration between variables and market prices. Özçim (2022) analyzed the effect of the macroeconomic variables (Brent oil, the ratio of deposits opened in TL to total deposits and exchange rate) on the volatility of the BIST Sustainability Index for the period of 2014-2021 on weekly basis. result of the study showed that the Brent oil variable did not affect the BIST Sustainability Index volatility, the exchange rate variable increased the volatility of the index and the interest rate variable decreased the volatility.

3. Data and Methodology

Inspired by the methodology of Chen et al. (1986), Phengpis et al. (2004) and Humpe and Macmillan (2009), a similar approach to investigate the relationship between stock market price, industrial production index and inflation. But some modifications made to enhance to applicability of their model for Turkish stock market, as Chen et al. (1986) indicated. Due to the newly developed instruments related to green finance, this study did not consider the spread between high-grade and low-grade bonds. Besides this, the alteration and unpredictability of Turkish monetary policies in the analysis period (sharp changes between positive and negative real interest rates, credit tightening, or expansions) could inhibit the explanatory power of the model. So, interest rates were excluded from the model, too. The study uses a function to examine the relationship between economic factors and BIST Sustainable Index as are follows:

$$lxusrd = \alpha_0 + \alpha_1 linf + \alpha_2 lind + \varepsilon_t$$
 (1)

where ε_{t} t is the error term xusrd is corresponding Borsa Istanbul Sustainability Index; inf is the consumer price index and, ind is the industrial production index. All variables included to equation in their natural logarithm forms. α_{i} 's are coefficient in model to capture the long run effects of explanatory variables.

Inflation and industrial production indexes are calculated by Turkish Statistical Institution (TURKSTAT). Sustainability index data are obtained by Matriks Data Platform, one of the accredited data distribution firms of Borsa Istanbul. The monthly time series are used from the period January 2015 and March

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2025. BIST Sustainability Index has been calculating since November 2014; but to interpret the date range of the analysis more clearly, it has been preferred to use data from the beginning of the new year. This period includes several shocks and volatilities, such as market crashes (in summer 2018, December 2021, and March 2025), a bull market (the 2021-2022 period), a global pandemic shock that has affected both the real economy and stock markets, several monetary policy regime changes, and local or international geographical / geopolitical shocks (earthquake in 2023, Russia-Ukraine war). Therefore, the number and forms of breaks in the variables cannot be determined clearly. That is why Fourier-based tests are referenced in this study. Appendix 1 shows the Inflation, Industrial Production Index and BIST Sustainability Index historical values in the logarithmic form and their Fourier approximations. According to Equation (1), following hypothesis is proposed:

H0: Inflation and Industrial Production Index are not associated with BIST Sustainability Index.

H1: Inflation and Industrial Production Index are associated with BIST Sustainability Index.

Equation (1) is based on the valuation model that a stock market's value (in terms of xusrd index) is the present value of expected future dividends which could be explained by nominal and real economic fundamentals. One of the earliest papers about the connections between inflation and stock markets, Bodie (1976) investigated the effectiveness of common stocks as an inflation hedge. For the period 1953-1972, the results indicated that the real return on equity is negatively related to both anticipated and unanticipated inflation. According to Feldstein (1983), higher rate of inflation at the t0 time, correlates with an accelerated increase in share prices. Boyd, et al (2001), indicates that higher rates of inflation relate to higher inflation and stock return variability. On the other side, Bekaert and Engstrom (2010) found that in recessions economic uncertainty and risk aversion may increase leading to higher equity risk premiums, which, in turn, increase yields on stocks for US markets. Tiryaki et al. (2018) examined the asymmetric effects of industrial production and some other macroeconomic variables on the BIST100 with NARDL model for the period 1994-2017. Their findings showed that the effects of the changes in industrial production on stock returns are asymmetric, and the increase in industrial production index in Turkey causes BIST100 stock returns to increase.

Descriptive statistics of all variables are reported in Table 1.

Table 1. Descriptive Statistics

	XUSRD	INF	IND
Mean	7.6918	6.3673	4.4971
Median	7.2270	6.1048	4.4575
Maximum	9.5948	7.9911	4.7226
Minimum	6.8011	5.5233	4.0702
Std. Dev.	0.9101	0.7495	0.1457
Skewness	1.0390	0.8129	-0.1645
Kurtosis	2.5116	2.3281	1.9958
Jarque-Bera	23.3505	15.8614	5.7232
Probability	0.0000	0.0004	0.0572**
Observations	123	123	123

^{**} denotes 5% significance level.

