

A REVIEW ON THE RELATIONSHIP BETWEEN OIL PRICES AND STOCK PRICES IN TURKEY: NEW EVIDENCES FROM FOURIER APPROACH

Türkiye'de Petrol Fiyatları ile Hisse Senedi Fiyatları Arasındaki İlişki Üzerine Bir
İnceleme: Fourier Yaklaşımından Yeni Kanıtlar*

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Abstract

Oil is one of the most important energy resources in production and consumption processes. Therefore, shocks from oil prices can affect many macroeconomic variables. One of these macroeconomic variables is stock prices, and it is important to investigate the long-term relationship between the two variables. The purpose of this study is to test the long-term existence of a relationship between oil prices and BIST100 index in Turkey by making use of data collected on daily basis between a period of 02/01/2002 and 02/07/2019. Within this context, Fourier stationarity and Fourier cointegration tests were utilized since they take into account both sharp and gradual/smooth structural breaks. Findings of the analysis indicate that there is not a long-term cointegration relationship between oil prices and stock prices under both sharp and gradual/smooth structural breaks. Regarding the findings in this context, it can be inferred that changes in oil prices are not to be effective on the share prices in Turkey.

Keywords:

Oil Prices, Stock
Prices, Fourier
Analysis

JEL Codes:

F65, Q43, C58

Özet

Petrol, üretim ve tüketim süreçleri içerisinde en önemli enerji kaynaklarından birisidir. Bu nedenle petrol fiyatlarında meydana gelen şoklar birçok makro ekonomik değişkeni etkileyebilmektedir. Söz konusu makro ekonomik değişkenlerden birisi de hisse senedi fiyatları olup, iki değişken arasındaki uzun dönemli ilişkiyi arařtırmak önem arz etmektedir. Bu çalışmanın amacı, 02/01/2002 - 02/07/2019 tarihleri arasında günlük olarak toplanan verilerden yararlanarak Türkiye'de petrol fiyatları ile BIST100 endeksi arasındaki ilişkinin uzun vadede varlığını test etmektir. Bu bağlamda, çalışmada hem keskin hem de aşamalı / yumuşak yapısal kırılmaları hesaba kattıkları için Fourier durağanlık ve Fourier eşbütünleşme testleri kullanılmıştır. Analizin bulguları, hem keskin hem de aşamalı / yumuşak yapısal kırılmalar altında petrol fiyatları ile hisse senedi fiyatları arasında uzun vadeli bir eşbütünleşme ilişkisi olmadığını göstermektedir. Bu bağlamda bulgulara bakıldığında, petrol fiyatlarındaki değişimlerin Türkiye'deki hisse senedi fiyatları üzerinde etkili olmadığı söylenebilir.

Anahtar Kelimeler:

Petrol Fiyatları, Hisse
Senedi Fiyatları,
Fourier Analizi

JEL Kodları:

F65, Q43, C58

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1. Introduction

Oil, as one of the main energy resources, is a significant input for all sectors, directly or indirectly. In 2018, the average daily oil consumption in the world is 99843 barrels and the share of oil consumption in all energy sources is approximately 33% (British Petroleum [BP], 2019). Therefore, increases in oil prices, which are an essential input in the production process, increase uncertainty and lead to negative effects on wealth and investment (Maghyereh and Al-Kandari, 2007, p. 450). Therefore, many macroeconomic variables are adversely affected by the volatility in oil prices.

There were significant increases in oil prices in certain periods. In 1973, there occurred the first oil shock, due to the embargo imposed by OPEC (Organization of Petroleum Exporting Countries). In 1979, the Iranian Revolution caused the second oil shock. Just after these two oil shocks, studies focusing on the relationship between oil prices and macroeconomic variables were contributed to the literature (Burbidge and Harrison, 1984; Gisser and Goodwin, 1986; Hamilton, 1983). Afterwards, an excessive volatility was observed in oil prices during the Iran-Iraq War, started in 1980, the Gulf War in 1990, the Asian Crisis in 1998, the Invasion of Iraq in 2003, Global Crisis in 2008, and the Arab Spring in 2010. All these developments have kept alive the examination of the relationship between oil prices and macroeconomic variables.

