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THE EFFECTS OF PRICE AND VOLATILITY INDICES OF STRATEGIC COMMODITIES ON STOCK MARKETS: A STUDY ON BRICS ECONOMIES*

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Abstract

The effect of gold, oil prices, which are strategic commodities, and gold, oil volatility indices on the BRICS stock exchanges is investigated in this paper. The relationship between the variables is analysed for the short and long-run using the NARDL method. Gold prices have a negative effect on stock markets except Brazil and Russia, in the short and long-run. Changes in oil prices have a negative effect on stock prices in South Africa, which imported oil, and a positive effect in net oil exporters Brazil and Russia, in the short and long-run. It is concluded that positive and negative shocks of strategic commodity volatilities have an asymmetric effect on the stock exchanges of emerging countries in the short and long-run.

Keywords: Strategic Commodity Prices, Gold Volatility Index, Oil Volatility Index, BRICS Economies, Nonlinear ARDL

JEL Codes: G10, G15, E30

STRATEJİK EMTİALARIN FİYAT VE VOLATİLİTE ENDEKSLERİNİN HİSSE SENEDİ PİYASALARI ÜZERİNDEKİ ETKİLERİ: BRICS EKONOMİLERİ ÜZERİNE BİR İNCELEME

Öz

Bu çalışmada, stratejik emtialar olan altın, petrol fiyatları ile altın, petrol volatilite endekslerinin BRICS borsalarına etkisi araştırılmıştır. NARDL yöntemiyle değişkenler arasındaki ilişki kısa ve uzun dönemli ilişki analiz edilmiştir. Kısa dönem ve uzun dönem için altın fiyatlarının Brezilya ve Rusya hariç hisse senedi piyasalarında negatif etkili olduğu tespit edilmiştir. Petrol fiyatlarındaki değişikliklerin kısa dönemde ve uzun dönemde, petrol ithal eden Güney Afrika'da hisse senedi fiyatlarını negatif, net petrol ihracatçısı Rusya ve Brezilya'da ise pozitif etkilediği tespit edilmiştir. Stratejik emtia volatilitelerinin negatif ve pozitif şoklarının ise kısa ve uzun dönemde gelişen ülkelerin borsaları üzerinde asimetrik etkili olduğu sonucuna ulaşılmıştır.

Anahtar Kelimeler: Stratejik Emtia Fiyatları, Altın Volatilite Endeksi, Petrol Volatilite Endeksi, BRICS Ekonomileri, Doğrusal Olmayan ARDL

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INTRODUCTION

All financial indicators related to stock exchanges, which play a big role in development of national economies and the spread of ownership, are very important factors in predicting market movements (Kurt Cihangir, 2019, p.294). While the relation among stock exchanges and macroeconomic variables has gained a very important dimension from past to present, studies that examine the existence and direction of this relationship in micro and macro dimensions are very effective tools for investors to make decisions. The most important macroeconomic variables affecting stock prices are exchange rate, inflation, money supply, industrial production index, interest rate, oil and gold prices, oil and gold volatilities (Gokmenoglu and Fazlollahi, 2015, p.479). The main economic indicators that guide investors about how effectively an economic and financial system is functioning are stock indices, futures based on securities, exchange rates and commodity prices, especially gold and oil prices, which are called strategic commodities (Singhal, Choudhary and Biswal, 2019, p.255). The most important common features of gold and oil, which are called strategic commodities, are their high liquidity and almost similar fluctuations. Since gold and oil prices show similar fluctuations; gold and oil volatility indices calculated using gold and oil prices are generally in line with each other. Undoubtedly, a developed stock market is one of the most important indicators of the development of an economy. Gold and oil prices have intense economic effects on the financial activities of all sectors in the world economy. The effect of gold and oil volatilities on stock prices is evident in consumption in the real sector, industrial production and investments in the financial sector.

Gold is one of the most preferred investment instruments in countries with limited financial product diversity. The significant increases in gold prices, especially in recent years, the use of gold to hedge against interest rate, inflation and exchange rate risks, and the fact that it is a liquid asset have increased the investment alternative of gold day by day. It can be stated that gold is an important investment alternative that remains popular in developing countries (Ray, 2013, p.12). The demand and value of gold increase during periods of economic crisis. The negative relationship between gold prices and stock prices indicates that gold is a strong instrument for hedging purposes, while the positive relationship indicates which gold is not a safe haven. What is theoretically expected among stock and gold prices is a negative relationship. This expectation is undoubtedly based on the fact that gold continues to be a reliable investment instrument during periods of downturn in the stock markets, and when gold prices fall, gold will be abandoned in favour of stock market investments. Therefore, gold investment remains one of the most reliable investments even in times of crisis in the stock market.

Developments in technology along with industrialisation increase the demand for energy and oil meets the increasing energy demand. Depending on the dependence of economies on oil, it leads to fluctuations in oil demand and supply and, accordingly, in oil prices. Since oil is the raw material of many industries, price movements in oil prices are reflected in the prices of products and affect the profitability and stock prices of companies. An increase in oil prices causes to an increase in production costs in industries where oil is used as raw material, a decrease in cash flows and thus in stock prices. Naturally, this situation varies depending on whether the companies are consumers or producers of oil or petroleum products. Considering that the number of companies that are oil consumers is much higher than the number of companies that are oil producers, it is normally that the expected relation must be negative between oil and stock prices.

Commodity and financial markets have been integrated with the globalisation trend. The financial service conditions that have improved with the integration of markets have enabled investors to see commodity markets as alternative investment instruments and to invest in these areas. Since the early 2000s, sharp increases in the prices of precious metals and energy products have been paralleled by increased activity in the commodity derivatives market. The number of commodity derivative contracts traded on the exchange almost tripled between 2002 and 2005. Both the number of exchange-traded commodity derivative contracts and over-the-counter trading of commodity derivatives have increased rapidly. According to statistics, the nominal value of over-the-counter commodity derivative contracts has increased 14 times to 6.4 trillion dollars in just 5-6 years since the early 2000s. The share of commodities in over-the-counter derivatives trading also increased from 0.5% to 1.7%. The presence of investors in commodity markets has increased significantly in the last few years (Domanski and Heath, 2007, p.53-54). The concentration of investments in commodity markets, combined with the economic factors affecting the markets, led to sharp volatility movements in commodity markets. Volatility refers to the fluctuation in the price of a particular product in financial markets over a certain period of time.

The recent excessive volatility in oil and gold prices has attracted the attention of financial actors, public authorities, and researchers. This fluctuation in strategic commodity prices affects the decision-making processes of the economic and financial systems of countries, investors, and public authorities. These sharp fluctuations in prices point to a period of high gold and oil price volatility in the global system in the near future.

