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The Effect of Commodity Volatility Indexes and FED Fund Rates on the Stock Market Indices of Developing Countries

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ABSTRACT

In this study, the impact of commodity prices and capital inflows on the stock markets, which is from the fundamental variables influencing the economic and structural problems of emerging markets, has been investigated. The relations between variables were analyzed using Johansen Cointegration Test, Vector Error Correction Model, Wald test and Variance Decomposition technique respectively. A long term relation among to the related emerging markets stock indices and Gold Volatility Index (GVZ), Oil Volatility Index (OVX) and Fed fund rates were detected. It is determined that GVZ and OVX individually or together affect stock market indices and FED fund rates didn't seem to have significant impact on these stock indices. It can be specified that stock market indexes are more affected than GVZ. In general, some part of the variables are defined such as importance to the emerging market economies to develop policies to respond to fluctuations in the commodity prices and the changes in global liquidity.

Keywords: *Emerging Markets Stock Indices, Commodity Volatility Indices GVZ, OVX, Fed Fund Rate, Johansen Cointegration Test, Variance Decomposition.*

***Jel Classification**: C30, F30, G15, O5O*

Emtia Oynaklık Endeksleri ve Fed Faiz Oranlarının Gelişen Ülkelerin Borsa Endekslerine Etkisi

ÖZET

Bu çalışmada, gelişmekte olan piyasaların ekonomik ve yapısal sorunlarını etkileyen temel değişkenlerden emtia fiyatlarının ve sermaye girişlerinin borsa üzerindeki etkisi incelenmiştir. Değişkenler arasındaki ilişkiler sırasıyla, Johansen Koentegrasyon Testi, Hata Düzeltme Modeli, Wald testi ve Varyans ayrıştırması teknikleri ile analiz edilmiştir. Buna göre, Altın Oynaklık Endeksi (GVZ), Petrol Oynaklık Endeksi (OVX) ve Fed faiz oranları ile ilgili borsa endeksleri arasında uzun dönem ilişki tespit edilmiştir. Ayrıca, borsa endeksleri üzerinde GVZ ve OVX'in tek tek veya birlikte etkili olduğu; ancak FED faiz oranlarının anlamlı bir etkisinin olmadığı; GVZ'nin, daha etkili olduğu belirlenmiştir. Genel itibariyle, gelişen piyasa ekonomilerinin, emtia fiyatlarındaki dalgalanmalar ve küresel likiditedeki değişimlere cevap verecek politikaların/stratejilerin uygulanmasında dikkate almaları gereken değişkenlerden bir kısmı belirlenmiştir.

Anahtar Kelimeler: *Gelişen Piyasa Borsa Endeksleri, Emtia Volatilite Endeksleri GVZ, OVX, Fed Faiz Oranları, Johansen Koentegrasyon Testi, Varyans Ayrıştırması.*

JEL Sınıflandırması: *C30, F30, G15, O5O*

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1. INTRODUCTION

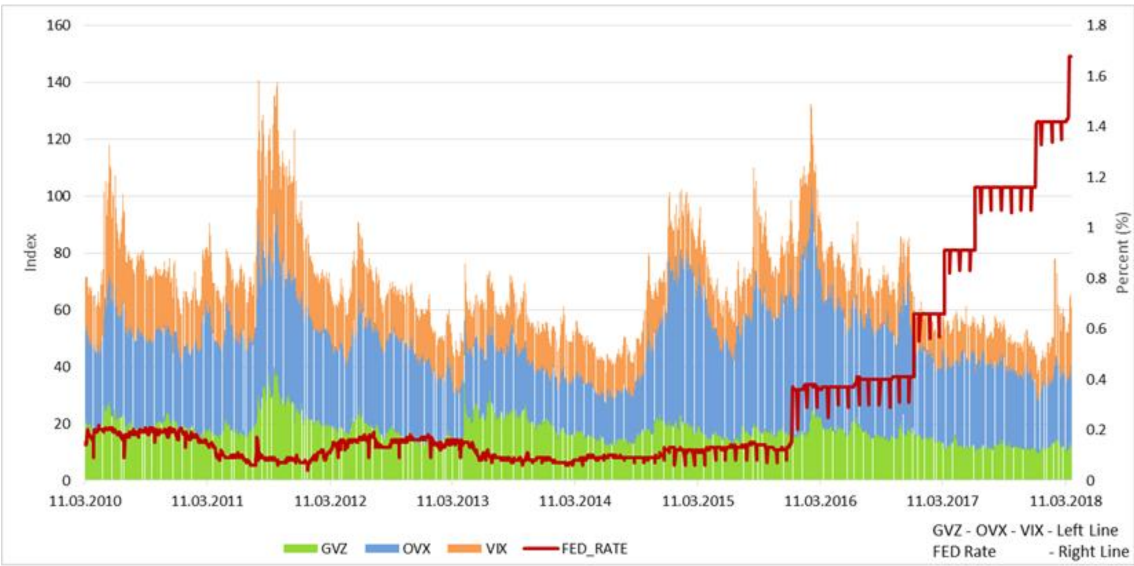
According to the World Bank's "Commodity Markets Outlook Report" dated October 2017, developing countries stand out in the oil and gold consumption. Russia, China, Brazil are taking the lead in the oil production while, China, India, Russia and Brazil are the leading countries in the oil consumption. Similarly, the world's largest gold producer, China, ranks first in the consumption. India, Turkey, and Russia are countries that stand out in the gold consumption. As seen, gold and oil price changes have significant importance on the developing countries. Apart from that, following the Global Crisis in 2008, the central banks of developed countries and their monetary policies applied has been the driving force of the international capital movement. It can be said that international capital has gravitate to the emerging markets which promissory higher interest rate in the period of quantitative easing which initiated after the 2008 Global Crisis. The international capital headed towards emerging markets attracting higher interest rates during the quantitative relaxation (quantitative expansion) period which was started following the Global Crisis in 2008 and starting from November 2014 when the monetary tightening was observed, it headed towards the developed countries as a safe place. Thereby, it can be said that the changes the US FED's in interest rates has been appeared as a factor affecting the stock markets of the countries.