In econometric time series analyses, it is of great importance that the series used for determining the relationship between variables is stationary. If the series used in the analysis are not stationary, it is not possible to use standard OLS test techniques. In this scenario, cointegration analyses are preferred. Therefore, in time series analysis, it is important to first test the stationarity of the series using a technique appropriate to their nature. The intense impact of

economic and political developments often prevents the data used in economic analyses from being linear. Therefore, the econometric literature has frequently developed and used tests that take both sharp and smooth structural breaks into account (Akyuz and Karul, 2023).

Becker et al. (2006) published a paper that discusses the importance of considering the nature of structural breaks in unit root or stationary tests. There

are several papers allow the structural breaks with pre-defined number of breaks or allow a single break smooth transition deterministic component before them. They indicate that economic variables can show a broad variety of breaks of unspecified number, duration or form, and that could be the cause of some important problems of interpretation. For finding a solution to unknown number and form of breaks, they develop a stationary test that uses a selected frequency component of a Fourier function

$$Y_t = Z_t' \gamma + r_t + \varepsilon_t$$
 $r_t = r_{t-1} + u_t$

where $\varepsilon_{\rm t}$ are stationary errors, u_t are iid with varia n c e $\sigma_{\rm u}^2$ Z_t={1} is level stationary process otherwise trend-stationary process (with cos and sin functions). k is the frequency of Fourier functions, and T is the sample size. Under the null hypothesis the process described in Eq (2) is stationary (Becker et al., 2006: 382-383).

For investigating to a long-run relationship between inflation, industrial production, and stock market indexes, a cointegration test used, which was deto approximate the deterministic component of the model. As their testing procedure relies on the Kwiatkowski et al. (1992) this test is also called Fourier KPSS stationary test. (Becker et al. 2006: 381-382). In the period of study, Turkish economy has affected by several interior or exterior economy policy shocks. These shocks implied their effects on both real economic sectors and capital markets. Thus, in this study, a Fourier based stationary test was preferred. The data generating process is defined below:

$$Z_{t} = \left\{1, \sin\left(\frac{2\pi kt}{T}\right), \cos\left(\frac{2\pi kt}{T}\right)\right\} \tag{2}$$

veloped by Tsong et al. (2016). This test also uses the Fourier components to consider the unknown number and forms of structural breaks, as well as Becker et al. (2006). They suggest that Fourier series could more effectively model unknown functions or non-periodic behaviors. Besides this, stationary tests are quite robust to structural breaks in economic data series, even breaks of opposite signs (Tsong et al. 2016: 1086-1087). The data generating process is defined below:

$$y_t = \alpha_0 + \sum_{k=1}^n \alpha_k \sin\left(\frac{2k\pi t}{T}\right) + \sum_{k=1}^n \beta_k \cos\left(\frac{2k\pi t}{T}\right) + \beta' x_t + \eta_t \qquad , t = 1, ..., T$$
 (3)

where $\eta_t = \gamma_t - 1 + u_t + v_{1t}$ with $\gamma_0 = 0$ and $x_t = x_{\{t-1\}} + v_{2t}$. In Eq(3), u_t is an iid process with zero mean and its $variance \sigma_u^2$ is , γ_t is a random walk with mean zero, k is Fourier frequency. If $\sigma_u^2 = 0$ and $\eta_t = v_{1t}$ is a stationary process, implying that dependent and independent variables are cointegrated. Therefore, null hypothesis of test is cointegration, against to the non-cointegration situation (Tsong et al. 2016: 1087-1088).

Table 2. Results from Stationary Test

4. Findings

In the theory of time series testing the cointegration relation between explanatory and dependent variables, examining the stationary properties is an important starting point. For this purpose, the Fourier-based KPSS test, which was improved by Becker et al. (2006), was applied. Table 2 shows the stationary test results.