After the 2008 global crisis, significant investment opportunities emerged in the stock exchanges of developing economies and they entered a rapid development phase. International capital movements accelerated, and significant capital transfers were realised from developed markets to emerging markets. Moreover, as stated in the World Gold Council and International Trade Centre reports, developing countries are the world’s leading producers and consumers of gold and oil (ITC, International Trade Centre Trade

Briefs 2018). Therefore, the fact that oil and gold which have the status of strategic commodities, have an important place in the markets of developing countries constitutes the starting point of this study.

The study aims to investigate the short-run and long-run asymmetric effects of oil, gold prices, gold, and oil volatility indices on stock markets of emerging countries during the period between June 2008 and April 2017. The motivation of the study is the idea that asymmetric effects of variables may have a different effect than symmetric effects. The NARDL bounds test approach developed by Shin, Yu, and Greenwood-Nimmo (2014) was used to find out the asymmetric cointegration between selected variables. Unlike the classical cointegration tests, an important reason why the NARDL method is preferred in this study is that it is possible to determine the short- and long-run relationships between variables, which cannot be obtained by classical methods, and to detect the asymmetric responses of the markets to negative and positive shocks of independent variables.

The study contributes to the domestic and foreign literature in terms of revealing the asymmetric effects of strategic commodities on stock prices in the BRICS economies, that are among the leading emerging countries in terms of market capitalization, trading volume and economic indicators. The asymmetric effects obtained as a result of the NARDL approach used in the study have caused scepticism towards the symmetric analyses previously used to investigate the relationship between commodity and stock prices. In addition, an important contribution of the study to the literature is that, unlike the classical cointegration tests, the effects of decreases and increases in independent variables are taken into account both in the short and long-run.

In order to select the countries to be included in the study, basic indicators related to the economic conditions and stock exchanges of that economies were accessed and the countries to be analysed in the study were determined with the main purpose of determining the countries ranking first in terms of market capitalization and trading volume among developing countries. These countries are Brazil, Russia, India, China, and South Africa, known as BRICS economies.

In line with the objective of the study, firstly, literature studies will be presented. In the next section of the study, the data set, model and methodology section, information on the dataset, model, and econometric method to be used in the analysis will be presented. The findings obtained by analysing the study will be presented in tables in the findings section. Finally, the study will be completed by listing and interpreting the results of the analysis in the result and evaluation section.

LITERATURE REVIEW

Studies examining the effects of oil and gold prices, which are the strategic commodities considered in the study, on stock markets are frequently encountered, but the lack of studies investigating the effects of prices as well as the volatility indices of these commodities on the markets makes this study unique. A review of the literature, detailed below, reveals that the volatilities of commodities are either not taken into account or are calculated using GARCH (Generalized Autoregressive Conditional Variance) models. In addition, generally symmetric analyses such as the ARDL (Autoregressive Distributed Lag) model are used in many papers. In our study, the NARDL (Nonlinear Lag Distributed Autoregressive) method is used to research the effect of increases and decreases in oil and gold prices and volatility indices and to assess whether this effect is asymmetric. Further, it is thought that the study will fill the gap in the literature since it deals with BRICS countries, which rank first among developing countries in terms of market capitalization and transaction volume, and there has not been a similar study on this group of countries before.