Oil, like capital and labor, is an important input used directly or indirectly in the production process in all sectors. As the increasing volatility in oil prices results in uncertainty, it also affects cash flows. When oil prices increase, production costs will increase if oil is not substitutable. Therefore, cash flow will decrease and this will trigger stock prices to fall. However, the increase in oil prices causes inflation to increase and the central banks raise interest rates. High interest rates make bonds more attractive rather than falling stocks. Additionally an increase in oil prices depends on whether the companies are producers or consumers of petroleum and petroleum products. Since oil-producing companies are less than oil consuming companies in the world, the increase in oil prices may have negative effects on stock prices (Basher and Sadorsky, 2006, p. 225-226).

The motivation of this study is to investigate the long-term relationship between stock prices and oil prices. In this context, it is to make suggestions to both investors and policy makers. With this motivation, the purpose of this study is to examine the impact of oil prices on stock prices in Turkey, utilizing Fourier SHIN cointegration test, contributed to the literature by Tsong, Lee, Tsai and Hu (2016). In this context, daily data for the period between 02/01/2002 and 02/07/2019 were used. The advantage of the Fourier SHIN Cointegration test over other tests in the literature is that it examines the long-term relationship between two variables, taking into account sharp structural breaks as well as smooth structural breaks. Since our study examines the relationship between stock prices and oil prices on daily data using Fourier approach, it is of importance to contribute to the literature.

The organization of this paper is as follows. In section 2 is presented the relevant literature. In section 3, we introduce econometric methodology used in the study. In section 4, data will be explained first and the empirical findings will be discussed later. In section 5, the findings obtained from the analysis will be examined and discussed.

2. Literature Review

A summary of the studies examining the relationship between stock prices and oil prices is presented in Table 1. Within an overall perspective, it can be inferred that there exists a relationship between oil prices and stock prices. In particular, it can be emphasized that shocks in oil prices have significant impact on stock prices. However, Apergis and Miller (2009), Arouri, Bellalah and Nguyen (2011), Çıtak and Kendirli (2019), Gay (2008) and İřcan (2010) provide evidences that there is no relationship between oil prices and stock prices.

Table 1. Literature Review

Author(s)	Period and method	Countries	Results
Sadorsky (1999)	1947: M1 – 1996: M4, VAR Model	USA	Movements in crude oil prices exhibit negative behavior in the stock market.
Marghyereh and Al-Kandari (2007)	1996: M1 – 2003: M12, Nonlinear Cointegration Test	Gulf Countries	There is a nonlinear relationship between the two variables.
Cong, Wei, Jiao and Fan (2008)	1996: M1 – 2007: M12, VAR Model	China	Shocks in oil prices do not have a significant impact on stock prices.
Gay (2008)	1999-2006 (Montly data), Box-Jenkins ARIMA Model	BRIC Countries	There is no relationship between the two variables.
Park and Ratti (2008)	1986: M1 – 2005: M12, VAR Model	USA and 13 European Countries	Shocks in crude oil prices cause negative shocks on real stock returns.
İřcan (2010)	3 December 2001 – 31 December 2009, Johansen Cointegration	Turkey	There is no long-term cointegration relationship between the two variables.
Arouri et al. (2011)	1999: M1 – 2009: M9, VAR Model and Cointegration	Gulf Countries	There is a short-term positive effect between the two variables. In the long run, however, there was no relationship between the two variables. (except for Bahrain).
Broadstock, Cao and Zhang (2012)	January 2000 – May 2011 (Weekly data), Time Varying Conditional Correlations	China	International oil prices affect the stock returns in the energy sector
Ünlü and Topcu (2012)	1990-2011 Johansen Cointegration, VEC and Toda-Yamamoto Causality	Turkey	Oil prices positively affect the stock market.
Şener, Yılancı and Tıraşođlu (2013)	2002-2012 (Daily data), Hidden Cointegration	Turkey	There is a long-term relationship between the two variables.
Cunado and Gracia (2014)	1973: M2 – 2011: M12 VAR and VEC Model	12 European Countries	Stock prices are due to shocks in oil prices and are negatively affected.

Table 1...