The relationship of commodities which have been evaluated as a financial asset since 2000's with economic indicators has been the subject of interest of researchers. Stock markets are the fundamental markets which provide the spread of the capital to the base and play a key role in the development of an economy. Therefore, every entity, indicator, variable which represents the stock markets are important. There has been many studies made which investigates the relation between commodity prices and the stock markets (Nasseh and Strauss, 2000; Pethe and Karnik, 2000; Henry et al., 2004; Cook, 2006; Singh, 2010; Dhiman and Sahu, 2010; Mensi et al., 2014; Kang, McIver, and Yoon, 2016; Raza, Shahzad, Tiwari, and Shahbaz, 2016, Aaron P. Henrichsen, 2017; Bekiros, Boubaker, Nguyen, & Uddin, 2017; Boubaker and Raza, 2017). In those studies, generally, the gold and the oil came forward as the commodities. The gold and the oil, which also described as strategic commodity (Jia, et.al., 2018; Bouri et al., 2017), are the two commodities with a high liquidity degree and they both indicate similar movements to each other over the time. Such that, the movements of the volatility indexes of GVZ and OVX which are calculated via the gold and the oil prices (implied volatility) seem synchronized (Lescaroux, 2009; Tiwari and Sahadudheen, 2015).

CBOE Gold ETF Volatility Index -GVZ, measures the market's expectation of 30-day volatility of gold prices to options on SPDR Gold Shares. CBOE Crude Oil ETF Volatility Index- OVX, measures the market's expectation of 30-day volatility of crude oil prices to United States Oil Fund. Both indices are volatility indices created using the new VIX methodology and driven by the CBOE (Chicago Board Options Exchange) to the market. The VIX Index is a calculation designed to produce a measure of constant, 30-day expected volatility of the U.S. stock market, derived from real-time, mid-quote prices of S&P 500 Index call and put options. On a global basis, it is one of the most recognized measures of volatility -- widely reported by financial media and closely followed by a variety of market participants as a daily market indicator (www.cboe.com).

Graph-1 depicts the time series of OVX, GVZ, VIX and the FED effective funds rates over the years. The changes in the VIX which is considered as a risk measure in the global sense (Siriopoulos ve Fassas, 2012; Clark et al., 2016; Kurt-Cihangir, 2018) is one of the primary aspect influencing the decisions of the financial units. An increase in VIX that means an increase in the perception of risk in the global sense, in which case, the financial units show a tendency towards more stable markets/investment instruments. After the Global Crisis in 2008, FED and the central banks of the developed countries reduced the interest rates which led to the post-crisis recovery (Bijak, 2012). However, with the provision of the global economic recovery, the monetary expansion period which was applied by the central banks of the developed countries gradually came to the end. As seen on the graph, together with the steady increase of the FED funds rate, the global risk perception and the "gold - oil" volatility indices show similar movements. In 2013 and 2014 periods where FED funds rate remained stationary, the fluctuations in GVZ, OVX and VIX have reduced. However, after FED's interest rate increase decision in December 2015, an increase in VIX has been observed and as a result, the fluctuation in GVZ and OVX has run up. In mid 2013, the forecast of an increase in FED's rates has caused capital outflows from developing countries and caused the loss in the value of national currency (IMF, 2015). Therefore, spillover effects of applied monetary policy by the central banks of the developed countries - especially FED- is a process that should be carefully managed. It is important to determine the effect of monetary policies - implemented by the developed countries- on the capital flows towards the developing countries (Fratzscher, et al., 2013; Broner et al., 2013; Janus and Riera-Crichton, 2013; Lim and Mohapatra 2016; Clark et al., 2016), as it will cause changes on the economic indicators and the asset prices of developing countries.

Graph 1. GVZ - OVX and FED Funds Rate Underlie on the Global Risk Perception



Source: Data stream, FRED Federal Reserve Bank

International portfolio investments (according to direct investments and other investments) are capital flows that are most sensitive to interest rate which are determined by the central banks of developed countries (Lim and Mohapatra, 2016). In mid 2013, the forecast of an increase in FED's interest rates has caused the loss of asset prices and the capital inflow for developing countries (Clark et al., 2016). Developing countries have been directly affected from the developed countries' monetary policies. Because, in order to solve their financial and structural problems (such as inflation, account deficit etc), they need more capital. Additionaly, since they take place at front of commodity production-consumption, they directly influenced from the fluctuations. In this sense, monetary policies implemented by the developed countries which is the driving factor of the international capital and the fluctuations in the commodity prices (gold-oil) can be considered as an influencing indicator which affects the stock markets of the developing countries.

In this study, the relationship between stock market index return series and GVZ, OVX and FED interest rate variables of Turkey, Brazil, Mexico, Indonesia, Russia and India will be investigated. There have been many studies which investigate the impact of the gold-oil prices and volatility and various financial indicators on the stock market. The main differences which distinguish this study from the others: Firstly, FED interest rates have been utilized in the analysis. Secondly, the count of markets examined is more and the sampled period which is examined is wide and up to date. The study plan is as below: In the second part, there is a literature review, in the third part, there is a methodology related to co-integration model and the error correction model. In the fourth part, the dataset has been defined and applied. Application and a general evaluation results are presented in Conclusion Section.

2. LITERATUR REVİEW

According to the studies from Raraga and Muharam (2014), Jain and Biswal (2016), Jain and Ghosh (2013) and Am and Shanmugasundaram (2017) who investigated the relation between gold prices, the exchange rate and stock index, that there are long term correlation in between those variables. Kataria and Gupta (2018) have researched the influence of international-global factors on the real effective exchange rate of 20 countries they selected. As the global factors, US FED interest rate, VIX and Brent oil prices have been taken. In order to see the influence of effective currency rate on VIX and FED fund rates, a sub model has been applied. As a result of this application, the reel effective currency rate loses value and there is a positive but statistically insignificant relation in between the FED fund rate and currency. Despite that, the relevant variables are significantly independent each other (Chang et al, 2013).