Hammoudeh and Yuan (2008), investigated the volatility behaviour of silver, copper and gold in the face of interest rate and oil shocks using a two-factor GARCH model for the period 1990-2006. Analyses indicate that silver and gold are good alternative investments in times of economic distress. Choi and Hammoudeh (2010), examined the volatility behaviour between industrial commodities (gold, oil, silver, copper) and stock markets (S&P 500 index) using the DCC-GARCH method using weekly data between 1990 and 2006. The dynamic conditional correlations obtained from the analysis show that the correlations between all commodities have increased, except the S&P 500 and commodities. Chan, Treepongkaruna, Brooks and Gray (2011), investigated the relationship between the returns of financial assets (US equities and bonds), real estate (US Case-Shiller Index), and commodities (gold and oil) using a general Markov Regime-Aversion Model (MS-VAR). Two different economic regimes are analysed in this study. The first one is economic stagnation and the second one is economic expansion. During the recessionary periods, there is a shift from gold to equity markets. There is also strong evidence of a flight from equity markets to treasury bonds. Le and Chang (2012), investigated the short and long-run relationships between oil and gold, and stock price, interest rate and exchange rate of Japan, which is a country that holds high amounts of gold and consumes oil, using monthly data between 2008 and 2011 with the ARDL approach. The results of the analyses show that gold and equity prices, among others, may lead to higher inflation expectations. Gold prices were found to affect interest rates in Japan, only, in short run. Moreover, the findings of the study can be interpreted as investors' optimal investment choice in the long run is to include gold or oil or both in their portfolios. Using daily data for the period 1998-2011, Sujit and Kumar (2011), investigated the relationships between gold price, oil price, S&P 500 returns and exchange rates using VAR and cointegration analyses. The volatility in gold prices is largely affected by gold itself rather than other commodities. It is concluded that changes in WTI oil prices explain approximately 2% of the fluctuations in the S&P 500, while changes in the S&P 500 explain 1.5% of the gold price fluctuations. Ray (2012), investigated the effect of some macro variables on Indian stocks using annual data for 1990-2010. Multiple regression analysis and Granger causality tests were applied. There is a negative relation among oil, gold and stock prices. Causality tests findings: Bidirectional causality was found stock prices and crude oil prices and wholesale price index. Samanta and Zadeh (2012), investigated the co-movements between NYMEX crude oil prices, gold prices, US Dollar index and Dow Jones industrial stock average index using daily data for the period 1989-2009. VARMA (vector autoregressive moving average) model was used in this study. It was found that gold and stock prices are affected by the changes in themselves, while oil prices and exchange rates may be affected by other variables. Although the diffusion indices obtained as a result of the estimations are very small, it is stated that the diffusion indices increase in the long run and therefore, it can be interpreted that the existence of cointegration.Barunik, Kocenda and Vacha (2013), analysed the dynamic relationships between gold, oil and US stocks with time-frequency analysis and wavelet approach using daily and intraday data for the period 1987-2012. As a result of the analyses, heterogeneity in the correlations between asset pairs is observed for all three of gold, oil and equity investments during economic downturns and financial crises. Heterogeneity is found to be even more dominant in the correlations between equities and gold. After financial crisis, correlations between the three assets increased and became homogenous. Bhunia (2013), tested the relation of gold prices, Indian stock markets and oil prices for 1991-2012. Co-integration and causality analyses used in the study. The variables act together in the long run. Gold is found to be an important alternative investment instrument and safe haven for Indian stock markets. Causality test revealed a bidirectional causality between gold prices and NSE index; BSE index and gold prices, NSE and crude oil prices, crude oil prices and BSE. Creti, Joëts and Mignon (2013), conducted a study analysing the relation between commodity markets volatility and stocks. In the study, daily data between 2001-2011 and the DCC GARCH method were used. The S&P 500 and prices of 25 commodities were selected in the paper. The analyses suggest that volatility has evolved over time and the correlations between commodities and stocks increased. According to the cost mechanism, the increase in oil prices leads to increased costs, decreased profitability, and ultimately to a decrease in the value of shares. Therefore, it can be stated that oil does not exhibit portfolio diversification material characteristics. The idea that gold prices increase inversely to stock prices during downturns in equity markets, thus gold prices are a safe haven during periods of equity market distress was supported. Hussin, Muhammad, Razak, Tha and Marwan (2013), analysed the relationship between strategic commodities, gold and oil prices and Malaysian Islamic stocks for the period 2007-2011 using the VAR model. No long-run co-integration between Islamic stock returns and strategic commodities has found. The findings in the causality context point to bidirectional causality between stocks and oil prices. It was found that stock returns and gold prices are not affected by each other in either direction. It is concluded that Islamic Malaysian stocks are affected by oil prices in the short-run. Therefore, gold prices are not a valid variable in predicting of Islamic stock markets. Gokmenoglu and Fazlollahi (2015), researched the interaction among oil, gold and stock markets and took the S&P500 as a basis for their study. ARDL cointegration approach was used to test the interaction. A long-run equilibrium between the variables and the S&P500. Basher and Sadorsky (2016), conducted a comparative analysis to model the hedging relations among oil, gold, VIX and bond prices in emerging equity markets. The findings of the analysis showed that oil prices are the ideal asset type for hedging emerging equity prices. Ayayadın and Barut (2016), tested the relation of oil and gold prices on BIST100 returns for the period 1997-2016 using cointegration and causality tests. Analyses indicated that there is a negative relation among oil prices and index return and a positive among gold prices and the index. Huang, An, Gao and Huang (2016), analysed the relation among Chinese stock markets, oil and gold prices using daily data between 1991 and 2014. According to the results; Brent oil and stock prices; gold and stock prices are mutually causal. Jain and Biswal (2016), analysed the relationships between the Indian stocks, Brent oil and gold prices and USD/INR (Indian rupee-dollar exchange rate) with the DCC-GARCH method for 2006-2015. The relationship among crude oil and the Indian rupee was higher in 2008 and 2013 than the other periods examined, the correlation among oil prices and the stocks was high, and there was a short-run negative relation between stock and gold. Raza, Shahzad, Tiwari and Shahbaz (2016), analysed the asymmetric effects of gold, oil prices and their volatilities on developing economies' stocks. Analyses using the NARDL method revealed a positive relation among gold and stock prices and a negative relation among oil and stock prices. Gold and oil volatilities are found to have negative effects on emerging economies. Bouri, Jain, Biswal and Roubaud (2017), investigated the co-integration and asymmetric causality between oil, gold and Indian stocks using expected volatility indices for the period 2009-2016. The analysis methods used are the ARDL approach and Kyrtsou-Labys tests. Analyses determine that the expected volatilities of oil and gold have a cointegration with the volatility of stock market and a asymmetric, positive effect. Moreover, there is an inverse bidirectional causality between expected oil and gold price volatilities. Gazel (2017), analysed oil, gold and the stock index, interest rate and exchange rate with the ARDL bounds test method for the period 2002-2016. Analyses indicated a long-run relation; all variables except gold were found to be significant at certain levels. However, the coefficient of gold is found to be negative; This shows that it is an alternative investment to the stock market. Oil prices have positive impact on BIST100. When the short-run coefficients are analysed, it is determined that the BIST100 index and all variables except gold has a significant relation. In the short run, gold affects the BIST100 index negatively and oil affects it positively, although not significantly. Öget and Şahin (2017), examined the cointegration relations among oil, gold, and BIST100 for the period 1997-2014 with the help of Johansen cointegration analysis. Analysis determined, one cointegration vector was found among the variables, but since the coefficient of the VECM was negative but insignificant, it was concluded that a long-run relationship could not be established. Kocaarslan, Sari, Gormus and Soytas (2017), investigated the effects of oil, gold, exchange rate and US equity market volatility expectations on the changing conditional correlations between BRIC countries and US equity markets. According to the study, the effects of volatility expectations in the US equity, oil and gold markets on correlations vary depending on the level of correlation and are asymmetric. Kurt Cihangir (2019), examined the effects of GVZ, OVX and FED funds rate on stock exchanges of developing economies (Turkey, China, Brazil, India, Indonesia, Russia and Mexico). The analysis was conducted for the period between March 2010 and February 2018. Johansen-Juselius Cointegration Analysis, VEC and Wald Test were used. A cointegration was found among emerging market indices and independent variables. Volatiility indices were found to affect stock exchanges when considered alone or together, but the effect of GVZ was found to be much higher. Tursoy and Faisal (2018), examined the effect of oil, gold prices on the Turkish stocks for 1986-2016 using ARDL for the short run and CCR, FMOLS and DOLS cointegration methods. Results show a negative relation between gold-stock prices and a positive relationship between oil-stock prices for short, long-run. Junttila, Pesonen and Ratikainen (2018), analysed the relation among oil and gold futures and stock prices in the US market for the period 1989-2016 with the DCC-GARCH model. It was concluded that the correlation between all US stocks and oil futures increases during crisis periods, whereas the correlation was negative in gold futures, supporting the safe haven hypothesis. Singhal, Choudhary and Biswal (2019), researched relations among gold, exchange rate and oil prices and the Mexican equity market using the ARDL bounds test co-integration approach. The analysis was conducted for the period between January 2006 and April 2018. The analysis reveals gold prices have a positive effect on Mexican stocks, while oil prices have a negative.

DATA SET, MODEL AND METHODOLOGY

The aim of the study is to investigate the short-run and long-run asymmetric effects of oil, gold prices, gold, and oil volatility indices on stock markets of emerging countries during the period between June 2008 and April 2017. Gold price data (USD/troy ounce) was obtained from the World Gold Council e-database, European Brent crude oil spot price FOB (free on board) (USD/barrel) data was obtained from the U.S. Energy Information Administration electronic database, and gold and oil volatility (GVZ-OVX) data were obtained from the official website of the Chicago Board Option Exchange (CBOE). These datas were used by Raza, Shahzad, Tiwari and Shahbaz (2016) to investigate the effects of gold and oil prices and their volatilities on stock markets. The stock market data to be used in the study consist of the monthly closing prices of the stock markets of the selected countries. The relevant time series are obtained from the IMF database. Since the implied volatility index data for gold and oil have been available since June 2008 and the last available period of stock index data from the IMF ended in April 2017, the analysis period was determined as June 2008-April 2017. Oil, gold prices, their volatilities and stock market data of emerging countries are analysed in US Dollars (USD).