Le and Chang (2015)	1997: M1 – 2013: M7, Gregory Hansen and Toda Yamamoto	Malaysia, Singapore and Japan	Increases in oil prices have different effects on stock prices in different markets and periods.
Abdullah, Saiti and Masih (2016)	2007 – 2014 (Daily data), MGARCH-DCC and Wavelet Approaches	Malaysia, Thailand, Singapore, Phillippine and Indonesia	In the study, which examined the relationship between Islamic stocks and oil prices, it was observed that both variables had less correlation in the short term and more correlation in the long term.
Kendirli and Çankaya (2016)	4 January 2000 – 30 April 2015 Granger Causality	Turkey	BIST100 Index and Borsa Istanbul Transportation Index are the reasons for crude oil prices.
Zortuk and Bayrak (2016)	2002: M4 – 2014: M8, Autoregressive Distribution Lag Test for Treshold Cointegration	G7 Countries	There is a cointegration relationship between stock prices and oil prices.
Hu, Liu, Pan, Chen and Xia (2017)	2004: M8 – 2016: M8, SVAR Model and NARDL	China	Shocks in oil prices have an impact on stock prices both in the short and long term.
Salisu and Isah (2017)	2000: M1 – 2015: M12, Panel ARDL	5 oil exporting countries and 8 oil exporting countries	Stock prices react asymmetrically to changes in oil prices in all countries.
Basher, Haug and Sadorsky (2018)	1974: M1 – 2015: M8, SVAR Model	8 Oil Exporting Countries	Shocks in oil prices have a significant impact on stock returns.
Elian and Kisswani (2018)	3 January 2000 – 9 December 2015 (Daily data), ARDL and Toda-Yamamoto Causality Test	Kuwait	There is a bilateral causal relationship between the two variables.
Naser and Rashid (2018)	1991: M1 – 2011: M3, FAVAR Model	BRIC	The response of stock prices to oil price shocks is quite permanent and certain.
Al-Hajj, Al-Mulali and Solarin (2018)	1990: M1 – 2016: M11, NARDL	Malaysia	There is a long-term relationship between the two variables.
Çıtak and Kendirli (2019)	2010: M1 – 2019: M6, NARDL	Turkey	Oil prices does not have any impact on the stock market returns in the long-run.
Mokni (2020)	1999-2018 (Montly data), Structural VAR and Time-Varying Parameter Regression Models	Oil-Exporting Countries	Stock market returns show different responses to oil shocks over time.
Ji, Liu, Zhao and Fan (2020)	1994: M2 – 2016: M12, SVAR Model	BRICS	There is a significant spreading effect from oil-specific demand shocks to stock returns.

Studies usually used monthly data except few exceptions (Abdullah et al., 2016; Broadstock et al., 2012; Elian and Kisswani, 2018; İřcan, 2010; Kendirli and ankaya, 2016; řener et al., 2013), were generally used in the studies. Most studies in the literature examining the relationship between stock prices and oil prices do not take structural breaks into account. However, studies that include both sharp and smooth structural shifts into model do not exist in the literature, although there exist studies considering sharp structural breaks (Le and Chang, 2015). Therefore, econometric methods that incorporate both sharp and smooth structural shifts in the model were preferred for this study.

3. Econometric Methodology

In this study, long-term relationship between stock prices and oil prices in Turkey were examined. In this context, the Fourier Shin Cointegration test recommended by Tsong et al. (2016) was used in the study. For the cointegration test, first the unit root properties of the variables should be examined. Therefore, the unit root properties of the variables were investigated by Fourier KPSS (Kwiatkowski-Phillips-Schmidt-Shin) unit root test first developed by Becker, Enders and Lee (2006). The FKPSS test, unlike other unit root tests, takes into account both sharp structural changes and smooth transition structural changes. Becker et al. (2006) consider the following data generation process:

$$y_t = \alpha_0 + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + \eta_t + \varepsilon_t \quad (1)$$

where the η_t process is described as:

$$\eta_t = \eta_{t-1} + u_t \quad (2)$$

where ε_t are errors and u_t , are independent and identically distributed with variance σ_u^2 . In addition to k shows the optimal number of observations and π is the constant (3.14).

Under the null hypothesis $\sigma_u^2 = 0$, so that the process described by eqn (1) is stationary. The test statistic is given by:

$$\tau_\mu(k) = \frac{1}{T^2} \frac{\sum_{t=1}^T \tilde{S}_t(k)^2}{\tilde{\sigma}^2} \quad (3)$$

where $\tilde{S}_t(k) = \sum_{j=1}^t \tilde{\varepsilon}_j$ and $\tilde{\varepsilon}_j$ are the OLS residuals from the Equation (1).