There are many studies that support the increased oil prices which are followed by stock market and other economic indicators. These indicators were negatively affected. (Blanchard, 2006; Wang et al., 2010; Adebiyi et al., 2009; Chen, 2010; Basher et al., 2012; Cunado and Garcia, 2014). On the other way, there are also studies which supports that oil prices has a positive effect on stock market indexes. (Basher and Sadorsky, 2006; Bjornland, 2008; Kilian and Park, 2007; Rati and Park, 2007; Mohanty et al., 2011; Tsai, 2015; Kang et al., 2016). Asteriou et al. (2013), for the countries that export/import oil, examined the relation between the fluctuations in the oil prices and stock markets and interest rates using the VAR model and the Granger Causality test. According to this approach, they have concluded that the short and long term oil prices and stock market relationship is stronger than interest rates and the stock market relationship. The studies (Chan et al., 2011; Elder et al., 2012; Baur and McDermott, 2010; Baur and Lucey, 2010) have found a negative relationship between the gold prices and stock markets.

Ahn (2015) has investigated the effect of the demand driven oil shocks on the macro economic variables (industrial production index, unemployment, inflation, the Fed funds etc.) using the information contained in the refinery products and the forward-looking asset prices. According to this, as a reaction to a demand driven oil price shock, Fed funds rate has increased immediately which has been found statistically significant. On the contrary, it was expressed that Fed funds show a reaction to a rate supply driven oil price shock and 6 months later, this situation had gained a statistical significance.

The common characteristic of the academic studies mentioned above is that they are based on prices of gold and / or petroleum as variables. In the recent studies, it has been seen that the interest has increased towards the volatility series obtained from these prices, rather than those price series. In that sense, OVX for volatility in oil prices, GVZ for volatility in gold prices, and VIX indexes, which are known as investor risk appetite indexes, are used to represent stock volatility. The studies which have investigated the relationship between OVX and the stock markets are, Malik and Ewing (2009), Lee and Chiou (2011), Arouri, et al. (2011, 2012), Bouri (2015a, 2015b), Ghosh and Kanjilal (2016), Dutta et al. (2017). Dutta, Nikkinen and Rothovius (2017) investigated the influence of OVX on the Middle East and African stock market markets with extended GARCH models. They concluded that all stock exchanges examined were sensitive to fluctuations in the OVX and that OVX was an important variable explaining the returns of the relevant stock exchanges.

There is a relationship between the volatility of gold and oil prices (Zhang and Wei, 2010, Šimáková, 2011, Ho, 2014). Ho (2014) used VAR model, impulse-response analysis and variance decomposition methods to investigate the Vietnamese stock market index and the dynamic relation between global market prices and world oil prices. As a result of the analysis, a long term relationship was found between the variables. In addition to this, it was specified that the stock prices were more influenced than the shocks in the gold prices and the gold prices were more influenced than the shocks in the oil prices. Baur and McDermott (2010) have investigated the role of gold, which is regarded as a safe port reducing the loss resulting from negative market shocks and therefore accepted as a balancing element, for a wider time frame (1979-2009). Accordingly, while gold is regarded as a safe port for major European stock exchanges and the US, this is not the case for Australia, Canada, Japan and the BRIC countries.

The studies that are related to determine the relation between oil and gas prices and stock markets are as follows; Thuraisamy, Sharma, and Ahmed, 2013; Mensi et al., 2014; Gokmenoglu and Fazlollahi (2015), Jin and An, 2016; Raza et al., 2016; Bekiros et al., 2017; Boubaker & Raza, 2017). Thuraisamy et al., (2013) used BEKK-GARCH model to investigate the relation between stock index volatility and “oil and gold” future contracts which was considered the most important commodity of 14 Asian countries. According to this study, in mature stock markets such as Japan, volatility shocks show tendency from stock markets towards commodity markets, whereas in relatively immature markets, the relationship is from commodity markets towards stock markets. Gokmenoglu and Fazlollahi

(2015), used ARDL cointegration model to investigate whether or not there is an impact of gold prices and gold volatility index GVZ, and oil prices with oil volatility index OVX on S&P500 index. It was noted that gold prices have been the most influential variable in both long term and short term and investors reacted to the fluctuations between gold and oil prices in the long term. Mensi et al. (2013), noted that gold an oil volatility affected S&P500 indexes. Arouri et al. (2015) investigated the relationship between gold price volatility and stock market return and noted that the return of China market index has been affected by gold prices volatility.

Bouri et al. (2017), investigated the impact of gold and oil prices on the stock market's expected volatility in Indian stock market which has been the biggest gold and oil exporters of the world. They concluded that there was a cointegration relationship between the implied volatility index calculated for India and gold and petrol implied volatility. Maghyereh et al. (2016), in the period of 2008 - 2015, used implied volatility indexes to investigate the risk spread and transfer between the oil market and stock market in USA, Canada, UK, India, Mexico, Japan, Sweden, Russia, South Africa, Germany and Switzerland. According to this, in the oil and stock market relationship, oil market plays a dominant role in the oil market. Jia, Bouri, and Roubaud (2018) investigated the relationship between US and BRICS countries stock market and gold and oil, which they describe as strategic commodities, based on implicit volatility. Accordingly, stocks of US and BRICS countries are affected by the OVX and GVZ indices as well as VIX.

Kozicki, Santor and Suchanek (2015) have not found a clear evidence to prove this relationship in their study of the relationship between commodity prices and quantitative easing announcements. The increase in commodity prices reached to the conclusion that the strong demand from the countries that are emerging from the quantitative easing and the restriction of supply is more effective. Moreover, they pointed out that the quantitative easing announcements were effective on the currencies and stock market of commodity exporting countries. Pala and Sönmezer (2017) investigated the effect of Fed's quantitative relaxation programs on volatility of commodity, foreign exchange and stock market by using GARCH models for 2005-2014 period. In the study where BIST 30 and S&P500 indexes representing the stock market and gold and Brent oil representing commodities, the volatility of related assets have not been influenced by quantitative relaxation periods.

3. METHODOLOGICAL ISSUES

The Johansen cointegration method consists of estimating the VAR model, which includes the levels of non-stationary series and their differences.

$$X_t = \beta_1 X_{t-1} + \beta_2 X_{t-2} + ... + \beta_k X_{t-k} + \mu + \varepsilon_t \quad (1)$$

In equation (1) above, X represents the vector of variables; β represents the coefficient matrix of variables and the long term relation of variables, μ represents the constant term vector and ε_t represents the error term in the model. In the Johansen cointegration analysis, the long term relationship between the variables is investigated by making use of the rank of the coefficient matrix.