The method to be used in the study is the nonlinear bounds test approach of the Autoregressive-Distributed Lag-ARDL model, called NARDL (Nonlinear ARDL). Shin, Yu, and Greenwood-Nimmo (2014) developed the NARDL model to estimate short and long-run effects.

The NARDL method has some advantages compared to classical co-integration tests. This approach, called the bounds test, provides accurate and reliable results even with data containing a small number of observations (Panopoulou and Pittis, 2004). Additionally, unlike other cointegration tests, in this approach, it is possible to investigate whether there is a cointegration relationship between the series, regardless of whether the series are at level (I(0)) or first differenced (I(1)) (Pesaran, Shin and Smith, 2001, p.290-291). The only condition here is that the series should be non-stationary at the second level (I(2)). In a simple equation, NARDL can analyse the presence of asymmetry between non-stationary variables and both short- and long-run relationships. Considering that many price series are non-stationary, it can be stated that NARDL is a suitable method for investigating the relationship between international gold, oil and stock prices (Badeeb and Lean, 2016, p.21).

When the positive and negative components of time series are considered separately, their co-integration is an example of non-linear co-integration. In their study Granger and Yoon (2002), improved ‘hidden cointegration’ for cointegration relationships that can be determined between negative and positive components of the variables. It is also stated that hidden cointegration is a simple non-linear cointegration (Granger and Yoon, 2002, p.5-25-26). Short-run and long-run asymmetric effects can be identified with the NARDL approach, and asymmetric cointegration modelling can be performed using negative and positive partial sum decompositions. At the same time, that method authorizes the joint analysis of stationary and nonlinear series for an unbounded error correction model.

The equations of the NARDL approach determined by Shin et al (2014) are shown below as equations (1)-(5) (Shin et al., 2014, p.7-17):

The nonlinear cointegration regression is shown in equation (1):

$$y_t = \beta^- x_t^- + \beta^+ x_t^+ + \mu_t \qquad (1)$$

Here β^- and β^+, are the long-run parameters of the kx1 vector of x_t regressor, the decomposed version of which is given in equation (2):

$$x_t = x_0 + x_t^- + x_t^+ \quad (2)$$

Here x_t^- (x_t^+), are the partial sums of the negative (positive) change in x_t as given in equations (3) and (4).

$$x_t^- = \sum_{j=1}^{t} \Delta x j\text{-} = \sum_{j=1}^{t} \max (\Delta x j, 0) \quad (3)$$

$$x_t^+ = \sum_{j=1}^{t} \Delta x j\text{+} = \sum_{j=1}^{t} \min(\Delta x j, 0) \quad (4)$$

The NARDL form of equation (2) (p,q) can be specified as in the asymmetric error correction model (AECM) equation (5).

$$\Delta y_t = \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q} \left(\pi_j^+ \Delta x_{t-j}^+ + \pi_{j-t}^- \Delta x_{j-t}^-\right) + \varepsilon t \quad (5)$$

Here $\theta^+ = -\rho\beta^+$ and $\theta^- = -\rho\beta^-$. In the NARDL approach, the first two steps of determining the relationship between variables are the same as those followed in the ARDL. In both approaches, equation (6) is estimated by performing basic hypothesis tests ($\rho = \theta^+ = \theta^- = 0$). Additionally, Wald test is used to determine short-run ($\pi^- = \pi^+$), the long-run ($\theta^- = \theta^+$) asymmetries of the relationships between variables, in the NARDL approach.

Linear models that assume a symmetric relationship are dominant when investigating the impact of the selected variables on the prices of stocks. Some studies focused on the asymmetry relationship, and EGARCH and regime switching methods were used to investigate asymmetric relationships, as in the studies of Miyazaki and Hamori (2013), Naifar and Al Dohaiman (2013), Doğru (2015), Tüzemen (2018). However, since it is not possible to simultaneously control the short- and long-run relationships and possible asymmetries in these methods, the NARDL method, which eliminates all these deficiencies, was preferred (Raza et al., 2016, p.291).

The long-run model investigating the asymmetric relationship among the variables in this study is as follows:

$$HF_t = \beta_1 + \beta_1^+ AF_t^+ + \beta_1^- AF_t^- + \beta_2^+ AV_t^+ + \beta_2^- AV_t^- + \beta_3^+ PF_t^+ + \beta_3^- PF_t^- + \beta_4^+ PV_t^+ + \beta_4^- PV_t^- + \mu_t \quad (6)$$

The explanations of the variables in the general model are as follows:

HF_t: Stock Prices, AF_t^+: Positive Partial Sums of Gold Prices, AF_t^-: Negative Partial Sums of Gold Prices, AV_t^+: Positive Partial Sums of Gold Volatilities, AV_t^-: Negative Partial Sums of Gold Volatilities, PF_t^+: Positive Partial Sums of Oil Prices, PF_t^-: Negative Partial Sums of Oil Prices, PV_t^+: Positive Partial Sums of Oil Volatilities PV_t^-: Negative Partial Sums of Oil Volatilities.

The decomposition of the independent variables into positive and negative partial sums is shown and formulated below, in order to investigate the non-linear co-integration relationship:

$$AF_t^+ = \sum_{j=1}^{t} \Delta AF_j^+ = \sum_{j=1}^{t} \max(\Delta AF_j, 0) \quad (7)$$

$$AF_t^- = \sum_{j=1}^{t} \Delta AF_j^- = \sum_{j=1}^{t} \min(\Delta AF_j, 0) \quad (8)$$

$$AV_t^+ = \sum_{j=1}^{t} \Delta AV_j^+ = \sum_{j=1}^{t} \max(\Delta AV_j, 0) \quad (9)$$

$$AV_t^- = \sum_{j=1}^{t} \Delta AV_j^- = \sum_{j=1}^{t} \min(\Delta AV_j, 0) \quad (10)$$

$$PF_t^+ = \sum_{j=1}^{t} \Delta PF_j^+ = \sum_{j=1}^{t} \max(\Delta PF_j, 0) \quad (11)$$

$$PF_t^- = \sum_{j=1}^{t} \Delta PF_j^- = \sum_{j=1}^{t} \min(\Delta PF_j, 0) \quad (12)$$

$$PV_t^+ = \sum_{j=1}^{t} \Delta PV_j^+ = \sum_{j=1}^{t} \max(\Delta PV_j, 0) \quad (13)$$

$$PV_t^- = \sum_{j=1}^{t} \Delta PV_j^- = \sum_{j=1}^{t} \min(\Delta PV_j, 0) \quad (14)$$

The NARDL (p,q,r,s,z) model in the form of an asymmetric error correction model, is given in equation (15).