Becker et al. (2006) proposed that a nonparametric estimate of σ^2 be obtained by choosing a truncation lag parameter l and a set of weights $w_j, j = 1, 2, \dots, l$:

$$\sigma^2 = \tilde{\alpha}_0 + 2 \sum_{j=1}^l w_j \tilde{\alpha}_j \quad (4)$$

where $\tilde{\alpha}_j$ is j th sample autocovariance of the residuals $\tilde{\varepsilon}_t$ from equation (1). The optimal frequency (k) number in Equation (1) is obtained by searching all frequencies from 1 to 5. Hence, the optimal number of frequency (k) is selected using the value which gives the minimum sum of squares residuals.

To test the significance of the Fourier components, Becker et al. (2006) suggest to use F-test. The necessary critical values for both the FKPSS and F-tests are tabulated in Becker et al. (2006) (Yılancı, Aslan and Özgür, 2018).

In the second phase of the analysis, the FSHIN cointegration test was used. In the FSHIN cointegration test, the following model is used.

$$y_t = d_t + x_t' \beta + \eta_t \quad (5)$$

where $\eta_t = \gamma_t + v_{1t}$, $\gamma_t = \gamma_{t-1} + u_t$ with $\gamma_0 = 0$, and $x_t = x_{t-1} + v_{2t}$. Here γ_t is a random walk with mean zero. The deterministic component d_t in Eq (5) is assumed as

$$d_t = \sum_{i=0}^m \delta_i t^i + f_t \quad (6)$$

with $m = 0$ or $m = 1$, and

$$f_t = \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) \quad (7)$$

The scalar v_{1t} and p-vector v_{2t} are stationary, and hence, y_t and x_t are all I(1) processes. Obviously, if $\sigma_u^2 = 0$, $\eta_t = v_{1t}$ is a stationary process, implying that y_t and x_t are cointegration against the alternative of non-cointegration can be written as $H_0: \sigma_u^2 = 0$ versus $H_1: \sigma_u^2 > 0$. In order to be able to test the basic hypothesis of cointegration, equation (5) can be rewritten as:

$$y_t = \alpha_0 + \alpha_1 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_2 \cos\left(\frac{2\pi kt}{T}\right) + x_t' \beta + v_{1t} \quad (8)$$

where k , t , T and π are defined as before. The FSHIN test statistic can be obtained by using: $CI_f^m = T^{-2} \hat{\omega}_1^{-2} \sum_{t=1}^T S_t^2$, where $S_t = \sum_{t=1}^T \hat{v}_{1t}$ is the partial sum of the OLS residuals from Eq (8), and $\hat{\omega}_1^2$ represents the consistent estimator for the long-run variance of v_{1t} .

F-test is also used in FSHIN cointegration test to test the significance of Fourier components. If F-test is not statistically significant, SHIN cointegration test results proposed by Shin (1994) should be used since the Fourier components are not significant.

4. Data and Empirical Findings

4.1. Data¹

Data set used in the study was taken from the Central Bank of Turkey and definitions are presented in Table 2. Natural logarithm of both variables was taken and included in the analysis. Daily data for the period of January 2, 2002 - July 2, 2019 were used.

Table 2. Variables Descriptions

Variable	Definition
In stockprice	Istanbul Stock Exchange National-100 Index (BIST100)
In oilprice	Europe Brent Spot Price FOB (Dollars per Barrel)

¹ Ethics of research and publication were followed in this study, which does not require permission from the ethics committee and/or legal/special permission.

