Research Article

Macroeconomic Determinants of BIST100: A Study Using Fourier and Asymmetric Causality Methods

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Abstract: This study examines the relationship between the Borsa Istanbul (BIST) 100 index, a key indicator in the Turkish financial markets, and selected macroeconomic variables, including gold prices, inflation, money supply and the VIX fear index. Fourier-based asymmetric causality tests and cointegration analysis are used to assess the long-run and short-run effects of these variables on the BIST 100 index. The results show a strong negative relationship between gold prices and the BIST 100 index, while inflation has a positive impact on the stock market. Although the money supply does not have a direct effect on the markets, it can promote optimism when considered alongside inflation and other economic activity. The VIX index has no significant effect on the BIST 100. These findings underscore the importance of understanding the role of macroeconomic variables in stock market dynamics, providing both investors and policymakers with critical insights for making strategic decisions.

Keywords: Borsa Istanbul (BIST) 100, Financial Markets, Fourier Approach, Asymmetric Causality
Jel Codes: G10, G12, C22, C32

BIST100'ün Makroekonomik Belirleyicileri: Fourier ve Asimetrik Nedensellik Yöntemleri ile Bir İnceleme

Öz: Bu çalışma, Türkiye'nin finansal piyasalarındaki önemli bir gösterge olan Borsa İstanbul (BIST) 100 endeksi ile seçilmiş makroekonomik değişkenler (altın fiyatları, enflasyon, para arzı ve VIX korku endeksi) arasındaki ilişkileri incelemektedir. Fourier tabanlı asimetrik nedensellik testleri ve eşbütünleşme analizleri kullanılarak bu değişkenlerin BIST 100 üzerindeki uzun ve kısa dönemli etkileri değerlendirilmiştir. Araştırmanın bulguları, altın fiyatları ile BIST 100 endeksi arasında güçlü bir negatif ilişki olduğunu ortaya koyarken, enflasyonun hisse senedi piyasası üzerinde pozitif bir etki yarattığını göstermektedir. Para arzının piyasalar üzerinde doğrudan bir etkisi gözlemlenmemiş, ancak piyasalarda iyimserlik yaratabileceği tespit edilmiştir. VIX endeksi ise BIST 100 üzerinde anlamlı bir etki yaratmamıştır. Bu sonuçlar, yatırımcıların ve politika yapıcıların, makroekonomik değişkenlerin hisse senedi piyasalarındaki rolünü dikkate alarak stratejik kararlar almalarının önemini vurgulamaktadır.

Anahtar Kelimeler: Borsa İstanbul (BİST) 100, Finansal Piyasalar, Fourier Yaklaşımı, Asimetrik Nedensellik
Jel Kodları: G10, G12, C22, C32

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1. Introduction

The Borsa Istanbul (BIST) represents a significant financial market in Turkey, providing a diverse array of investment opportunities for both domestic and international investors. The BIST 100 Index serves as a measure of the performance of the 100 largest and most liquid companies listed on the market, and it is regarded as a significant indicator of the economic conditions in Turkey. This index serves as a parameter that reflects investors' risk perceptions, investment decisions and general economic expectations. The performance of the BIST 100 Index is heavily influenced by macroeconomic variables, which represent various aspects of the economy.

Macroeconomic variables serve as indicators that convey insights regarding the overall economic conditions of a nation and significantly influence the dynamics of financial markets. The money supply (M2) is subject to a range of influences, such as exchange rates, interest rates, inflation, and commodity prices, all of which can have a direct effect on stock market behavior. In particular, within emerging economies such as Turkey, the impact of these variables may be considerably amplified, as these economies tend to be more vulnerable to global economic conditions and market uncertainties. This study seeks to investigate the correlation between the BIST 100 index and specific macroeconomic variables, including inflation, gold prices, money supply, and the VIX fear index. This research aims to analyze the long-term and short-term impacts of these variables on the BIST 100, thus offering significant insights for investors and policymakers.

It is essential for investors and policymakers to comprehend the interplay between macroeconomic variables and the stock market. For example, the exchange rate can cause fluctuations in the BIST 100 index by affecting the profitability of importing and exporting companies (Kılıç and Özyürek, pp. 20-22). High inflation rates may cause investors to exit risky assets by reducing their real returns (Altın, 2022). At the same time, volatility indicators such as the VIX index, a measure of global uncertainty, may lead to large fluctuations in the stock market by affecting investors' risk perceptions (Sadeghzadeh, 2018).

The BIST 100 index exhibits a significant correlation with the broader Turkish economy, thus, comprehending the influence of macroeconomic variables on the index is essential for informed investment decision-making. The dynamics of exchange rates, inflation, interest rates, and global economic indicators significantly influence the fluctuations of the BIST 100 and inform the development of investment strategies. Fluctuations in exchange rates can directly influence the performance of the stock market by altering the cost structure and competitiveness of Turkish companies (Kuzu, 2019). Similarly, the prices of safe-haven assets such as gold can trigger flight movements in the stock market during periods of economic uncertainty (Gazel, 2016).

This study utilizes Fourier-based asymmetric causality tests and cointegration analysis to examine the long-term and short-term links between selected macroeconomic factors and the BIST 100 index. The choice of these approaches is predicated on their ability to effectively tackle structural fractures and asymmetric effects, resulting in more accurate outcomes. This study provides an extensive examination of the correlation between macroeconomic indicators and the BIST 100 Index. The analysis of these elements influencing the dynamics of the Turkish economy and stock market performance would augment the current body of knowledge and yield substantial insights into investor decision-making processes.

The study's primary findings indicate a negative association between gold prices and the BIST 100 index, but inflation exerts a beneficial influence on the stock market. The expansion of the money supply does not exert a direct influence; nonetheless, it may foster a sense of confidence in the markets when analyzed in conjunction with inflation and diverse economic activities. The VIX fear index does not significantly influence the BIST 100. The results highlight the importance of macroeconomic factors in affecting stock market outcomes, especially in emerging markets such as Turkey.

The macroeconomic factors used to assess their influence on the BIST 100 index, including inflation rate, gold price, money supply, and the VIX fear index, were identified through a review of the literature.

1.1 Inflation and Stock Market Relationship

Inflation is the continuous increase in the general level of prices in the economy and this increase threatens economic stability by reducing consumer purchasing power. The effects of inflation on stock markets can be felt both directly and indirectly. During periods of high inflation, the increase in operating costs may adversely affect the profitability of companies and this may lead to a decline in stock prices. At the same time, high inflation rates may reduce investors' real return expectations, which may cause investors to turn to safer and fixed-income investment instruments (Altın, 2022).

Central banks may raise interest rates and impose restrictive monetary policies in response to rising inflation. Growing interest rates raise the cost of borrowing, which restricts businesses' ability to make investments and stifles economic expansion. This situation may reduce the attractiveness of stocks and direct investors to safer harbours such as bonds (Gürsoy, 2020). Under the expectation of high inflation, investors tend to exit risky assets and turn to more stable investment instruments, which may increase the selling pressure in the stock market.

Stock indices such as the BIST 100 index are sensitive to changes in inflation rates. For example, an increase in inflation rates may adversely affect consumer spending and reduce the sales and profitability of companies. This may cause declines in stock market indices because investors are concerned that the return on equity investments will decrease in a high inflation environment (Hamad et al. 2020). Moreover, rising inflation may lead investors to reassess their market risks and diversify their portfolios with less risky assets.