$$\Delta HF_t = \alpha + \rho HF_{t-1} + \theta_1^+ AF_{t-1}^+ + \theta_1^- AF_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j \Delta HF_{t-j} + \sum_{j=0}^{q}\left(\pi_1^+ \Delta AF_{t-j}^+ + \pi_1^- \Delta AF_{j-t}^-\right) + \theta_2^+ AV_{t-1}^+ + \theta_2^- AV_{t-1}^- + \sum_{j=0}^{r}\left(\pi_2^+ \Delta AV_{t-j}^+ + \pi_2^- \Delta AV_{j-t}^-\right) + \theta_3^+ PF_{t-1}^+ + \theta_3^- PF_{t-1}^- + \sum_{j=0}^{s}\left(\pi_3^+ \Delta PF_{t-j}^+ + \pi_3^- \Delta PF_{j-t}^-\right) + \theta_4^+ PV_{t-1}^+ + \theta_4^- PF_{t-1}^- + \sum_{j=0}^{z}\left(\pi_4^+ \Delta PF_{t-j}^+ + \pi_4^- \Delta PF_{j-t}^-\right) + \quad (15)$$

Here $\theta^+ = -\rho\beta^+$ and $\theta^- = -\rho\beta^-$. ($\theta_1^+ = -\rho\,\beta_1^+$ and $\theta_1^- = -\rho\,\beta_1^-$. $\theta_2^+ = -\rho\,\beta_2$+ and $\theta_2^- = -\rho\,\beta_2^-$. $\theta_3^+ = -\rho\,\beta_3^+$ and $\theta_3^- = -\rho\,\beta_3^-$. $\theta_4^+ = -\rho\,\beta_4^+$ and $\theta_4^- = -\rho\,\beta_4^-$.)

It has already been mentioned that the asymmetric ARDL (NARDL) approach can be applied regardless of whether the variables are I(0) or I(1), but it can't be applied if one or more of the variables in the model are I(2) (Ibrahim, 2015, p.6-7). It should be noted that when the variables I(0) or at least when their first differences are taken (I(1)), the NARDL method find out more ideal results compared to conventional cointegration methods (Fousekis, Katrakilidis and Trachanas, 2016, p.500). Firstly, unit root tests are used to test the order of integration of the variables. If the results of the unit root test show that all of the variables are integrated at any level less than two, the model in equation (5) is estimated using the standard OLS method by performing the basic hypothesis tests ($\rho = \theta^- = \theta^+ = 0$). In the NARDL method, the model is estimated by considering the most appropriate lags and after each estimation, insignificant lags are deleted until only significant results are obtained for all independent variables. Based on the bounds test approach developed by Pesaran et al., (2001) and recently extended by Shin et al., (2014), the F test is used to test the null hypothesis $\theta_1^- = \theta_1^+ = \theta_2^- = \theta_2^+ = \theta_3^- = \theta_3^+ = \theta_4^- = \theta_4^+ = 0$.

The t-test was used to check the null hypothesis of no long run relationship. The null and alternative hypotheses for the F test are given below:

H_0: $\rho = \theta^- = \theta^+ = 0$ (The relationship between variables is symmetric.)

H_a: $\rho = \theta^- = \theta^+ \neq 0$ (The relationship between variables is asymmetric.)

The null and alternative hypotheses for the t-test examining of long run relationship are as follows:

H_0: There is no long run relationship.

H_a: There is long run relationship.

After confirming the presence of co-integration, the Wald test is used to determine the short run ($\pi^- = \pi^+$) and long run ($\theta^- = \theta^+$) asymmetries of the relationships between variables in the NARDL approach.

The null and alternative hypothesis of the short (W_{SR}) and long run (W_{LR}) Wald test are presented below:

H_{0WSR}: $\pi^- = \pi^+$

H_{aWSR}: $\pi^- \neq \pi^+$

H_{0WLR}: $\theta^- = \theta^+$

H_{aWLR}: $\theta^- \neq \theta^+$

FINDINGS

All of the test findings required for NARDL analysis from time series analysis are presented in order in this section. In the analysis of the study, firstly, ADF (Augmented Dickey Fuller) and PP (Phillips Perron) unit root tests were used to test the stationarity of the time series. Table 1 shows the results of unit root tests for the logarithmic form of the gold and oil prices, their volatilities, and stock markets price series of emerging economies.

Table 1: Unit root test

Dependent Variables[a]	**ADF-t_{ist}**		**PP-t_{ist}**	
	Level-Stable and Trending	**1st Difference Constant and Trending**	**Level-Stable and Trending**	**1st Difference Constant and Trending**
lnChina	-2.604	-7.240***	-2.506	-7.242***
lnIndia	-2.410	-7.326***	-3.082	-7.324***
lnBrazil	-2.151	-8.486***	-2.688	-8.423***
lnRussia	-2.447	-7.614***	-3.095	-7.569***
lnS. Africa	-4.589***		-4.598***	
Independent Variables[a]	**ADF-t_{ist}**		**PP-t_{ist}**	
	Level-Stable and Trending	**1st Difference Constant and Trending**	**Level-Stable and Trending**	**1st Difference Constant and Trending**
lnAF	-1.725	-12.310***	-1.527	-12.578***
lnAV	-3.287*		-3.287*	
lnPF	-1.479	-6.812***	-1.962	-6.874***
lnPV	-2.188	-9.762***	-2.263	-9.751***
Critical Values				
%1	-4.046	-4.047	-4.046	-4.047
%5	-3.452	-3.453	-3.452	-3.453
%10	-3.151	-3.152	-3.151	-3.152

[a], **Dependent Variables:** China, India, Brazil, Russia and South Africa Stock Prices

[b], **Independent Variables:** AF: Gold Prices, AV: Gold Volatility, PF: Oil Prices and PV: Oil Volatility.

***,** %10; **, %5 and ***, %1 indicate significance levels.

It was determined that the series whose natural logarithm was taken were not stationary at their levels, except for the South Africa and gold volatility series, and stationarity was ensured when their first differences were taken.

The NARDL method, which has the advantage of being applied to series that are stationary or non-stationary at the same level (provided that they are not I(2)), can be used (Katrakilidis and Trachanas, 2012, p.1066).

For the NARDL models to be constructed, the most appropriate lag lengths of the variables were first determined according to Akaike, Schwarz, Hannan-Quinn and FPE information criteria. The maximum lag length for the independent and dependent variables was set as 12 (max p= max q) in order to select the most appropriate NARDL models, and insignificant lags were removed from the established models by applying the general-to-specific approach as in the study of Shin et al. 2014.

The co-integration between time series is investigated with the help of the bounds test. In order to investigate for the presence of a long run asymmetry between the time series, the F-statistic (F_{PSS}) developed by Pesaran et al., (2001) and used to checking null hypothesis of no asymmetric relationship and the t-statistic (t_{BDM}) developed by Banerjee, Dolado and Mestre (1998) and used to checking null hypothesis of no long-run relationship were determined., F test was applied to the first period lags of the variables to analyse the co-integration relationship. Bounds test results are shown in Table 2.