According to this, in the case of Rank=n, it is assumed that there is no cointegration relation between the variables forming the vector X and the variables are stable at the level and the cointegration equation can’t be written. In the case of Rank=0, it is accepted that there is at least one cointegration relation among the variables, in other words all the variables move together in the long run and therefore, the cointegration equations can be established using their stationary status. In the case of Rank<n, there are more than one cointegration relation between the variables forming the X vector. In this case, the error correction mechanism is working because the variables are not stationary.

Furthermore, the procedure uses two statistics to determine the number of cointegrated vectors: the Trace statistic (λ_{trace}) and the Maximum Eigenvalues (λ_{max}) statistic (Johansen, 1988). Trace statistics tests null of r cointegrations against an alternative of n cointegrations where n is a number of variables in the system. Max-Eigen test statistics is used to check for existence of a cointegrating rank of 0 or 1 is compared against the corresponding critical values at 5 percent. Max-Eigen and trace statistics is formulated in the following way:

$$\lambda_{\max}(r, r+1) = TIn(1-\lambda)_{i+1} \quad (2)$$

Null hypothesis is the r cointegrating vectors against the alternative of r + 1 cointegrating vectors.

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{q} In(1-\lambda_i) \quad (3)$$

The null hypothesis of the trace statistics tests is no cointegration

H0: r = 0 against the alternative of more than 0 cointegration vector H1: r > 0.

After the existence of the relation between the Johansen method and the cointegration is proven, it is necessary to establish the error correction mechanism that models the dynamic relations (Engle and Granger, 1987). The purpose of the vector error correction model (VECM) is to determine the rate of adaptation of variables from the deviations in short-term equilibrium values to long-term equilibrium. As the error correction coefficient grows, it is assumed that short-term deviations from the model can be adapted to the long-term equilibrium value so quickly (Chimobi and Igve, 2010).

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} ... + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha ECT_{t-1} \quad (4)$$

In equation (4) above, ECT represents the error correction term and α parameter represents the adaptation rate. In the VECM established in this way, since the first-level differences are taken as a reference instead of the level values, the problems caused by the stochastic trends are avoided and the causality relationship that has emerged has a static structure (Stock and Watson, 2011: 666).

4. EMPIRICAL ANALYSIS

The uncertainty in the market implies investors' expectations about future market conditions as well as historical volatility (Poon and Granger, 2003; Ji and Fan, 2012). For this reason, volatility indices related to oil and gold have been taken as independent variables. In order to test the causal relationships, the following multivariate model is to be estimated

RSMI = f(GVZ, OVX, Fed_Rate)

Where, RSMI: Return on Stock Market Index. The variables used in the analysis are given in the Table-1 below. The data used for the estimations consist of daily observations over the period is selected from March 15, 2010 through February 15, 2018.

Table 1. Data set and Sources used in the Analysis

Stock Market Indices on Selected Countries		**Source**	**Other Variables**	**Source**
Brazil	BVSP	Data stream	GVZ – CBOE Gold Volatility Index	Yahoo Finance
Russia	MCX	Data stream	OVX – CBOE Crude Oil Volatility Index	Yahoo Finance
China	SSE	Data stream	US Effective Federal Funds Rate	Federal Reserve Board
India	SENSEX	Data stream		
Indonesia	JKSE	Data stream		
Mexico	IPC	Data stream		
Turkey	BIST100	Data stream		

Table 2. Descriptive Statistics

	R_BIST	**R_BVSP**	**R_IPC**	**R_JKSE**	**R_MCX**
Mean	0.0000	38620.0000	0.0000	10011.0000	0.0000
Median	0.0000	81469.0000	0.0000	21810.0000	0.0000
Maximum	6.0000	895111.0000	6.0000	388665.0000	4.0000
Minimum	-11.0000	6373.0000	-9.0000	210685.0000	-5.0000
Std	Dev		1.000000	448302.000000	1.000000
Skewness	0.0000	529703.0000	0.0000	150793.0000	0.0000
Kurtosis	7.0000	60268.0000	5.0000	43188.0000	6.0000
Jarque-Bera	1464.0000	408.0000	354.0000	7534.0000	1077.0000
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	77.0000	8632.0000	19.0000	98208.0000	40.0000
Observations	1996	1996	1996	1996	1996
	R_SENSEX	**R_SSE**	**D_GVZ**	**D_INTRATE**	**D_OVX**
Mean	20365.0000	0.0000	45284.0000	0.0000	24106.0000
Median	35608.0000	0.0000	106676.0000	0.0000	14607.0000
Maximum	167159.0000	7.0000	13608.0000	5.0000	507022.0000
Minimum	985283.0000	-9.0000	299684.0000	-11.0000	41893.0000
Std	427592.0000	0.0000	901090.0000	1.0000	106922.0000
Skewness	392463.0000	0.0000	455588.0000	0.0000	754008.0000

Kurtosis	512514.0000	9.0000	198162.0000	8.0000	491232.0000
Jarque-Bera	330.0000	3264.0000	79.0000	2696.0000	907.0000
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Sum	64849.0000	90.0000	38618.0000	48.0000	11655.0000
Observations	1996	1996	1996	1996	1996

The correlation values between the stock exchange index return series used in the study and the change series of the independent variables are given in Table 3. Accordingly, the gold volatility index GVZ and the oil volatility index OVX seem to be inversely related to all stock index returns. One unit increase in the gold and oil volatility indices leads to a decrease in all stock market indexes examined. The stock market indices which have been mostly influenced by the changes in GVZ are IPC, BVSP, MCX, BIST, SENSEX, JKSE and SSE (respectively, %26, %21, %17, %14, %13, %12 and %9). The stock market indices most affected by the change in the OVX are the same as those in the GVZ, but their values are different (respectively, %37, %30, %24, %20, %15, %15 and %8). There was no significant correlation between stock returns series and US Fed fund rates. Correlation between GVZ and OVX was estimated to be approximately 24% in the positive direction.