All things considered, there are many variables that affect the intricate link between inflation and the stock market. High inflation may put pressure on stock market indices by threatening investors' real returns. At the same time, uncertainty in inflation expectations may increase market volatility and raise investors' risk perception. In this context, it is critical for investors and policymakers to closely monitor changes in inflation rates and to understand the potential effects of these changes on stock markets.

1.2 Relationship between Gold Prices and Stock Exchange

Historically, gold has served as an investment vehicle regarded as a secure refuge. In times of economic uncertainty, investors frequently gravitate towards gold, as it is perceived as a secure asset that provides protection against market volatility and economic fluctuations. This safe-haven characteristic implies that gold prices and stock markets frequently have an inverse connection. Increases in gold prices are often associated with investors moving out of equities and into gold, which they perceive as safer. Therefore, a rise in gold prices can generally lead to declines in stock markets (Gülhan, 2020).

Generally, a negative correlation exists between gold prices and the BIST 100 index. Gold, as an asset that appreciates in times of economic crises and uncertainty, may cause investors to flee from risky assets. This may lead to increased selling pressure on stock market indices and thus a decline in stock prices (Kuzu, 2019). Especially in periods of increased uncertainty in global markets, investors' demand for gold increases, which leads to an increase in gold prices. In the same period, a downward trend is generally observed in stock markets.

The impact of gold prices on the stock market also depends on investors' portfolio management strategies. Gold is an asset that is generally used for portfolio diversification. Investors may invest in gold to reduce the risk in their portfolios, and this strategy is particularly favoured during periods of increased uncertainty in equity markets. An increase in gold prices may indicate that investors are reducing their risky positions in the stock market and turning to safer harbours.

1.3 Relationship between Money Supply and Stock Market

The money supply denotes the aggregate quantity of money circulating within an economy and serves as a crucial factor influencing economic activity. The alterations in the money supply are typically influenced by the monetary policy determinations made by central banks, and such alterations may yield diverse impacts on financial markets. An augmentation in the money supply is typically executed to invigorate economic activity, which may yield favorable outcomes for stock markets. Increasing money supply may increase investors' demand for stocks by increasing liquidity, which may lead to an increase in stock market indices (Kuzu, 2019; Türk, 2024).

An increase in the money supply typically results in a decrease in interest rates. Reduced borrowing costs associated with low interest rates stimulate consumer spending and corporate investment. This could enhance corporate profitability and consequently exert a favorable influence on stock prices. Furthermore, diminished interest rates may prompt investors to divest from fixed income assets, including bonds, and transition towards equities in pursuit of superior returns. Consequently, an expansion in the money supply has the potential to foster a prevailing sense of optimism within stock markets, thereby bolstering stock market indices (Eryılmaz, 2015).

Conversely, a substantial rise in the money supply could exacerbate inflationary pressures. Increased inflation has the potential to diminish real returns, leading investors to exercise caution regarding risky assets. The interplay between the expansion of the money supply and stock markets is influenced by inflation expectations and prevailing economic conditions. Changes in the money supply can have an impact on the stock market, which may also be affected by additional macroeconomic variables such as gold prices and currency exchange rates (Altın, 2022).

1.4 Relationship between Fear Index (VIX) and Stock Market

The Volatility Index (VIX), often termed the Fear Index, serves as a crucial metric for assessing market expectations regarding volatility and uncertainty. The VIX index serves as a measure of the anticipated volatility associated with S&P 500 index options and is commonly described as the "market's fear barometer". High VIX values indicate increased uncertainty and anxiety in the markets, while low VIX values indicate calmer market conditions. Movements in the VIX index can significantly affect investors' perception of risk and therefore movements in equity markets.

Periods when the VIX index is high are often associated with economic or financial crises, political uncertainty or other large-scale events. During such periods, investors generally avoid risky assets and seek safer harbours. This leads to increased selling pressure in equity markets and declines in stock market indices. In particular, increases in the VIX index have been observed to have negative effects on the BIST 100 index (Kılıç and Özyürek, 2022).

The stock markets of the BRICS nations usually experience drops in response to spikes in the VIX index, according to Gürsoy's (2020) analysis of this relationship. These findings suggest that the VIX index reflects the uncertainty in global markets and investors are shifting out of risky assets and towards safer assets. In a similar vein, Başarır (2018) found in his research that short- and long-term fluctuations in the VIX index had a notable impact on the BIST 100 index.

Increases in the VIX index indicate that investors' expectations of future market volatility have worsened and therefore they are more cautious. Investors generally move out of equities and into safer assets such as bonds, gold or cash when VIX levels rise. This behaviour can lead to reduced liquidity in stock markets and lower prices. Investors must take the VIX into account in their risk management strategies due to the inverse link between the VIX index and stock market indices (Münyas and Bektur, 2021).

2. Literature Review

The relationship between the stock market and macroeconomic variables has been well examined. Most studies investigating the relationship between macroeconomic variables and the BIST 100 are performed at the national level. A thorough analysis of multiple macroeconomic factors, such as inflation, interest rates, money supply, gold and oil prices, exchange rates, and CDS premiums, has been performed in conjunction with the VIX index, as outlined in the literature. A plethora of studies examines all of these issues. Therefore, a chronological classification is excluded in the following literature review.

Gazel (2016) examined the historical relationship between the BIST 100 index and gold prices. The Engle-Granger cointegration test and Granger causality analysis were performed using daily data from January 2006 to February 2016. The Engle-Granger cointegration analysis demonstrates a long-term cointegration relationship between the BIST 100 index and gold prices. While gold prices are recognized as the Granger cause of the index, the outcomes of the Granger causality test indicate that the BIST 100 index does not serve as a Granger cause for gold prices. The results indicate that the BIST 100 index is substantially influenced by gold prices.

Budak et al. (2017) analyzed the influence of key macroeconomic variables on the BIST 30, BIST 50, and BIST 100 indices. An extensive analysis of monthly data from January 2005 to December 2016 investigated the relationship between macroeconomic conditions and stock market indices, employing the ARDL model and the Johansen cointegration test. The study's findings indicated that macroeconomic variables, such as interest rates and exchange rates, significantly affected BIST indexes. Interest rates and foreign exchange rates adversely influence the BIST 100 index, whereas the producer price index exerts a beneficial effect. The ARDL model results indicate a long-term cointegration relationship among the BIST, interest rate, exchange rate, and producer price index.

İlarslan (2017) utilized the Bayes Theorem framework to analyze the correlation between gold prices and the BIST 100 index. Bayes Theorem and Pearson Correlation Analysis were used on monthly data from January 2000 to July 2017. The BIST 100 index and gold prices demonstrated a positive and statistically significant correlation (correlation coefficient: 0.91). The data suggest a 52.1% probability that the BIST 100 index will exhibit an upward trend in response to rising gold prices. This study emphasizes the necessity of utilizing systematic techniques to comprehend and forecast the impact of variations in gold prices on the BIST 100 index.

Hatipoğlu and Tekin (2017) investigated the impact of the VIX index, oil prices, and exchange rates on the BIST 100 index. The research employed a quantile regression model, analyzing daily data from 2002 to 2016. The results demonstrated that the exchange rate considerably affected the top quantiles, while the VIX index had a considerable impact on the BIST 100 index throughout all quantiles. Additionally, a proportionate relationship is seen between oil prices and the BIST 100 index, with the correlation being notably strong mostly near the median quantiles. The research demonstrates that an increase in the VIX index, a global measure of market uncertainty, corresponds with a simultaneous decrease in the BIST 100 index.