Table 2: Bounds test results for asymmetric co-integration

Markets	**F_{PSS}**			**t_{BDM}**		
China	3.119382			-3.093102		
India	2.831796			-3.0995770		
Brazil	6.544930[a]			-4.051451[b]		
Russia	6.460586[a]			-4.767444[a]		
South Africa	7.090507[a]			-6.564461[a]		
Critical Values	**F_{PSS}**			**t_{BDM}**		
	k*=4			k=4		
	%1	%5	%10	%1	%5	%10
	3.74	2.86	2.45	-3.43	-2.86	-2.57
	5.06	4.01	3.52	-4.60	-3.99	-3.66

[a] 1%, [b] 5%, [c] 10% significance level; * denotes the number of independent variables before decomposition into positive and negative partial sums.

Since the F statistics calculated by the bounds test are above the upper critical value according to the table in the study of Pesaran et al., (2001), it is defined that there is an asymmetric co-integration relationship between the time series except for China and India and the null hypothesis is not accepted. The t statistics calculated in the study were compared with the table lower and upper critical values in Banerjee et al. (1998), it is defined that there is a long-run relationship between the series except for China and India and the null hypothesis is not accepted. Since the bounds tests only show the test statistics of asymmetric cointegration in the long run, NARDL models were constructed for all countries to determine asymmetric relationships in the short run.

According to the F_{PSS} and t_{BDM} results ($F_{PSS} > F_{PSScritical}$; $I\ t_{BDM}\ I > t_{critical}$); there is asymmetric co-integration and long-run relation between selected series. These tests showed the presence of a non-linear (asymmetric) long-run relationship (cointegration) between the independent and dependent variables.

After determining co-integration, the NARDL technique was used by constructing models to determine the short run and long run relationships. Dynamic asymmetric estimation results of stock prices (NARDL estimation results) were calculated to determine the short-run asymmetric effects between variables. Wald test was performed to determine short run and long run asymmetries. The Wald test determines the short and long-run symmetric and asymmetric relationships of the negative and positive partial sums of the variables in the model. NARDL estimation result tables and Wald test results are shown in Tables 3 and 4.

Table 3 shows the optimal NARDL model estimation results. It shows the effect of changes in independent variables on dependent variables. Table 4 shows the NARDL model estimation results for the short run and long run. The Wald test results show that the null hypotheses of short- and long-run symmetries of independent variables are not accepted for most selected countries.

Table 3: NARDL models estimation results

Variable	China		India		Brazil		Russia		South Africa	
	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error
Fixed	0.650[a]	0.212	0.609[a]	0.198	0.609[b]	0.261	1.257[a]	0.307	1.837[a]	0.295
HF_{t-1}	-0.143[a]	0.046	-0.140[a]	0.045	-0.181[a]	0.059	-0.371[a]	0.077	-0.359[a]	0.054
AF^{+}_{t-1}	-0.077	0.141	0.062	0.103	0.425[a]	0.122	0.350[b]	0.159	-0.583[a]	0.212
AF^{-}_{t-1}	-0.005	0.095	-0.062	0.070	-0.068	0.080	0.149	0.118	-0.162	0.160
AV^{+}_{t-1}	0.028	0.063	-0.082[c]	0.045	-0.176[a]	0.054	-0.148[c]	0.078	-0.000	0.094
AV^{-}_{t-1}	-0.103	0.069	-0.071	0.056	-0.042	0.064	-0.075	0.076	-0.174[c]	0.102

PF^{+}_{t-1}	-0.046	0.079	-0.100^{c}	0.059	-0.030	0.073	0.338^{c}	0.142	0.170	0.119
PF^{-}_{t-1}	-0.017	0.036	-0.036	0.028	-0.173^{a}	0.036	-0.068	0.066	0.297^{a}	0.083
PV^{+}_{t-1}	0.045	0.036	-0.017	0.027	-0.093^{a}	0.033	-0.120^{b}	0.052	0.128^{c}	0.070
PV^{-}_{t-1}	0.120^{b}	0.057	-0.015	0.043	0.075	0.049	0.086	0.069	-0.010	0.090
ΔHF_{t-1}	0.294^{a}	0.094	0.193^{b}	0.096						
ΔAF^{+}_{t}					0.499^{b}	0.170	0.382^{b}	0.182		
ΔAF^{+}_{t-1}					0.420^{b}	0.195				
ΔAF^{-}_{t}	0.459^{a}	0.168								
ΔAF^{-}_{t-1}					-0.454^{b}	0.187				
ΔAF^{-}_{t-2}							0.579^{a}	0.156		
ΔAV^{+}_{t}							-0.184^{a}	0.063		
ΔAV^{-}_{t}					-0.239^{b}	0.094				
ΔAV^{-}_{t-2}							0.195^{b}	0.097		
ΔPF^{+}_{t}							0.599^{a}	0.143		
ΔPF^{+}_{t-2}							-0.340^{b}	0.151		
ΔPF^{-}_{t}									-0.483^{b}	0.215
ΔPF^{-}_{t-1}	0.349^{a}	0.096	0.265^{a}	0.089						
ΔPF^{-}_{t-2}					0.263^{b}	0.103	0.524^{a}	0.109		
ΔPV^{+}_{t}			-0.138^{a}	0.048	-0.202^{a}	0.053			-0.295^{b}	0.128
ΔPV^{+}_{t-1}			0.163^{a}	0.056			0.128^{b}	0.060		
ΔPV^{+}_{t-2}					0.243^{a}	0.062				
Adj-R^2	0.302		0.342		0.504		0.553		0.353	
X^2_{NORM}	6.500^{a}	[0.038]	40.760^{a}	[0.00]	0.523	[0.76	27.344^{a}	[0.000]	4803.731	[0.000]
X^2_{SC}	0.917	[0.534	2.795	[0.066]	2.657	[0.07]	1.590	[0.209]	0.292	[0.747]
X^2_{HET}	2.077	[0.062]	1.378	[0.161]	0.634	[0.84]	0.535	[0.466]	1.462	[0.122]

+ and - indicate positive and negative cumulative sums respectively. X^2_{SC}, X^2_{HET}, X^2_{NORM} show the results of LM (Lagrange Multipliers) tests for autocorrelation, variance and normality, respectively. [ ] p indicates probability values. $^{c, b}$ and ^{a} indicates that the null hypothesis of short and long run symmetry are not accepted at 10%, 5% and 1% significance level, respectively.