The stock prices and oil prices used in the study are presented in Figure 1. The figures display an upward trend on oil prices until global crisis in 2008 and sharp decreases in prices in post-crisis period. As a result of the developments, so-called ‘Arab Spring’, started in 2010, oil prices increased once again. We observe that there occurred sharp declines in oil prices between 2014 and 2016 again. There are several reasons for this. The first cause is that China's energy demand decreased, depending on the fact that its growth rate slowed down during this period. Secondly, the oil supplied to the market in this period is higher than the demand. This is specifically caused by the fact that Saudi Arabia, the largest oil producer, refused to reduce its oil supply in this period. Thirdly, perhaps most importantly, the US appeared to be a country to meet its own energy needs [as oil and natural gas], just after it begins to produce a significant amount of oil and natural gas as a result of the US shale gas / shale oil revolution and investments in this period. Consequently, the downward trend in oil prices in general continued during the first months of 2016 as well. Russian and Saudi Arabian Energy Ministers, who want to reduce the negative effects of this circumstance for themselves, announced that they had decided to freeze the oil supply at the level of January 11 along with an agreement signed on 16 February 2016.

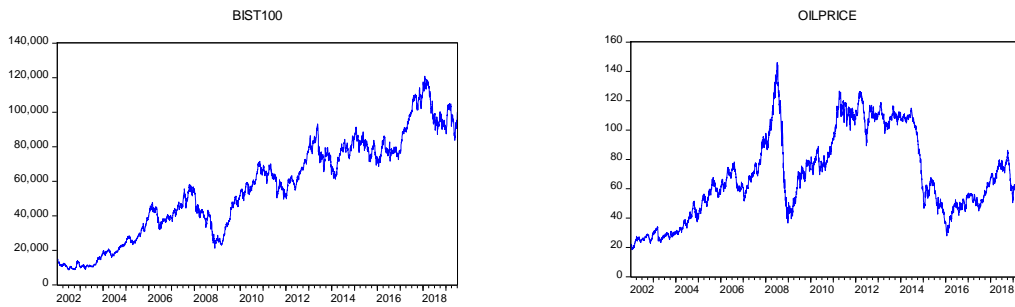


Figure 1. BIST100 and Oil Price (02/01/2002 – 02/07/2019)

Descriptive statistics of the data set used in the study are presented in Table 3. Accordingly, while the average stock price in Turkey was calculated as 55995.55 for the period taken, oil prices were at the level of \$ 69.47. When the standard deviation estimates examined, stock prices were more volatile than oil prices in the period under consideration. Jarque - Bera statistics reject the null hypothesis that assumes both variables are normally distributed. Therefore, both variables do not have characteristics to be normally distributed. This is expected when working with financial data.

Table 3. Descriptive Statistics

	stockprice	oilprice
Mean	55995.550	69.470
Median	56754.410	65.470
Maximum	120845.300	146.080
Minimum	8627.420	18.410
Std. Dev.	28653.140	28.947
Jarque – Bera (Prob.)	185.827 (0.000)	225.011 (0.000)
Obs.	4565	4565

4.2. Empirical Findings

Before the analysis of the long-term relationship between stock prices and oil prices, the stationarity characteristics of both series were investigated. It is observed in Table 4 that both series are not stationary. Therefore, the difference between the two series was taken and the FKPS test for stationarity was employed again. The F test, which provides the significance level of trigonometric terms, indicates that trigonometric terms in series the difference taken are not significant; for this reason, KPSS stationarity test was also applied to the series the difference taken. According to the findings obtained from this test, it is figured out that the difference between the two series becomes stationary. Therefore, both series are first order integrated I(1) series.

Table 4. Findings of Fourier KPSS Stationarity Test

Variables	FREQ	Min SSR	FKPSS	KPSS	F_t
ln stockprice	1	405.687	1.171 (53)		3152.68*
ln oilprice	1	1103.820	2.624 (53)		2032.64*
Δ ln stockprice	3	8543.49	0.275 (5)*	0.088 (13)*	2.083
Δ ln oilprice	3	1.403	0.072 (15)*	0.261 (14)*	2.053

Notes: 5% critical values for the F-KPSS: = 1 \Rightarrow 0.170 $freq = 3 \Rightarrow$ 0.439. 5% critical values for the F_t are 4.651. 5% critical values for the KPSS are 0.463. The values in parentheses indicate the bandwidth width.

When series in Figure 2 are examined, it is observed that Fourier estimations of both series are appropriate and capture long oscillations on the series.