Sadeghzadeh (2018) examined the influence of psychological factors on the BIST 100 index. The study utilized econometric studies of the closing values of the US VIX Fear Index, Turkish Consumer Confidence Index (CCI) data from 2004 to 2018, and the BIST 100. Longitudinal research indicated that rises in the VIX index led to a decrease in the stock market index, whereas increases in the HDI had an opposing effect on the stock market, defying theoretical predictions. In the short-term assessments, both indices impacted the stock market, aligning with theoretical predictions. The VIX index seems to have a decreasing effect on the stock market throughout both timeframes, whereas the HDI exhibits its influence only in the short term.

Başarır (2018) investigated the causal relationship between the VIX and the BIST 100. The data collected daily from January 3, 2000, to February 9, 2018, were analyzed using the frequency domain causality test. The findings demonstrated that no substantial causal association existed between the VIX index and the BIST 100 index, regardless of the correlation timeframe. Evidence indicates a unidirectional relationship between the VIX index and the BIST 100 index in both the short and long term. The results demonstrate that the VIX index provides significant insights for predicting the BIST 100 index over both short- and long-term periods. The findings suggest that the VIX index could be an essential indicator for investors seeking to forecast variations in the BIST 100 price.

Sarıtaş and Nazlıoğlu (2019) examined the correlations between the BIST 100 index, the volatility index (VIX), and the Turkish exchange rate. A VAR model and Granger causality analysis were utilized on daily data collected from January 2, 2009, to November 12, 2018. The findings demonstrate a causal relationship between the exchange rate and the VIX and BIST 100 indices. The exchange rate is positively affected by variations in the VIX index, but the BIST 100 index is negatively impacted. Moreover, the results from the variance decomposition study reveal that the VIX index contributes a larger share of the variance in exchange rate forecast error variance than the BIST 100 index. The study's findings provide substantial insight into the impact of VIX index fluctuations on Turkey's financial markets.

A 2020 study by Hamad et al. examined the effects of inflation on the BIST 100 index. Monthly data from January 2009 to March 2020 were employed to develop the VAR model and conduct the Granger Causality Test. The study's findings demonstrate a unidirectional causal relationship between the BIST 100 index and the inflation rate. The BIST 100 index exhibits a decrease due to rising inflation. Moreover, impulse-response functions demonstrate that the two variables exhibit a negligible association. The study offers substantial new insights about the impact of inflation on stock market indices and underscores the factors that must be considered when making investment decisions.

Tuncay (2021) examined the volatility effects of the VIX fear index on the BIST sector indices. The CCC-GARCH model was applied with daily data from 2013 to 2020. The study's findings indicate substantial negative connections between the BIST sector indices and the VIX index. Nonetheless, this association is shown to be tenuous. A discernible inverse correlation is present between the VIX index and the BIST Transport index (LXULAS). Moreover, fluctuations in the VIX index markedly affect the volatility of sectoral indexes, with this effect being particularly pronounced across different industries. The findings demonstrate that the VIX index functions as a vital indicator in Turkish financial markets, with varied effects across different sectors.

Altın (2022) examined the impact of interest rates and inflation on the BIST in Turkey. The study employed the autoregressive distributed lag (ARDL) model, examining monthly data from January 2003 to April 2022. The results indicate that interest rates and inflation exert both short-term and long-term impacts on the indices of Borsa Istanbul. It has been observed that rising interest rates compel investors to shift from stocks to fixed-income instruments, leading to a decrease in stock prices. Moreover, inflation has demonstrated a similarly detrimental impact. The results demonstrate that interest rates and inflation substantially affect Borsa Istanbul; hence, investors ought to exercise caution regarding these factors.

The relationship between stock markets and macroeconomic variables is extensively examined in existing literature, resulting in a diverse array of conclusions. This study provides a thorough analysis by examining the effects of variables including interest rates, currency rates, gold prices, and volatility on stock markets in several countries and throughout a range of time periods. The following research is of significant significance in this area of study.

Investigations into the impact of interest rates on stock markets have yielded diverse results across different nations and time periods. In their foundational research, Alam and Uddin (2009) analyzed the correlation between interest rates and stock values in 15 industrialized and developing countries from 1988 to 2003. A persistent negative correlation between interest rates and corporate valuations was identified by panel regression analysis, indicating that stock prices could be enhanced by regulatory oversight of interest rates.

In keeping with this line of inquiry, Massomeh and Omar (2017) examined how interest rate uncertainty affected the growth of stock markets in 12 emerging nations between 1980 and 2011. They looked at both short- and long-term effects using Pesaran et al. (2001)'s limits test approach. They found that all of the countries they looked at had significant short-term affects, and nine of them also had long-term consequences. These results highlight the critical role that sound interest rate policies and a strong banking sector play in promoting economic expansion.

Noorie et al. (2020) conducted a study investigating the correlation between several macroeconomic indicators and the returns of the BIST-30 index. The study employed a VAR model utilizing monthly data spanning from June 2010 to February 2020. Alongside the Granger Causality Test, variance decomposition analysis and impulse-response graphs were performed. The results indicate that the selected macroeconomic parameters and BIST-30 returns do not significantly demonstrate a Granger causal link. During a period of two and a half months, it was seen that fluctuations in the CDS adversely impacted BIST-30 returns. Moreover, interest rates yielded significant and advantageous effects.

In a more recent work, Gu, Zhu, and Wang (2022) employed a Bayesian time-varying regression model on monthly data from 2005 to 2018 with an emphasis on the Chinese stock market. According to their research, although interest rates often reduce stock returns, they can increase them in advantageous market circumstances. This suggests that properly calibrated interest rate policies could effectively stabilize China's economy.

Another important area of research, particularly in emerging nations, has been the connection between stock markets and currency rates. An important study on this subject was carried out by Samanta and Zadeh (2012), who looked at the co-movements of stock prices, oil prices, gold prices, and the US dollar exchange rate between 1989 and 2009. Gold and stock prices typically preserve a degree of independence, indicating a less interwoven relationship in this context, but oil prices and currency rates have a more significant impact on one another, according to their usage of VARMA and cointegration tests.

In 2019, Khan extended the research by analyzing the Shenzhen Stock Exchange from 2008 to 2018 utilizing the ARDL model. The study's findings demonstrated that fluctuations in exchange rates negatively and considerably impacted stock returns, underscoring the need for exchange rate stabilization measures and wise investor advisement.

Huang, Wang, and Zhang (2021) broadened their research to encompass the BRICS nations and examined the influence of exchange rate fluctuations on the stock markets in these countries utilizing the TVP-VAR model. Their analysis reveals that the current account holds greater significance in Russia, whilst the financial account exerts more influence in Brazil; yet, both accounts impact China, South Africa, and India. This demonstrates that, under diverse economic conditions, exchange rates exert a multitude of intricate effects on stock markets.

Narang and Singh (2013) conducted a comprehensive analysis of co-movements in the Indian market to investigate the causal relationship between gold prices and the Sensex, utilizing data from 2002 to 2012. Their findings reveal an absence of a causal association between fluctuations in the Indian stock market and gold prices, underscoring the separate dynamics of the two variables.

Shaique, Aziz, and Herani (2016) investigated the correlation between gold prices and stock markets, focusing on Pakistan's KSE-100 index in light of these results. Data research from 1993 to 2014, employing the Augmented Dickey-Fuller and Johansen Cointegration tests, reveals no long-term association between gold prices and stock market performance. This signifies that investors want to conduct separate assessments of these two investment alternatives.

The VIX index serves as a crucial metric for market volatility, and its impact on stock returns has been thoroughly examined, especially in the context of developed and emerging nations. Sarwar (2012) analyzed the US market and the BRIC nations, identifying a substantial negative association between VIX movements and stock performance in these countries from 1993 to 2007. The correlation's notable strength during times of high VIX confirmed its role as a sentiment indicator in both emerging and developed markets.