Table 3. Correlation Values of Variables

		Correlation	Prob.				Correlation	Prob.
R_BVSP	R_BIST	0.263960	0.000000		D_GVZ	R_IPC	-0.259132	0.000000
R_IPC	R_BIST	0.287281	0.000000		D_GVZ	R_JKSE	-0.117751	0.000000
R_IPC	R_BVSP	0.494365	0.000000		D_GVZ	R_MCX	-0.168398	0.000000
R_JKSE	R_BIST	0.280621	0.000000		D_GVZ	R_SENSEX	-0.127418	0.000000
R_JKSE	R_BVSP	0.171449	0.000000		D_GVZ	R_SSE	-0.091254	0.000000
R_JKSE	R_IPC	0.236484	0.000000		D_FED_RATE	R_BIST	0.008460	0.705600
R_MCX	R_BIST	0.269210	0.000000		D_FED_RATE	R_BVSP	-0.001993	0.929100
R_MCX	R_BVSP	0.311389	0.000000		D_FED_RATE	R_IPC	0.038755	0.083400
R_MCX	R_IPC	0.317949	0.000000		D_FED_RATE	R_JKSE	0.016682	0.456300
R_MCX	R_JKSE	0.232489	0.000000		D_FED_RATE	R_MCX	0.028738	0.199400
R_SENSEX	R_BIST	0.253342	0.000000		D_FED_RATE	R_SENSEX	0.000015	0.999500
R_SENSEX	R_BVSP	0.223800	0.000000		D_FED_RATE	R_SSE	-0.031237	0.163000
R_SENSEX	R_IPC	0.268732	0.000000		D_FED_RATE	D_GVZ	-0.001628	0.942000
R_SENSEX	R_JKSE	0.374360	0.000000		D_OVX	R_BIST	-0.196845	0.000000
R_SENSEX	R_MCX	0.257364	0.000000		D_OVX	R_BVSP	-0.304074	0.000000
R_SSE	R_BIST	0.094030	0.000000		D_OVX	R_IPC	-0.367833	0.000000
R_SSE	R_BVSP	0.112488	0.000000		D_OVX	R_JKSE	-0.145683	0.000000
R_SSE	R_IPC	0.121530	0.000000		D_OVX	R_MCX	-0.238395	0.000000
R_SSE	R_JKSE	0.209591	0.000000		D_OVX	R_SENSEX	-0.151142	0.000000
R_SSE	R_MCX	0.114748	0.000000		D_OVX	R_SSE	-0.077957	0.000500
R_SSE	R_SENSEX	0.191459	0.000000		D_OVX	D_GVZ	0.237371	0.000000
D_GVZ	R_BIST	-0.143120	0.000000		D_OVX	D_FED_RATE	0.030417	0.174300
D_GVZ	R_BVSP	-0.214589	0.000000					

4.1. Preliminary Analysis

If there is a stationary linear combination between non-stationary series, a cointegrating relationship exists between them. Therefore, one needs to test the stationary of the level form of series. Augmented-Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Phillips-Perron (PP) tests are used to determine whether or not the series are stationary. The ADF and PP tests have the null hypothesis of existence of a unit root, rejection of which indicates stationarity.

Table 4 presents the results for this unit root tests for variables in levels and first differences. The unit root test results show that variables are non-stationary at level form but do not contain unit root after first differencing.

Table 4. Augmented-Dickey-Fuller (ADF) and Phillips-Perron (PP) Unit Root Tests

Variables	ADF Test Statistic				PP Test Statistic			
	Level	Prob.	First Difference♣	Prob.	Level	Prob.	First Difference♣	Prob.
GVZ	1.171221	0.2210	-30.069520	0.0000***	-1.009308	0.2814	-54.805300	0.0001***
OVX	-1.243536	0.1968	-47.336800	0.0001***	-0.942958	0.3084	-50.171860	0.0001***
FED_RATE	2.821111	0.9990	-41.127590	0.0000***	3.421717	0.9999	-67.674780	0.0001***
BIST	1.045876	0.9230	-46.965050	0.0001***	1.118568	0.9322	-46.941570	0.0001***
BVSP	0.243417	0.7568	-45.642560	0.0001***	0.289773	0.7697	-45.699070	0.0001***
IPC	0.771249	0.8800	-42.618850	0.0001***	1.009389	0.9181	-43.298240	0.0001***
JKSE	1.607433	0.9741	-25.981770	0.0000***	2.051733	0.9909	-45.968140	0.0001***
MCX	0.717512	0.8699	-46.916970	0.0001***	0.834137	0.8911	-47.039640	0.0001***
SENSEX	1.618336	0.9747	-44.893040	0.0001***	1.691165	0.9784	-44.908100	0.0001***
SSE	-0.247066	0.5973	-43.946720	0.0001***	-0.279022	0.5856	-44.042270	0.0001***

♣: Include in test equation: None
***, **, * %1, %5 and %10 that shows the significance levels.

4.2. Johansen Cointegration Test

The Vector Autoregressive (VAR) analysis proposed by Hall (1991) has been applied to determine the optimal lag length. It is necessary to determine optimal lag length of VAR model using information criteria. Appendix 1 shows that the optimal lag length for the VAR procedure under the sequential modified LR test statistic, final prediction error (FPE), Akaike (AIC), Schwarz (SC), and Hannan-Quinn (HQ) information criteria. The appropriate lag length was found to be 4 for all stock indexes.

By determining that variables are stationary at the same level (I(1)), a prerequisite for the investigation of cointegration is provided. Table 5 shows the results of the cointegration tests between the variables according to Trace and Maximum Eigenvalue values. According to this, at least one cointegration relation between the stock market index and the independent variables (OVX, GVZ, Fed funds rate) in terms of trace statistics and maximum eigenvalue values is found to be valid for all stock market indices. Therefore, there is a long-term relationship between stock market indices and independent variables examined.