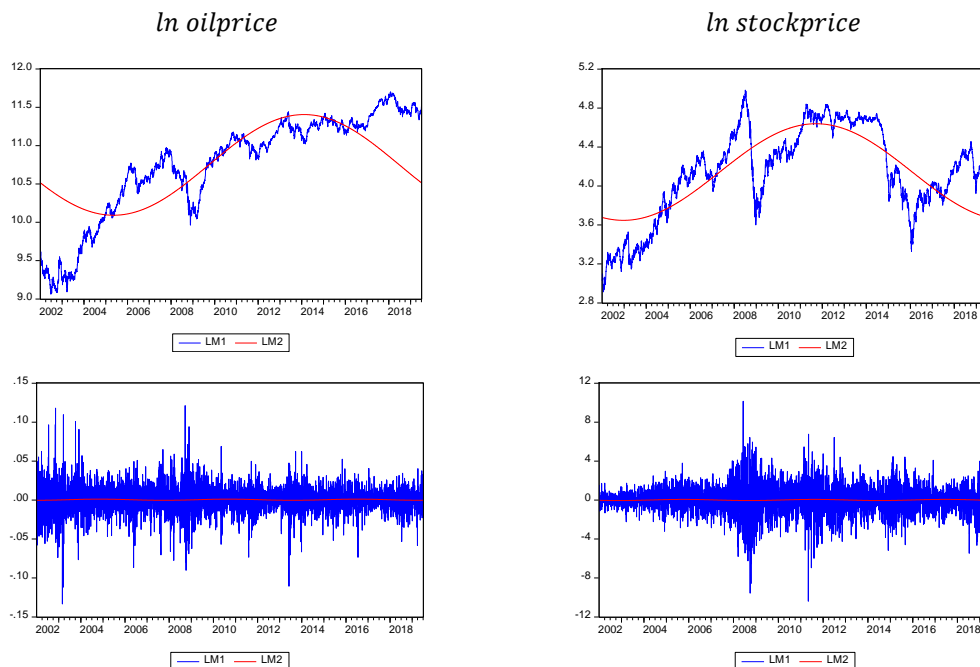


Figure 2. Variables and Fourier Functions

Table 5. Findings of Fourier SHIN Stationarity Test

FREQ	Min SSR	FSHIN	SHIN	F_t
2	220.653	0.197	1.741	8.019*

Notes: 5% critical values for the Fourier SHIN cointegration test for frequencies 2 are 0.182. 5% critical values for the SHIN cointegration test are 0.314. 5% critical values for the F_t are 4.066. (*) notation represents significance in 5%.

The long-term relationship between stock prices and oil prices was examined by both FSHIN and SHIN cointegration tests. Findings for Cointegration Test are given in Table 5. Fourier components, trigonometric terms, are significant as the F test is statistically significant. Therefore, FSHIN cointegration test findings can be interpreted. However, both FSHIN cointegration test findings and SHIN cointegration test results indicate that there exists no long-term relationship between the two variables. Accordingly, sudden changes in oil prices do not have any long-term impact on stock prices. Finally, the findings obtained in this study, are compatible and parallel with those obtained by Apergis and Miller (2009), Arouri et al. (2011), Gay (2008) and İřcan (2010).

5. Conclusions

In this study, the impact of oil prices on stock prices in Turkey by making use of the Fourier SHIN cointegration test developed by Tsong et al. (2016). Findings obtained indicate there exists no significant long-term relationship between the two variables, considering the sharp and soft fractures as well. Accordingly, we can conclude that oil prices are not among the determinants or predictors of stock prices in the long run. Therefore, both variables do not move together in the long run. When a long-term investment decision is taken for investors, oil prices may not be considered as an important indicator in the decision-making process for the BIST100 index. However, the relationship between the two variables in sectors where oil is an important input can be examined in future studies.

On the other hand, the change in oil prices may have a better effect on the inflation rate. In this case, the inflation rate may have a deeper and a stronger impact on stock prices. From the investors' point of view, it will be useful and functional for them to examine other macroeconomic variables as they do not prioritize the movements in oil prices during the decision-making process. Because, the findings additionally indicate that other national and international macroeconomic variables (such as production, inflation, interest rate, foreign trade balance) may be determinant on stock prices. In this case, further investigation is required regarding the relationship between other macroeconomic variables and stock prices.

Researchers' Contribution Rate Statement

I am a single author of this paper. My contribution is 100%.

Conflict of Interest Statement

There is no potential conflict of interest in this study.

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