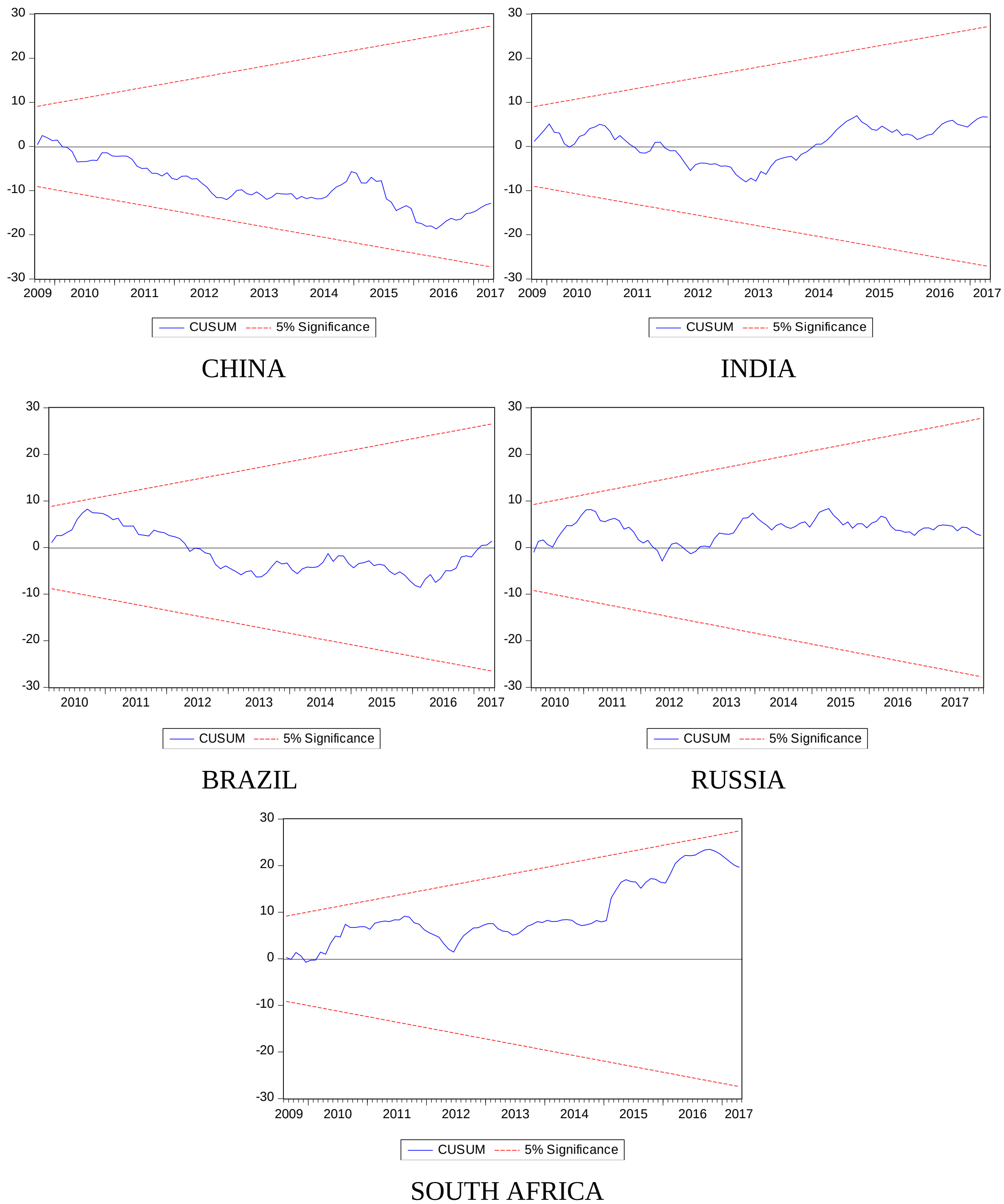
Table 4: Wald test results and long run coefficients

Variable	China		India		Brazil		Russia		South Africa	
	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error	Coefficient	St. Error
W_{SR_AF}	9.288[a]	[0.000]			10.328[a]	[0.000]	16.865[a]	[0.000]		
W_{SR_AV}					7.511[a]	[0.001]	13.878[a]	[0.000]		
W_{SR_PF}	11.095[a]	[0.000]	9.395[a]	[0.000]	6.868[a]	[0.001]	14.838[a]	[0.000]	22.105[a]	[0.000]
W_{SR_PV}			9.719[a]	[0.000]	12.756[a]	[0.000]	15.623[a]	[0.000]	23.848[a]	[0.000]
L^{+}_{AF}	-0.542		0.446		2.340[b]		0.943[c]		-1.623[a]	
L^{-}_{AF}	-0.035		-0.443		-0.374		0.401		-0.453	
W_{LR_AF}	0.136	[0.712]	0.585	[0.446]	3.644[c]	[0.059]	0.701	[0.404]	1.969	[0.163]
L^{+}_{AV}	0.198		-0.586		-0.972[b]		-0.399[c]		-0.002	
L^{-}_{AV}	-0.723		-0.513		-0.233		-0.202		-0.485	
W_{LR_AV}	1.555	[0.215]	0.015	[0.901]	1.680	[0.198]	0.336	[0.563]	1.104	[0.296]
L^{+}_{PF}	-0.326		-0.716		-0.168		0.910[b]		0.475	
L^{-}_{PF}	-0.119		-0.257		-0.953[a]		-0.184		0.829[a]	
W_{LR_PF}	0.144	[0.705]	1.146	[0.287]	6.180[b]	[0.014]	13.439[a]	[0.000]	1.381	[0.242]
L^{+}_{PV}	0.314		-0.126		-0.513[b]		-0.324[b]		0.357[c]	
L^{-}_{PV}	0.840[b]		-0.111		0.416		0.231		-0.029	
W_{LR_PV}	1.589	[0.210]	0.001	[0.964]	6.006[b]	[0.016]	5.443[b]	[0.021]	2.058	[0.154]

L^{-} and L^{+} are the long-run coefficients indicating the estimation results of negative and positive changes, respectively. $\boldsymbol{\beta}^{+/-} = (-\boldsymbol{\theta}^{+/-}|\boldsymbol{\rho})$. W_{SR} and W_{LR} stands for the Wald test statistic of the short run and log run symmetry null hypothesis, respectively

In order to test the accuracy of the models, the existence of variance, instability and autocorrelation problems among the error terms obtained from the models were tested with diagnostic tests. The presence of autocorrelation and variance problems in the models were determined by LM tests. For LM tests, X^2_{SC}, X^2_{HET}, X^2_{NORM} coefficients are calculated X^2_{SC} refers to the results of the Breusch-Godfrey Serial Correlation LM Test and is a test with the reverse hypothesis. Therefore, p-probability values greater than 0.05 indicate that there is no autocorrelation problem in the model. X^2_{HET} is a test that tests for the presence of heteroskedasticity in the NARDL model with the Heteroskedasticity-White test and has a reverse hypothesis. Therefore, the p probability values obtained as a result of the White test are greater than 0.05, indicating that there is no changing variance problem in the models. The stability of the models was tested with the CUSUM (Cumulative Sum of Recursive Residuals) test. The expected feature of the most appropriate model to be established is that there should be no autocorrelation and changing variance among the error terms and the model should exhibit a stable structure. When the results of the diagnostic tests given at the bottom of Table 3 are analysed, it is determined that autocorrelation and changing variance problems are not encountered in the established models. The stability of the model coefficients was tested with the CUSUM test, and it was found that all NARDL models were stable that shown at Figure 1. The CUSUM graphs show that the cumulative sum of the recurrent residuals is within the bounds at 5% significance level, thus the coefficients are stable, and the models are reliable.