Table 5. Results of Johansen Cointegration Test

BIST							
	Rank test (trace)				**Rank test (maximum eigenvalue)**		
Number of Cointegration	Eigenvalue	Trace statistic	5% Critical value	Prob.	Max-Eigen statistic	5% Critical value	Prob.
None	0.017427	59.63545	47.85613	0.0027*	35.02128	27.58434	0.0046*
At most 3	0.002231	4.450083	3.841466	0.0349*	4.450083	3.841466	0.0349*
BVSP							
	Rank test (trace)				**Rank test (maximum eigenvalue)**		
Number of Cointegration	Eigenvalue	Trace statistic	5% Critical value	Prob.	Max-Eigen statistic	5% Critical value	Prob.
None	0.014226	63.80128	47.85613	0.0008*	28.54256	27.58434	0.0376*
At most 1	0.012237	35.25872	29.79707	0.0106*	24.52659	21.13162	0.0160*
IPC							
	Rank test (trace)				**Rank test (maximum eigenvalue)**		
Number of Cointegration	Eigenvalue	Trace statistic	5% Critical value	Prob.	Max-Eigen statistic	5% Critical value	Prob.
None	0.017023	55.61348	47.85613	0.0079*	34.20143	27.58434	0.0061*
JKSE							
	Rank test (trace)				**Rank test (maximum eigenvalue)**		
Number of Cointegration	Eigenvalue	Trace statistic	5% Critical value	Prob.	Max-Eigen statistic	5% Critical value	Prob.
None	0.017987	58.80950	47.85613	0.0034*	36.15572	27.58434	00031*
At most 3	0.002627	5.239669	3.841466	0.0221*	5.239669	3.841466	0.0221*
MCX							
	Rank test (trace)				**Rank test (maximum eigenvalue)**		
Number of Cointegration	Eigenvalue	Trace statistic	5% Critical value	Prob.	Max-Eigen statistic	5% Critical value	Prob.
None	0.014242	62.16147	47.85613	0.0013*	28.57340	27.58434	0.0373*
At most 1	0.010857	33.58807	29.79707	0.0175*	21.74629	21.13162	00410*
SENSEX							
	Rank test (trace)				**Rank test (maximum eigenvalue)**		
Number of Cointegration	Eigenvalue	Trace statistic	5% Critical value	Prob.	Max-Eigen statistic	5% Critical value	Prob.
None	0.016588	59.86349	47.85613	0.0025*	33.32105	27.58434	0.0082*
SSE							
	Rank test (trace)				**Rank test (maximum eigenvalue)**		
Number of Cointegration	Eigenvalue	Trace statistic	5% Critical value	Prob.	Max-Eigen statistic	5% Critical value	Prob.
None	0.015571	58.68142	47.85613	0.0035*	31.26100	27.58434	0.0161*

(1) Series: Relevant Stock Market Index, GVZ, OVX, FED Funds Rate
(2) Null hypothesis of no cointegration is rejected at the5%significance level for the seven stock market indexes.
*Statistically significant at 5% level

4.3. Vector Error Correction Model (VECM)

After the determination of the long-term equilibrium relation between the stock market indices and the independent variables, the VECM was applied to determine the short-term relationship. In this model, because the error correction term coefficient is negative and statistically significant, the long term equilibrium has been satisfied, in spite of the short term deviations. Table 6 gives the results of VECM. The IPC, SENSEX and SSE error correction parameters are statistically insignificant although they are negative. In this case, the significance of the dynamics between variables can't be adequately reflected. The significance of the relationship between variables can also be regarded as a sign of a causality relationship.

Table 6. Result of VECM Coefficient

	BIST	BVSP	IPC	JKSE	MCX	SENSEX	SSE
Error Correction Coefficient (ECC)	-0.002637	-0.007083	-0.000166	-0.001626	-0.011261	-0.000167	-0.001333
Probability	0.0453**	0.0000***	0.8833	0.0152***	0.0000***	0.8069	0.1091
***, **, * %1, %5 and %10 that shows the significance levels.							

After establishing the long term model among the variables and determining the short term relation with the error correction model, the Wald test was applied to test the existence of the causality relation from the independent variables to the stock market index. The causality relationships between variables were investigated based on the estimated VECM (for BIST, BVSP, JKSE and MCX) and VAR model (for IPC, SENSEX, and SSE).

Table 7. Results of Wald Test

Y** \ X*		GVZ	OVX	FED_RATE
BIST	Chi-sq	9.534766	12.94059	0.326826
	Prob.	0.0490***	0.0116***	0.9880
BVSP	Chi-sq	12.94059	3.999490	4.798494
	Prob.	0.0116***	0.4061	0.3086
R_IPC	Chi-sq	13.58263	6.528243	4.449292
	Prob.	0.0088***	0.1630	0.3486
JKSE	Chi-sq	17.02034	48.23950	2.631969
	Prob.	0.0019***	0.0000***	0.6212
MCX	Chi-sq	13.06455	17.41528	1.676610
	Prob.	0.0110***	0.0016***	0.7950
R_SENSEX	Chi-sq	4.219025	34.21632	2.360900
	Prob.	0.3772	0.0000***	0.6697
R_SSE	Chi-sq	3.999101	11.30056	3.023059
	Prob.	0.4061	0.0234***	0.5540
X*: Independent Variables Y**: Dependent Variables ***: Statistically significant at 5% level				

According to the Wald test results (Table 7), the changes in the FED interest rates do not affect the return of any stock market indices in short-term. The independent variable representing the volatility of oil prices is the short-term cause of the introduction of the BIST, JKSE, MCX, SENSEX and SSE indices of changes in the OVX.

4.4. Variance Decomposition

The variance decomposition measures the percent change in the the forward looking error term variance of the other variable caused by the shock in any of the variables in the system (Chang et al., 2001). In other words, it explains what percentage of the change of a variable is caused by itself and what percentage is caused by other variables (Tarı, 2012). The variance decomposition method determines the variation in the internal variables as the individual shocks that affect all the internal variables. This Method is used to explain stock index returns using the power of independent variables (GVZ, OVX, Fed_Rate). Because of the long term equilibrium relation (cointegration) between the stock market indices and the independent variables examined, the VECM model was used for the variance decomposition. The common result for all stock market indices is that the changes in the FED interest rates cause a very small change in the variance of the stock market indices.

Table 8 gives the estimation results of the variance decomposition for the BIST index. Accordingly, the BIST index has been influenced by itself by 97% over the calculated 45 periods. When the contributions of other variables on BIST variable are examined, it is seen that the contribution of OVX is higher than that of GVZ in the first 20 periods (GVZ 0.38%, OVX 1.3%) while the contribution of GVZ is higher than OVX in the next period.