Thielen (2016) also identified a negative link between VIX levels and stock returns when analyzing the VIX in regard to the S&P 500 and DAX indexes. The VIX's predictive value for typical market fluctuations was constrained, as only substantial changes in the VIX served as reliable indicators for investors.

Bouri, Jain, and Biswal (2016) added to the global viewpoint by analyzing the spillover effects of gold, crude oil, and the VIX on the BRIC stock markets. They discovered that the VIX has a major influence on market volatility, especially during times of high uncertainty. These results demonstrate how the VIX is a key risk indicator that influences investor sentiment in emerging economies.

The asymmetric spillover effects of the VIX on emerging market volatilities, namely in China, Brazil, and broader emerging market indices, were examined by Badshah, Bekiros, Lucey, and Uddin (2018) in order to further expand the investigation. Their quantile regression and copula analysis highlight the VIX's function in risk transmission during financial stress by showing that positive shocks have a stronger impact on emerging market volatility than negative shocks, especially in extreme market situations.

Last but not least, Cheuathonghua, Padungsaksawasdi, Boonchoo, and Tongurai (2019) looked into how the VIX affected 42 countries across borders between 1998 and 2014. Their findings demonstrate that, especially in volatile and bearish times, even small VIX swings have a big impact on developed market returns and emerging market volatility. This implies that the VIX is an important worldwide risk factor that has a special impact on markets with lower trading volumes.

3. Methodology And Results

3.1 Methodology and Data Set

The function of the econometric model that will examine the interaction between the BIST-100 index and various macroeconomic indicators selected by considering the literature is given in equation (1):

$$lnbist = f(lnaltın, lnenf, lnm2, lnvix) \quad (1)$$

This study analyzes the relationship between the BIST-100 index and the gold bullion sales price (TL/Gr.), M2, consumer price index, and various macroeconomic variables, denoted by the "vix" notation as fear, greed, or implied volatility index, using monthly data from April 2011 to September 2023, within the framework of the Fourier approach. The econometric model developed in the study is as follows, based on the function shown in equation (1):

$$lnbist_t = \beta_0 + \beta_1 lnaltın_t + \beta_2 lnenf_t + \beta_3 lnm2_t + \beta_4 lnvix_t + \varepsilon_t \quad (2)$$

In the econometric model given in Equation (2) β_0 and ε_t notations represent the constant and error term, respectively. β_0 from β_4 The parameters up to 'are the coefficients of the explanatory variables included in the function. The data set of the model is given in Table 1:

Table 1. Descriptive İnformation about the Variables

Variable	Notation	Description	How to use	Source
BIST-100	lnbist	According to closing prices (2003=100).	Logarithmic	Electronic Data Distribution System (EDDS)
Gold	InGold	Gold bullion sales price (TL/Gr.).	Logarithmic	EVDS
Inflation	lninf	Consumer price index (2003=100).	Logarithmic	EVDS
Money Supply	lnm2	M2 money supply (thousand TL).	Logarithmic	EVDS
Fear index	lnvix	A measure of volatility or variability that exists implicitly in the market and can be observed in a short period of time.	Logarithmic	investing.com database

Table 2 presents the series' descriptive statistics prior to the study.

Table 2. Descriptive Statistics of The Data Set

	LNBIST	LNGOLD	LNINF	LNM2	LNVIX
Average	7.475	5.332	5.904	21.308	2.863
Hydrangea	7.124	4.980	5.737	21.136	2.806
The most	10.290	7.448	7.433	23.236	3.980
At least	6.411	4.283	5.227	20.235	2.252
Std. Error.	0.962	0.900	0.554	0.803	0.324
Skewness	1.162	0.835	1.022	0.678	0.757
kurtosis	3.265	2.440	3.206	2.514	3.3748
Jarque-Bera	34.251	19.406	26.390	12.970	15.209
Probability	0.000	0.000	0.000	0.001	0.000
Number of Observations	150	150	150	150	150

When we look at the descriptive statistics of the variables given in Table 2, the first thing that catches the eye is that the Jarque-Bera statistic, which gives meaning to the assumption of normality, does not allow to accept the basic hypothesis claiming the assumption of normality, including all variables. However, when the descriptive statistics are analysed, no anomaly is found for the assumption of normality on the series based on the assumption that the series are normally distributed to the extent that the median and mean values of the series converge to each other. In addition, the elimination of outlier values and differences between the series by logarithmic transformation eliminated the problem of varying variance for the empirical part (Tatoğlu, 2023). According to other descriptive statistics, all series are positively skewed (right-skewed), while the gold and money supply series are flattened and the BIST-100, inflation and fear index series have a pointed distribution. The correlation matrix, which provides preliminary information about the relationship between the series in the econometric model, is given in Table 3:

Should a time series exhibit structural variations that are not adequately addressed, the employed methodology may inaccurately assess the extent of cointegration, ultimate ly resulting in questionable outcomes (Büberkökü, 2014). Unit root tests, including the Perron (1989) test that integrates structural breaks exogenously into the model, the Zivot and Andrews (1992) test permitting one structural break, the Lumsdaine and Papell (1997) test accommodating two structural breaks, and the Lee and Strazicich (2003) test which considers the potential for one or two structural breaks for both the null and alternative hypotheses, are fundamentally estimation-based.

Therefore, in a study where traditional methods are applied, the selected period should not include structural change or should be subjected to a robustness test to determine the reliability of the method used. In other words, it is important that econometric methods take these breaks into account, especially in sample periods with many structural breaks such as Turkey. Unit root tests based on Fourier functions completely eliminate these difficulties (Örnek & Türkmen, 2019; Yilanci, 2017).

Consequently, the investigation commenced with the application of the Fourier Kwiatkowski-Phillips-Schmidt-Shin (FKPSS) unit root test, developed by Becker et al. (2006), to assess the stationarity of the variables. Subsequently, to ascertain the long-term relationship of the series, the Fourier-Shin co-integration test, formulated in accordance with the Fourier methodology, was employed as a co-integration assessment tool. The dynamic least squares (DOLS) method was selected as the estimator for long-run coefficients. Subsequent to establishing the long-run relationship between the series, an analysis of the short-run causality relationship is conducted. The asymmetric causality test developed by Hatemi-J and Roca (2014) was employed. The primary objective of this research, distinct from its foundational premises, is to enhance the reliability of the findings. To achieve this, Fourier approaches that incorporate breaks and asymmetric causality analysis are employed. The initial step involved conducting a stationarity test on the series.