Constant Model					
	Leve	el	First Diffe	erence	
Variables	Statistics	k	Statistics	k	
Lnind	2.411***	1	0.014	2	
Lninf	3.619***	1	0.278***	1	
Lnxusrd	3.509***	1	0.055	1	

Constant and Trend Model					
	Level		First Difference		
Variables	Statistics	k	Statistics	k	
Lind	0.211***	2	0.01	2	
Linf	0.411***	1	0.139**	2	
Lxusrd	0.298***	1	0.036	2	

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Notes: *** indicates 1% and ** indicates 5% of statistical significance. "k" represent Fourier frequency. The maximum number of k is set to 3 and it is selected by the minimization of sum of squared residuals as in Becker, et al (2006). The statistics are based on the Quadratic Spectral rule. The critical values for Constant model are 0.132 (10%), 0.172 (%5), and 0.270 (%1) for k=1; 0.315 (10%), 0.415 (%5), and 0.667 (%1) for k=2. The critical values for Constant and Trend model are 0.103 (10%), 0.132 (%5), and 0.202 (%1) for k=2 (Becker, et al, 2006: 389)

As shown in the graphs in the appendix, all series ex-

hibit clear trends. Therefore, on the stationary test, only the constant and trend model's results are commented on. According to the test results, all series reject the null hypothesis at a 1% significance level. This shows that all series have unit root at their level. But after taking the first differences, lind and lxusrd are stationary, but linf is stationary at 1% significance level.

To examine the long-run cointegration relationship, the Fourier-based cointegration test, which was improved by Tsong et al. (2006), was used. Panel A of Table 3 shows the results of the cointegration test.

Table 3. Results from Cointegration Test

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	Panel A: Test Results			
	Level Shift	Trend Shift		
CI _k	0.048	0.087		
K	1	3		
F-Statistic	95.263***	15.401***		
p-Value	0	0		
	Panel A: Test Results			
	Level Shift	Trend Shift		

	Panel A: Test Results			
	Level Shift	Trend Shift		
	Coefficient	p-Value	Coefficient	p-Value
Lnind	0.402	0.709	3.382	0.001
Lninf	1.100	0.000	1.530	0.000
constant	-1.307	0.744	-15.925	0.000

Notes: *** indicates statistical significance level at 1%. "k" denotes Fourier frequency. The critical values for level shift model are 0.155 (10%), 0.092 (5%), and 0.070 (1%). The ciritical values for trend shift model 0.143 (10%), 0.094 (5%), and 0.075 (1%). The maximum number of k is set to 3 and is selected by the minimization of sum of squared residuals as in Tsong, et al (2016). The statistics are based on quadratic spectral rule. F statistics are figured to check Fourier components' significance. For extensive discussion, please see Tsong, et al (2016, p.1092).

The cointegration test results indicate that the null hypothesis is not rejected. So, the model (Eq. 1) confirms that there is a long-term relationship between the BIST Sustainability Index, the industrial production index, and inflation rates.

Lastly, to determine the long-run relationship, the dynamic OLS (DOLS) estimator was used. Panel B of Table 3 summarized the results of the DOLS estimators. The estimated coefficients (for linf and lind) are positive and statistically significant at a 1% level for the trend-shift model. These results are supporting the results of Feldstein (1983) and Boyd et al (2001) for inflation; Tiryaki et al. (2018) for industrial production index.

6. Conclusion

This study examined the impact of two key macroe-conomics variables on Sustainability Index of Borsa Istanbul, using Fourier-based cointegration test for monthly observations covering the period January 2015-April 2025. The economic variables are consumer price index and industrial production index as for nominal and real economic terms, respectively.

Because of Türkiye's economic situation, there are several economic turbulences. These turbulences also affect stock market prices via positive or negative shocks. That is one of the important reasons why linear regression methods are not fitting for Türkiye. Thus, Fourier-based analysis methods were used in the study. Fourier-based stationary and cointegration tests allow an unknown number and type of breaks. The analysis indicated that there is a positive and significant linkage between the Sustainability Index and macroeconomic variables.

For investors, it is very important to be aware of the variables that could affect the value of the assets they own. Especially for individual or institutional investors with a sensitivity to sustainability, being aware of the factors that could affect the stocks in

a specific group they have chosen (in this study, the BIST Sustainability Index) is very important for their potential risk perceptions. In this regard, the study aimed to measure the impact of two important macroeconomic variables, inflation and the industrial production index, on the BIST Sustainability Index, albeit in a limited scope. Especially considering the scarcity of studies that take structural breaks into account based on the Fourier approach, this study is expected to serve as a guide for future research in the relevant field.

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Appendix 1

The Variables' Historical Values and Their Fourier Approximations