Table 8. Resources by Variables for the Change in the Variance of BIST Variable

BIST					
Period	SE	BIST	GVZ	OVX	Fed_Rate
1	1060.655	100.0000	0.000000	0.000000	0.000000
5	2319.977	98.89642	0.094004	1.003227	0.006351
10	3286.720	98.47148	0.197931	1.319495	0.011099
15	4027.718	98.08537	0.448735	1.448628	0.017263
20	4655.071	97.65522	0.790147	1.529814	0.024819
25	5210.877	97.18887	1.188418	1.589588	0.033120
30	5716.443	96.70163	1.619646	1.636963	0.041761
35	6184.226	96.20688	2.066583	1.676067	0.050473
40	6622.201	95.71492	2.516848	1.709160	0.059074
45	7035.813	95.23322	2.961698	1.737638	0.067441

Table 9 shows the variation in the variance of the BVSP index variable according to the variable resources. According to this, the BVSP index has been most affected by itself during the calculation period. When the contribution of the other variables is examined, it is seen that GVZ is more likely to be cause for the change than OVX and Fed fund rates. While the contribution of GVZ is low in the first 20 periods (average 0.65%), this contribution increases in the second 20 periods (average 2.7%).

Table 9. Resources by Variables for the Change in the Variance of BVSP Variable

BVSP					
Period	SE	BVSP	GVZ	OVX	Fed_rate
1	804.9618	100.0000	0.000000	0.000000	0.000000
5	1739.619	99.71572	0.124022	0.020273	0.139981
10	2367.601	99.56521	0.324351	0.012049	0.098394
15	2822.824	99.24442	0.675838	0.008984	0.070754
20	3185.324	98.79881	1.121505	0.007402	0.072280
25	3488.003	98.26028	1.625813	0.006374	0.107538
30	3748.162	97.65359	2.161634	0.005603	0.179175
35	3976.226	96.99791	2.707966	0.004994	0.289134
40	4179.045	96.30770	3.248772	0.004529	0.438995
45	4361.398	95.59358	3.772076	0.004231	0.630112

Table 10 gives the estimation results of variance decomposition for the IPC index. According to this, for the 45 periods examined, the IPC index has been mostly influenced by itself and the effect of the GVZ, OVX and Fed fund rate variables appears to be very low.

Table 10. Resources by Variables for the Change in the Variance of IPC Variable

IPC					
Period	SE	IPC	GVZ	OVX	Fed_rate
1	362.9904	100.0000	0.000000	0.000000	0.000000
5	799.9901	99.80271	0.037877	0.039721	0.119689
10	1096.330	99.83170	0.031881	0.026946	0.109472
15	1329.435	99.84772	0.024238	0.022293	0.105750
20	1527.582	99.85774	0.018875	0.020026	0.103357
25	1702.970	99.86450	0.015219	0.018714	0.101569
30	1862.026	99.86916	0.012823	0.017881	0.100134
35	2008.618	99.87239	0.011359	0.017318	0.098936
40	2145.291	99.87459	0.010578	0.016922	0.097911
45	2273.825	99.87605	0.010296	0.016633	0.097018

Table 11 contains the sources of variation in the variance of the JKSE variable. According to this, the JKSE index is most affected by itself and the increase in the influence of GVZ with the increase of the period attracts the attention. The effect of OVX seems to be almost constant with 2%.

Table 11. Resources by Variables for the Change in the Variance of JKSE Variable

JKSE					
Period	SE	JKSE	GVZ	OVX	Fed_rate
1	46.39844	100.0000	0.000000	0.000000	0.000000
5	97.05150	97.12487	0.834150	1.963960	0.077022
10	129.7980	96.78001	1.192065	1.932073	0.095851
15	156.6183	96.21713	1.717140	1.969739	0.095994
20	179.8270	95.60709	2.302513	1.998861	0.091536
25	200.6784	94.97586	2.914596	2.023604	0.085935
30	219.8367	94.34286	3.532019	2.044871	0.080255
35	237.6969	93.72101	4.140875	2.063236	0.074876
40	254.5164	93.11879	4.732114	2.079173	0.069927
45	270.4729	92.54147	5.300021	2.093071	0.065435

Table 12 lists the sources of variation in the variance of the MCX variable. According to this, for the 45 periods examined, MCS index has been mostly affected by itself with 99.6% and the effect of the GVZ, OVX and Fed fund rate variables has been very low.

Table 12. Resources by Variables for the Change in the Variance of MCX Variable

MCX					
Period	SE	MCX	GVZ	OVX	Fed_rate
1	21.12173	100.0000	0.000000	0.000000	0.000000
5	44.64230	99.47652	0.231765	0.263022	0.028689
10	61.58606	99.57088	0.128574	0.262663	0.037883
15	74.80773	99.60438	0.090897	0.262623	0.042103
20	86.01734	99.62200	0.070883	0.262737	0.044382
25	95.92349	99.63297	0.058285	0.262917	0.045826
30	104.8964	99.64050	0.049546	0.263116	0.046839
35	113.1586	99.64599	0.043092	0.263318	0.047599
40	120.8561	99.65017	0.038115	0.263515	0.048196
45	128.0908	99.65346	0.034154	0.263703	0.048681

Table 13 contains the sources of variation in variance of the SENSEX variable. According to this, SENSEX variable has been mostly affected by itself with 96.5% and the OVX has an average effect of about 2.5%. In addition, while the effect of OVX increases with time; the effect of GVZ appears to have diminished over time. As in the other indices, the effect of the Fed fund rate variable on SENSEX remains very low.

Table 13. Resources by Variables for the Change in the Variance of SENSEX Variable

SENSEX					
Period	SE	SENSEX	GVZ	OVX	Fed_rate
1	226.3565	100.0000	0.000000	0.000000	0.000000
5	500.1499	97.08537	0.975711	1.911988	0.026929
10	694.9366	96.58396	1.104711	2.295372	0.015954
15	846.3201	96.45146	1.104813	2.431066	0.012664
20	974.3267	96.41080	1.077940	2.500130	0.011129
25	1087.277	96.40265	1.044416	2.542637	0.010298
30	1189.485	96.40835	1.010224	2.571615	0.009813
35	1283.530	96.42025	0.977495	2.592734	0.009518
40	1371.101	96.43482	0.946978	2.608866	0.009338
45	1453.376	96.45028	0.918868	2.621625	0.009228

Table 14 contains the sources of variation in the variance of the SSE variable. Accordingly, the SSE variable is most affected by itself. It is seen that the effect of GVZ increases with time, whereas the effect of OVX decreases with time. The impact of the Fed fund rate variable on SSE remains quite low.