3.1.1 Fourier KPSS (FKPSS) Stationarity Test

Becker, Enders and Lee (2006) Unlike other unit root tests, the Fourier KPSS unit root test is indifferent to the date and number of structural breaks. For this reason, in addition to sudden shocks, it also takes into account smooth transitions in addition to significant structural breaks, claiming that these shocks will not disappear suddenly. In other words, the main reason for adding Fourier functions is to obtain stronger results by taking into account slow changes rather than sudden changes. In the Fourier KPSS test, the null hypothesis claims stationarity as in the KPSS test, unlike the known unit root tests. Becker et al. (2006)'s model considered in his studies is given in equation (3);

$$y_t = \alpha_0 + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + \eta_t + \varepsilon_t \tag{3}$$

Considering the meaning of the notations in the above equation; ε_t error term, t is the trend, T is the sample size and k is the frequency value. In addition π is accepted as a fixed number (3,1428), while η_t The explicit form of is given in equation (4);

$$\eta_t = \eta_{t-1} + u_t \tag{4}$$

Here u_t; σ_u^2 symbolises an independent (iid), similarly distributed error term with variance. The null hypothesis of the test is;

$H_0 = \sigma_u^2 = 0$ is as follows. The test statistic for the model to be used for level stationarity is given in equation (5), while the test statistic for the model required for trend stationarity is given in equation (6);

$$y_t = \alpha_0 + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + \varepsilon_t \tag{5}$$

$$y_t = \alpha_0 + \beta_t + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + \varepsilon_t \tag{6}$$

The hypothesis is tested from the error terms obtained from Equation (5) or (6). The test statistic calculation is done as follows;

$$\tau_\mu(k) = \frac{1}{T^2}\frac{\sum_{t=1}^{T}\check{S}_t(k)^2}{\check{\sigma}^2} \tag{7}$$

Here $\check{S}_t(k) = \sum_{t=1}^{T}\check{e}_j$ is explained as.

If the data generation process contains a non-linear trend, the standard KPSS unit root test should be preferred. Becker et al. (2006) The study suggests that the F test will be decisive in testing the null hypothesis of no linear trend. The F test statistic is given in equation (8);

$$F_i(k) = \frac{(SSR_0 - SSR_1)/2}{SSR_1/(T-q)} \tag{8}$$

SSR_0 and SSR_1 where q denotes the sum of residual squares and q signifies the independent variable. The KPSS test is employed exclusively in instances where the null hypothesis of the F test remains unrefuted. In this instance, the trigonometric terms will lack significance, resulting in a diminished interpretive capacity of the FKPSS test. The critical values for the FKPSS test are detailed in the work of Becker et al. (2006). Should the computed test statistic fall below the critical values established by Becker et al. (2006), it indicates that the additional trigonometric terms lack significance. The research employed the Fourier-Shin cointegration test introduced by Tsong et al. (2016) to examine the presence of a long-term relationship among the variables.

3.1.2 Fourier-Shin (FSHIN) Co-integration Test

Tsong, Lee, Tsai and Hu (2016) In this test, unlike similar co-integration tests, it is assumed that there is a cointegrated relationship as the main hypothesis. Basis Shin (1994) Fourier-Shin cointegration test based on the KPSS stationarity test, Arai and Kurozumi (2007) The regulation to allow for endogenous structural breaks added to the cointegration test developed by Shin (1994) was found to be insufficient by Tsong et al. Tsong et al. (2016) The authors added Fourier functions to this test and introduced a new arrangement in which long-run sudden and smooth transition structural breaks between the series are also taken into account. The model considered in the Fourier-Shin cointegration test is given in equation (9) (Tsong vd., 2016, pp. 1088-1089);

$$y_t = d_t + x_t'\beta + \eta_t \tag{9}$$

In Equation (9); $\eta_t = \gamma_t + v_{1t}$, $\gamma_t = \gamma_{t-1} + u_t$, $\gamma_t = 0$ and $x_t = x_{t-1} + v_{2t}$ formulated as v_{1t} and v_{2t} because it represents stasis, y_t and x_t represents variables that are stationary only at first difference. u_t zero mean, σ_u^2 independent similar error term with constant variance, γ_t shows the random walk process with zero mean. Given in equation (9) d_t The definition of the deterministic component is as follows;

$$d_t = \sum_{i=0}^{m} \delta_i t^i + f_t \tag{10}$$

In the deterministic components given in Equation (10), m=0 for the constant term and m=1 for the constant and trend. f_t The Fourier function represents the Fourier function and its explicit form is given in equation (11);

$$f_t = \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) \tag{11}$$

In Equation (11), (*k*) represents the Fourier frequency value, *t* represents the trend, and *T* represents the sample size. When equation (9) is rearranged to test the null hypothesis (*H0* : σ_u^2 =0) in the Fourier-Shin cointegration test, equation (9) is rearranged;

$$y_t = \alpha_0 + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + x_t'\beta + v_{1t} \tag{12}$$

The model for the Fourier-Shin cointegration test statistic is given in equation (13);

$$CI_f^m = T^{-2}\hat{\omega}_1^{-2}\sum_{t=1}^{T} S_t^2 \tag{13}$$

Here $S_t = \sum_{t=1}^{T} \hat{v}_{1t}$ the partial sum of the error terms obtained from equation (9), $\hat{\omega}_1^{-2}$ If $\hat{v}_{1t}$ represents the consistent estimator of the long-run variance of. CI_f^m A cointegration connection between the variables with structural breakdowns is determined if the statistic is less than the critical values in Tsong et al. (2016). If the null hypothesis cannot be rejected in the F test, interpreting the results of the Shin co-integration test instead of the Fourier-Shin co-integration test will bring more consistent results since the trigonometric terms will lose their meaning. Hypotheses for the Fourier-Shin co-integration test:

$$H_0 : \sigma_u^2 = 0$$

$$H_1 : \sigma_u^2 > 0$$

Currently, the main hypothesis asserts the existence of cointegration, while the alternative hypothesis argues that cointegration is nonexistent. A cointegration relationship among the variables is established when the computed test statistic is less than the critical value; conversely, if this condition is unmet, the alternative hypothesis is accepted, and the null hypothesis is rejected. It may be concluded that no cointegration relationship exists between the variables in this instance. The analysis indicates a co-integration relationship among the variables; hence, the Dynamic Least Squares (DOLS) approach will be utilized to derive long-run coefficient estimates.

3.1.3 Dynamic Least Squares (DOLS) Estimation Method

Stock and Watson (1993) The DOLS method has significant advantages in cointegration vector estimation due to its flexibility to be applied to small samples and the ability to test I(0), I(1) and I(2) series together. In the face of problems such as autocorrelation and endogeneity among variables, the DOLS estimator performs robust estimations and creates an important consistency compared to similar tests. (Hepsağ, 2009).

All of the variables to be used in the analysis, whether I(1) or higher order I(d), find application when a cointegration relationship is detected between the dependent variable and the independent variables. DOLS vector estimation methodology includes both lags and priors of the independent variable in the cointegration equation. In other words, in DOLS analysis, when all variables are I(d) and there is only one cointegration relationship, the dependent variable is used to obtain parameter estimates by regressing the dependent variable on the lagged and prior values of the differences of other variables. (Çetin and Seker, 2012). In DOLS methodology, deviations in static equations are eliminated by adding dynamic elements to the equations. In this technique, Monte Carlo simulation is used and effective results are obtained in series with few observations and heterogeneous characteristics. (Mark and Sul, 2003). The model to be considered in the DOLS technique is given in equation (14);

$$Z = \alpha + X'\beta + \sum_{i=-p}^{p} \gamma \Delta x_{t+1} + \mu_t \quad (14)$$

p given in equation (14), α, μ_t denotes lag length (AIC), constant term and error term, respectively. Z and X notations correspond to the dependent and independent variables, respectively. After determining the long-run effects between variables in the study, the short-run causality relationship was investigated. While doing this, Hatemi-J Roca (2014) test was used to observe asymmetric effects.