Figure 1: CUSUM graphs of NARDL models



RESULT AND EVALUATION

This study investigates the short and long-run asymmetric effects of gold, oil prices, gold and oil volatility indices on emerging markets stock prices for the period between June 2008 and April 2017. The NARDL test was used to determine the asymmetric co-integration relationship between the variables.

In this study, after determining the presence of co-integration among the variables, the asymmetric effects are investigated. The short and long-run asymmetry of the negative and positive components of all independent variables analysed with the Wald test. It is concluded that the asymmetric effects of the long run asymmetry of gold prices on Brazil, the long run asymmetry of oil prices on Brazil and Russia, and the long-run asymmetry of oil volatility on Brazil and Russia stock markets are significant.

When the findings of the study are analysed, it may be stated that the direction of the effect of gold prices on the stock markets of the developing countries examined is negative except for Brazil and Russia. When the value of stocks falls, gold prices are expected to rise; when the value of stocks rises, gold prices are expected to fall. Although the aggregate stock markets of countries are considered to have a negative correlation with strategic commodity prices, it should be noted that this relationship will show different responses to gold and oil price changes when sectoral indices in countries are considered. Stock prices in energy markets affected positively bu positive change in oil prices, due to expected higher profits. Likewise, the prices of banking sector stocks and gold ETFs (exchange-traded funds) affected positively by positive change in gold prices. The effect of negative and positive changes in gold prices on stock prices in the economies is significantly related to economies' position in the money market, economic growth, interest rates and inflation levels. If high GDP and high inflation levels prevail in an economy, gold and stock prices rise together. Positive change in gold market due to low interest rates facilitates gold investment, which is an alternative investment to fixed income investments such as equities. In economies where both inflation and interest rates are high, stock markets negatively affected by positive change in gold prices, while stock markets positively affected by negative change in gold prices. In economies with low-interest rates and low inflation, stock markets positively affected by positive change in gold prices, while stock markets negatively affected by a negative change in gold prices.

Commodities and stock markets relation is expected to be positive in economies with high commodity reserves and negative in economies with high commodity consumption. Stock and gold prices positive relationship in Russia can be attributed to the high amount of gold reserves and the high demand for gold mutual funds. In addition, the low inflation and interest rates in Brazil and Russia, which are seen as fast-developing economies, can also be seen as a reason for the positive effect of the increase in gold prices on stock markets. In South Africa, where gold demand is very low, the long-run effects between gold volatility and stock prices are insignificant.

Oil and stock markets relation is expected to be positive in countries with high oil reserves and negative in countries with high oil consumption. In Russia, which ranks second in the world after Saudi Arabia in terms of crude oil reserves, and in Brazil, another country that is a net oil exporter, it is found that a decrease in oil prices decreases stock prices or an increase in oil prices increases stock prices, as expected. These results confirm the expected positive relation between stocks and oil prices in countries with high oil production mentioned in the literature. Although there is an inverse relation between stock markets and oil prices in China and India, which rank second and third in the world in oil consumption, these effects are found to be statistically insignificant. The highly developed and relatively closed structures of the Indian and Chinese stock markets suggest that this ambiguity may be possible.

Since the findings of the study show that prices and volatilities of selected strategic commodities have asymmetric (non-linear) effects on the stock markets of selected emerging countries in the short and long-run, the symmetric models that have been previously applied have been viewed with scepticism. It is determined that the asymmetric effect finding obtained as a result of the study is consistent with some studies conducted in the literature. These studies are; Hammoudeh and Yuan (2008), Apergis and Miller (2009), Chang, Mcaleer and Tansuchat (2013), Arouri, Lahiani and Nguyen (2011), Lin, Wesseh and Appiah (2014), Sadorsky (2014a), Sadorsky (2014b), Raza et al., (2016), Bouri et al., (2017) and Kocaarslan et al,. (2017).

As a matter of fact, the results of the analyses show that negative and positive changes in gold, oil prices and volatilities can cause different effects. The NARDL models estimation results show that the effects of prices and volatilities on emerging stock markets are in the opposite direction, . If there is a positive relation between gold prices and stock prices of the related country, there is a negative relation between gold volatility and stock prices, or vice versa. This effect also confirms the expected negative relationship between the GVZ and OVX indices (referred to as AV and PV in the study). In this direction, Chen and Zou (2015) also found negative and asymmetric relation among oil prices and the oil implied volatility index OVX. The finding that the negative GVZ and OVX long run coefficients indicates that high volatility in gold and oil markets is a negative indicator according to stock exchange investments and reduces stock prices. Therefore, it can be stated that gold and oil volatility indices may be used to estimate stock market movements more accurately in emerging markets.

As it is known, capital markets are expected to react to the ups and downs of all commodities volatility, especially the stock prices related to these commodities. The study reveals that the significant responses of emerging markets to changings in the volatilities and prices of gold and oil, which are strategic commodities, suggest that these markets are weak and vulnerable to uncertain economic conditions, negative economic trends and possible crises. Gold and oil prices, which are among the commodities that affect the markets the most, and determining how these variables are affected by volatility indices are among the issues that investors take into account when making forecasts, for emerging stocks investors. The results obtained in the study suggest that caution should be exercised when investing in these markets, which are vulnerable to fluctuations in commodity prices, and it may be useful to turn to alternative investment instruments in portfolio diversification.

In future studies on the subject, it is thought that selecting countries by differentiating the countries that produce and consume gold and oil, addressing the energy and manufacturing sub-sectors in the stock markets of the selected countries and using the local gold and oil prices of the countries may increase the clarity of the results to be obtained. Based on the idea that the NARDL method can provide good results with a small number of data, it is thought that in studies where the number of data is reduced, gold and oil prices can be analysed separately based on periods of severe fluctuations. In addition, taking into account the distinction between developing and developed countries in terms of the effects of gold and oil prices and volatilities in future studies may also contribute to the literature.

AUTHOR STATEMENT / YAZAR BEYANI

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