3.1.4 Hatemi-J and Roca (2014) Asymmetric Causality Test

Hatemi-J and Roca (2014) asymmetric causality test developed by the Granger and Yoon (2002) by the author of the study, the hypothesis is based on a hypothesis put forward by the author of the study. This hypothesis claims that positive and negative shocks may be different in the relationship between variables and is based on three basic elements; firstly, the lag length to be preferred when constructing the VAR model is determined, then the number of lags to be added to the model is determined and finally, critical values for the Wald test statistic are calculated. With the completion of these steps, the dynamics of the series are revealed and the possible hidden structure is tried to be found by reducing the deviation in future forecasts. (Adıgüzel, Kayhan and Bayat, 2016). In short, the main objective of this test is to determine how the causality evolves under different shock conditions. (Yilanci and Bozoklu, 2014). The econometric technique of the methodology followed in the analysis is as follows (Hatemi-J and Roca, 2014):

P_{1t} and P_{2t} co-integrated variables,

$$P_{1t} = P_{1t-1} + \varepsilon_{1t} = P_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i} \quad (15)$$

$$P_{2t} = P_{2t-1} + \varepsilon_{2t} = P_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i} \quad (16)$$

While t=1,2...,T notation in these equations $P_{1,0}$ and $P_{2,0}$ constant terms, ε_{1i}, ε_{2i} $iid(0,\delta^2)$is . Positive and negative changes for each of the variables, respectively $\varepsilon_{1i}^{+} = \max(\varepsilon_{1i}, 0)$, $\varepsilon_{2i}^{+} = \max(\varepsilon_{2i}, 0)$ and $\varepsilon_{1i}^{-} = \min(\varepsilon_{1i}, 0)$, $\varepsilon_{2i}^{-} = \min(\varepsilon_{2i}, 0)$ formulated in such a way that the equations to be used in the estimation of the results are $\varepsilon_{1i} = \varepsilon_{1i}^{+} + \varepsilon_{1i}^{-}$ and $\varepsilon_{2i} = \varepsilon_{2i}^{+} + \varepsilon_{2i}^{-}$ 'is. Thus;

$$P_{1t} = P_{1t-1} + \varepsilon_{1t} = P_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^{+} + \sum_{i=1}^{t} \varepsilon_{1i}^{-} \tag{17}$$

$$P_{2t} = P_{2t-1} + \varepsilon_{2t} = P_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^{+} + \sum_{i=1}^{t} \varepsilon_{2i}^{-} \tag{18}$$

The sum of positive and negative shocks in the variables according to each variable, respectively $P_{1t}^{+} = \sum_{i=1}^{t} \varepsilon_{1t}^{+}$, $P_{1t}^{-} = \sum_{i=1}^{t} \varepsilon_{1t}^{-}$, $P_{2t}^{+} = \sum_{i=1}^{t} \varepsilon_{2t}^{+}$, $P_{2t}^{-} = \sum_{i=1}^{t} \varepsilon_{2t}^{-}$ will be in the form (Hatemi-J and Roca, 2014, p. 8). $P_t^{+} = (P_{1t}^{+}, P_{2t}^{+})$ vector is used to investigate the causality relationship caused by positive shocks as can be understood from its sign. The vector equation of the VAR (L) model where the lag is accepted as "k";

$$P_t^{+} = v + A_1 P_{t-1}^{+} + A_2 P_{t-2}^{+} + \cdots + A_L P_{t-k}^{+} + u_t^{+} \tag{19}$$

In the formulation expressed by Hatemi-J (2012), a 2x1 vector of constant terms denoted by the symbol v and u_t^{+} 2x1 vector of error terms with positive shocks represented by r=1,2,...,k and 2x2 parameter matrix for r=1,2,...,k A_r represented by (Hatemi-J, 2012: 451). The optimal lag length (k) can also be determined using the test statistic developed by Hatemi-J (2003, 2008). (Adıgüzel et al., 2016).

$$HJC = \ln(|\widehat{\Omega}_f|) + k2T^{-1}(m^2 \ln T + 2m \ln(\ln T)) \tag{20}$$

$|\widehat{\Omega}_f|$ The symbol indicates the variance-covariance matrix of the error terms when the lag length is k. "m" in the equation represents the number of equations in the VAR model and T represents the sample size. (Hatemi-J and Roca, 2014, p. 9). Null hypothesis in asymmetric causality test, A_r While it is claimed that the jth row of the matrix is equal to the kth column of the matrix, the test statistic being greater than the critical values implies the acceptance of the null hypothesis of no relationship. (Adıgüzel et al., 2016).

3.2 Findings

Using monthly data for the period 2011:04-2023:09 in Turkey, BIST-100 index, gold bullion sales price (TL/Gr.), 2 money supply, consumer price index and "fear index" are analysed. The Fourier approach, which is followed methodologically in the analysis, is preferred because it provides more consistent results since it takes into account slow structural changes as well as sudden changes in economies. Fourier approach is applied by adding trigonometric functions (sin, cos) to standard tests. Using a data set of 150 observations, the study firstly investigated the unit root of the variables using the Fourier technique and the first difference level (I(1)) is denoted by the "D" notation:

Table 3. Fourier Unit Root Test

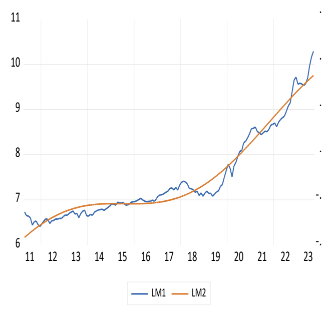
CONSTANT AND TREND MODEL						
VARİABLES	K	Min KKT	Fourier KPSS	F statistic	KPSS	ADF
LNBİST	1	5.304	0.068	287.774(9) †		0.377 (0.998)
DLNBİST	5	0.692	0.116**	3.290(7)	0.091**	-9.798 (0.000)***
INGOLD	1	2.087	0.086	459.975(9) †		-0.743 (0.967)
DLNALT	1	0.375	0.032**	0.726(7)		-9.704 (0.000)***
LNINF	1	1.240	0.090	248.357(9) †		1.794 (1.000)
DLNINF	1	0.038	0.039**	12.079(4) †		-6.827 (0.000)***
LNM2	1	0.927	0.091	370.059(9) †		1.946 (1.000)
DLNM2	1	0.076	0.020**	4.303(6)	0.193***	-11.137 (0.000)***
LNVİX	1	10.687	0.054	28.808(7) †		-3.825 (0.017)**
DLNVİX	3	8.840	0.105**	0.187(34)	0.096**	-16.427 (0.000)***

Note: Bandwidths are obtained using the Newey-West method and are shown in parentheses. The 5% critical value for Ft is 4.972. The 5% critical values for the FKPSS test are 0.054, 0.132, 0.1423 and 0.1484 for frequencies 1, 2, 3 and 5, respectively.*, ** and *** denote that the variables are stationary at 10%, 5% and 1% significance levels. The 1% and 5% critical values for the KPSS test are 0.216 and 0.146, respectively. † indicates that the trigonometric terms are significant at 5% level. Lag Length based on SIC, Probability based on MacKinnon (1996) one-sided p-values.

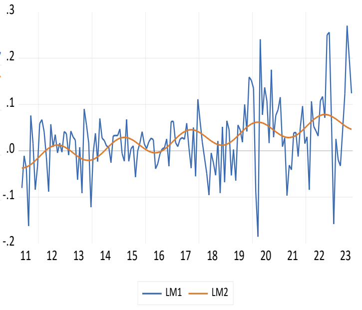
The null hypothesis asserting that the series is stationary is rejected based on the findings of the Fourier KPSS stationarity test, as the computed test statistics at the level exceed the critical values. The observation that the F test statistics exceed the critical values signifies that the series' trigonometric functions are statistically significant. The Fourier unit root test was reapplied by differencing the series identified as unit rooted at the level, confirming their stationarity. Nonetheless, the observation that the F test statistics fall below the critical values suggests that the trigonometric functions of the series lack significance in their first differences. The conventional KPSS unit root test was conducted on the differenced values of the series, revealing that these values exhibited stationarity. Furthermore, with the aforementioned unit root tests, the Augmented Dickey-Fuller test, recognized as a conventional unit root test, was utilized. The findings indicated that all series, except for LNVIX, exhibit a unit root at their level values.

On the other hand, when the graphs of the series that are stationary at level are analysed, it is seen that it is not possible to talk about a strong stationarity. Therefore, these series were subjected to differencing and a strong stationarity was determined as I(1) for all series. In this case, it is determined that the series contain unit root when smooth transitions are also taken into account. When the first differences of the related variables were taken, the series were found to be stationary. In addition, it was decided that F-statistic and Fourier functions should be used in stationarity analysis. The course of the level and difference values of the series with structural change is presented in Figure 1:

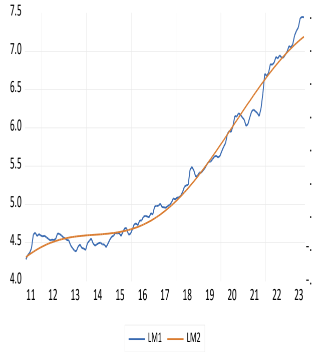
Lnbist



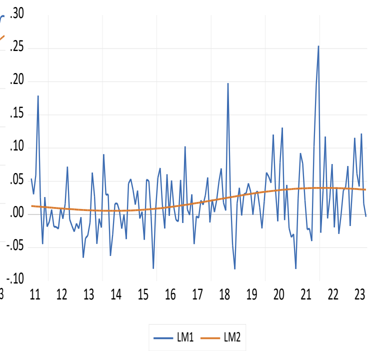
Dlnbist



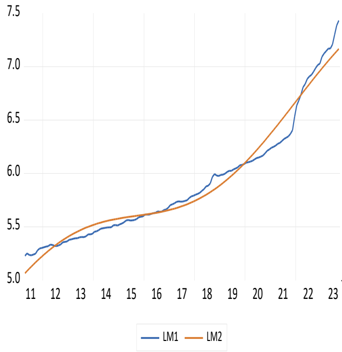
lnalt



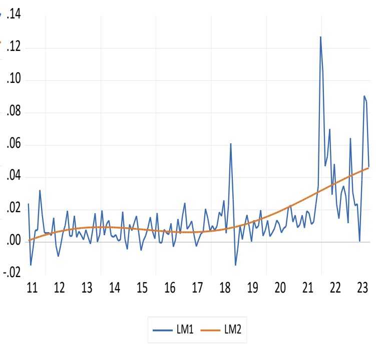
Dlnalt



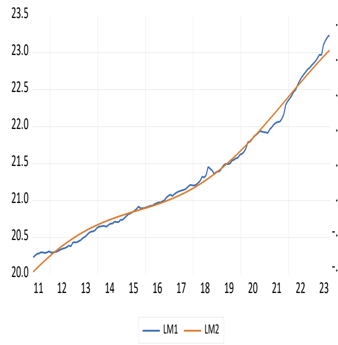
Lninf



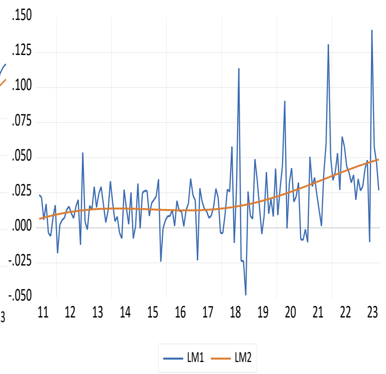
Dlninf



Lnm2



Dlnm2



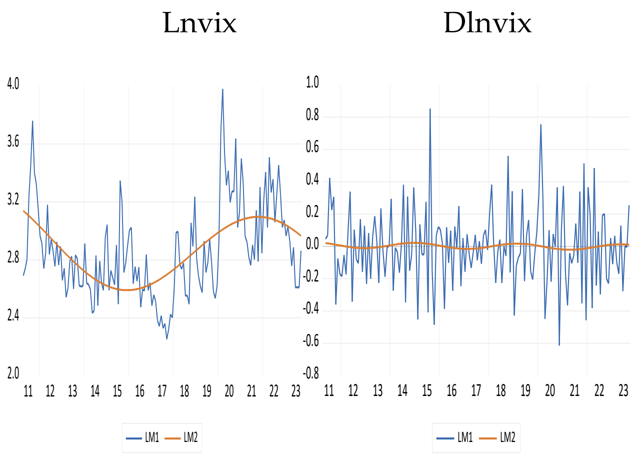


Figure 1. Variables and Fourier Functions

When the graphs in Figure 1 are analysed, it is seen that the Fourier estimates are reasonable and capture the long oscillations in the series. In the graphs in Figure 1, the blue curves show the actual time path and the red coloured curves show the predicted time path. While the estimated curves represent the realised time path, it is found that they move with accurate averages. For this reason, it is understood that allowing structural changes in the stationarity investigation is necessary for unit root detection.

Table 4. Fourier Shin Cointegration Test Results

Constant and trend (m=1)					
Model	Frequency(k)	MinKKT	Fourier Equiv. Test Ist.	Shin Equiv. Test Ist.	F Test Ist.
$lnbist = f(lnaltın, lnenf, lnm2, lnvix)$	3	0.501	0.034	0.064**	0.835

Note: The critical values of the Fourier co-integration test statistic for m=1 and p=4 are 0.099, 0.065 and 0.053 at 1%, 5% and 10% significance levels, respectively, and the critical values of the F test are 5.860, 4.019 and 3.306 at the above significance levels, respectively (Tsong, 2016: 1091). The critical values for the Shin cointegration test are 0.231, 0.314, 0.533 at 10%, 5%, 1% significance levels, respectively.

Following the establishment of the stationarity of the variables at first difference I(1), the Shin and Fourier-Shin co-integration tests were conducted to assess long-run relationships. The results of these examinations are presented in Table 4: The findings presented in the table for the Fourier Shin co-integration test indicate that the test statistic for the model is less than the critical values. Nevertheless, the results of the F test indicated that the trigonometric terms were deemed insignificant for the model, prompting the subsequent application of the Shin co-integration test. The analyses reveal the presence of cointegration among the variables. The coefficients of the cointegrated structure indicate that the variables exhibit a tendency to move together over the long term (Stock & Watson, 1993). The Dynamic Least Squares Method (DOLS), as developed by the study's author, was employed to estimate the results. The results derived from the DOLS method are illustrated in Table 5:

Table 5. Estimation of Long Run Coefficients DOLS method

VARIABLES	COEFFICIENT	T-STATISTIC	P-VALUE
LNALT	-0.984***	-5.168	0.000
LNINF	1.073***	3.215	0.001
LNM2	0.500	1.241	0.216
LNVİX	-0.012	-0.281	0.778
C	-0.018**	-2.246	0.026
T	0.000***	3.150	0.002
SİN	0.013*	1.731	0.085
COSİNE	0.014	1.193	0.234

Note: *, **, ***: 0.01, 0.05 and 0.10 significance levels. C: Constant Term, T: Trend Term

Table 5 displays the long-run coefficient estimates in conjunction with the Fourier trigonometric terms, revealing that the gold series exhibits statistical significance at the 1% level, the inflation constant term and trend attain significance at the 5% level, and the sine term is significant at the 10% level. Analysis of prolonged interactions with the stock market reveals that a 1% rise in gold prices corresponds to a 0.98% decline in the stock market. A 1% rise in consumer pricing indices, acknowledged as indications of inflation, results in a 1.03% increase in the stock market. Subsequent to the co-integration analysis and the determination of long-run coefficients among the study variables, asymmetric causality tests were utilized to examine the short-term associations. The causality test employed by Hatemi-J and Roca in 2014 was utilized. Table 6 delineates the examination outcomes, which elucidate the causal relationship between the positive and negative parts of the variables.

Table 6. Hatemi J-Roca (2014) Asymmetric Causality Test Results

Direction of Causality	*M-Wald*	*Boostrap Critical Value*		
		%1	%5	%10
$lnbist^{+}$ ≠> $lnalt^{+}$	3.850** (0.050)	7.746	4.274	2.774*
$lnbist^{+}$ ≠> $lnalt^{-}$	4.420** (0.036)	7.300	4.138**	2.640*
$lnbist^{-}$ ≠> $lnalt^{-}$	0.812 (0.367)	7.111	3.899	2.702
$lnbist^{-}$ ≠> lnalt+	0.059 (0.809)	7.423	3.917	2.756
$lnbist^{+}$ ≠> $lninf^{+}$	0.112 (0.738)	7.571	4.390	2.810
$lnbist^{+}$ ≠> $lninf^{-}$	0.979 (0.322)	7.967	3.948	2.696
$lnbist^{-}$ ≠> $lninf^{-}$	0.071 (0.791)	7.515	4.255	2.722
$lnbist^{-}$ ≠> lninf+	0.414 (0.520)	6.412	3.936	2.695
$lnbist^{+}$ ≠> $lnm2^{+}$	3.327* (0.068)	7.871	4.075	2.927*
$lnbist^{+}$ ≠> $lnm2^{-}$	0.897 (0.344)	8.031	3.979	2.683
$lnbist^{-}$ ≠> $lnm2^{-}$	0.476 (0.490)	8.551	3.756	2.493
$lnbist^{-}$ ≠> lnm2+	2.219 (0.136)	6.807	4.157	2.920
$lnbist^{+}$ ≠> $lnvix^{+}$	0.205 (0.651)	6.879	4.127	2.831
$lnbist^{+}$ ≠> $lnvix^{-}$	0.560 (0.454)	6.432	3.924	2.848
$lnbist^{-}$ ≠> $lnvix^{-}$	1.058 (0.304)	7.359	4.417	3.036
$lnbist^{-}$ ≠> lnvix+	0.444 (0.505)	8.772	3.936	2.705

Notes: ≠> indicates the null hypothesis of no causality. Values in parentheses show asymptotic probability values. The optimal lag length obtained from the VAR model is determined as 2. ***.** and * values indicate causality relationship between variables at 1%, 5% and 10% levels of significance, respectively. Bootstrap number is 1,000

The results of the Hatemi-J and Roca (2014) Asymmetric Causality Test reveal that the relationships between BIST (Borsa Istanbul) and variables such as gold, money supply (M2), inflation (CPI), and the volatility index (VIX) are asymmetric. According to the test results, **positive shocks in BIST** have a significant causality relationship with gold prices in both **positive and negative directions**. Specifically, positive movements in BIST are found to cause both increases and decreases in gold prices (M-Wald: 3.850 and 4.420; $p < 0.05$). This indicates that positive shocks in the BIST index have a bidirectional effect on gold prices, and market participants respond asymmetrically to these positive shocks. In contrast, **negative shocks in BIST** have no significant effect on gold prices (M-Wald: 0.812 and 0.059; $p > 0.10$), suggesting that negative shocks are either less reactive to or absorbed by the gold market. Additionally, **positive shocks in BIST** have a **marginal effect at the 10% significance level** on the M2 (M-Wald: 3.327; $p = 0.068$), but this effect is limited. There is no significant causality relationship between **BIST and inflation (lninf) or the volatility index (lnvix)** ($p > 0.10$). These results suggest that there is either no or only a weak causality relationship between the BIST index and inflation or volatility. These findings demonstrate that the effects of shocks in financial markets are not symmetric, and positive shocks tend to have more pronounced effects on the markets. In particular, the asymmetric causality relationships between BIST and the gold market highlight that positive and negative shocks create different dynamics in financial markets and that market participants exhibit heterogeneous responses to these shocks. In conclusion, this study shows that **the asymmetric causality between the BIST index and the gold market** is an important tool for understanding the complex dynamics in financial markets, and it suggests that policymakers and investors should develop strategies by considering these asymmetric structures in the markets.).

4. Conclusion and discussion

This research investigated the correlation between the Borsa Istanbul (BIST) 100 index, a significant metric in the Turkish financial markets, and various macroeconomic variables. The analysis employed Fourier-based asymmetric causality tests and cointegration techniques to examine the impacts of gold prices, inflation, money supply, and the VIX fear index on the BIST 100. The findings offer significant understanding of the influence of these macroeconomic variables on the BIST 100, particularly within the context of an emerging market such as Turkey.

A significant finding is the pronounced inverse correlation between the price of gold and the BIST 100 index. In times of economic uncertainty, it is observed that investors often shift their focus towards gold, regarded as a safe-haven asset, which consequently results in declines within the stock market. This outcome aligns with the research conducted by Gazel (2016) and Akgün et al. (2013), who similarly observed that the safe-haven status of gold results in adverse impacts on the BIST 100 during times of increasing prices. In a similar vein, Güler and Gülcü (2015) identified a negative correlation between gold prices and the BIST 100, thereby reinforcing the findings of this research.

The positive effect of inflation on the BIST 100 is another notable finding. Rising price levels have led to increased investment activity in the market, driven by inflation expectations. This result is consistent with the studies of Altın (2022) and Kılıç and Özyürek (2022), which emphasize the impact of inflation on investor behaviour and market dynamics. Inflation can affect investment decisions because rising prices can increase the demand for equities, especially in an environment where real returns are adjusted for inflation.

However, the effect of the money supply was found to be limited. While no direct relationship was found between money supply and the BIST 100, expansionary monetary policy may promote market optimism. This finding contrasts with the findings of Başarır (2018) and Karaca (2014), who argued that increases in money supply could have a significant impact on stock markets in both the short and long term. The limited impact observed in this study suggests that the influence of money supply on financial markets may vary in different economic periods in Turkey.

The negligible impact of the VIX fear index on the BIST 100 constitutes a significant finding of this study. The VIX index is commonly viewed as a barometer of global uncertainty and is expected to impact financial markets. This analysis demonstrates a lack of a substantial correlation between the VIX index and the BIST 100. This study contradicts the claims of Başarır (2018), who argued that the VIX index can generate short-term volatility in the Turkish stock market. The study's findings indicate that the VIX index exerts a minimal influence, suggesting that Turkish markets have a certain resilience to global volatility. Nonetheless, numerous research in the current literature have reported conflicting results on the impact of the VIX index on emerging markets. Sadeghzadeh (2018) and Kuzu (2019) emphasized the significant effect of the VIX index on global markets, noting that its influence is typically more limited in emerging markets.

In light of these findings, policymakers and investors should carefully assess the impact of macroeconomic variables on the BIST 100. Economic policy tools can be used to control inflation and prevent excessive demand for safe-haven assets such as gold. In addition, improving investors' financial literacy regarding the impact of inflation and gold prices on stock markets could improve decision-making. Given the limited impact of money supply on the BIST 100, the effects of expansionary monetary policies should be closely monitored and appropriate measures taken if necessary. Finally, the minimal impact of the VIX index suggests that policymakers should focus on developing strategies to further enhance the resilience of Turkish markets to global volatility.

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