Table 14. Resources by Variables for the Change in the Variance of SSE Variable

SSE					
Period	SE	SSE	GVZ	OVX	Fed_rate
1	45.00888	100.0000	0.000000	0.000000	0.000000
5	101.5522	99.45076	0.124161	0.392668	0.032407
10	147.2082	99.46497	0.184648	0.332449	0.017937
15	181.7572	99.32086	0.365178	0.301014	0.012946
20	210.7547	99.09966	0.613278	0.276479	0.010585
25	236.2863	98.83226	0.902475	0.256019	0.009250
30	259.3957	98.53801	1.215073	0.238507	0.008413
35	280.6899	98.23020	1.538636	0.223309	0.007853
40	300.5571	97.91820	1.864343	0.209999	0.007461
45	319.2626	97.60856	2.185997	0.198261	0.007178

The Variance Decomposition analysis, which was conducted in order to determine the power of explanation of the returns of stock indices of the independent variables, achieved the following results:

- There is no significant impact of Fed fund rates on the return of any stock market index being examined.

- It has been determined that all of the stock market indexes examined in general are most affected by themselves. The following comments should be considered with this acceptance.
- The BIST index was affected more than the OVX (by GVZ) in the first 20 periods; the effect of GVZ increased in subsequent periods.
- BVSP index is more affected than GVZ by OVX and Fed interest rates. This relationship was also found in the Wald test where the short-term relationship was determined.
- The effect of the GVZ and OVX variables used in the model in the IPC index is very low.
- In the JKSE index, the effect of GVZ increased with the increase of the period; where as the effect of OVX remains constant.
- The effect of the GVZ and OVX variables used in the model in the MCX index is very low.
- SENSEX index is affected both by GVZ and OVX; however, it was found that the effect of OVX increased with the increase of the period, while the effect of GVZ decreased.
- In the SSE index, the effect of GVZ increased over time, whereas the effect of OVX decreased over time.

5. CONCLUSION AND DISCUSSION

In this study, basic variables affecting the economic and structural problems experienced by the developing markets, especially due to the savings deficit, commodity prices and capital inflows have been explored. The relationship between the benchmark indices of Turkey, Brazil, Mexico, Indonesia, Russia, India and China's stock exchanges together with gold volatility index GVZ, oil volatility index OVX and Fed und rates has been investigated.

Study results are compatible with studies Mensi et al. (2013), Gokmenoglu and Fazlollahi (2015) Bouri et al. (2017) Jia, Bouri, and Roubaud (2018) which indicate a relationship between stock markets and gold- petrol volatility indices (GVZ-OVX) and the study of Pala and Sönmezer (2017) which indicates no relationship between quantitative relaxation aspects.

The methods are estimated separately for each stock index return series. According to the results of the analysis, it was determined that there is a long-term relationship between all stock indices examined and GVZ, OVX and Fed_Rate. According to the established VECM, the resulting error correction coefficients are negative valued and significant for BIST, BVSP, JKSE and MCX indices. That is, the short term cyclical deviations in these indices are back to balance in the long run. On the other hand, the error correction coefficient for the IPC, SENSEX and SSE indices has been negative, but statistically insignificant. In the short run, the Wald test was applied to test the existence of the causality relation from the independent variables (GVZ, OVX, Fed_Rate) to the stock market index returns. According to this, in the short term, while the BIST, JKSE and MCX indices were associated with both OVX and GVZ, SENSEX and SSE indexes were found to be associated only with OVX and BVSP and

IPC indices were associated only with GVZ. Changes in short-term Fed fund rates are not related to any index.

It is thought that the results of this study will contribute to the international portfolio diversification of financial units and the policy makers and implementers in emerging markets. It is recommended that the researches of further studies to investigate the relationship between the volatility spread of stock markets and the gold-oil volatility indexes according to the level of the development of the countries or to investigate the relationship between the debt instruments market and the gold-oil volatility indexes.

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APPENDICES

Appendix 1. Determination of Suitable Lag Lengths for Cointegration Analysis between Variables (VAR Lag Order Selection Criteria)

BIST						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-34523.3	NA	1.31e+10	34.64861	34.65985	34.65274
1	-18961.4	31045.73	2200.843	19.04810	19.10427	19.06873
2	-18818.3	284.9783	1937.229	18.92052	19.02163*	18.95765*
3	-18786.9	62.32769	1907.582	18.90510	19.05114	18.95873
4	***-18757.4***	***58.62255****	***1881.796****	***18.89149****	***19.08247***	***18.96162***
BVSP						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-34008	NA	7.82e+09	34.13143	34.14267	34.13556
1	-18334	31269.34	1172.548	18.41844	18.47461	18.43907
2	-18189.2	288.2737	1030.389	18.28920	18.39031*	18.32633
3	-18154.8	68.35548	1011.536	18.27073	18.41678	18.32437*
4	***-18127.1***	***54.85697****	***999.7658****	***18.25903****	***18.45001***	***18.32916***
IPC						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-32674.5	NA	2.05e+09	32.79330	32.80453	32.79742
1	-16705.4	31858.22	228.7404	16.78410	16.84027	16.80472
2	-16561.4	286.5158	201.1862	16.65574	16.75685*	16.69287
3	-16528.4	65.67334	197.7728	16.63863	16.78467	16.69226
4	***-16495.8***	***64.54631****	***194.5154****	***16.62202****	***16.81300***	***16.69215****
JKSE						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-29209.1	NA	63351748	29.31572	29.32696	29.31985
1	-12774.8	32786.12	4.429372	12.83977	12.89594	12.86039
2	-12602.8	342.4181	3.787569	12.68323	12.78434*	12.72036
3	-12571.2	62.92420	3.728482	12.66751	12.81355	12.72114
4	***-12536***	***69.79204****	***3.657349****	***12.64825****	***12.83922***	***12.71838****
MCX						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-26366.8	NA	3656183.	26.46344	26.47467	26.46756
1	-11125.7	30405.86	0.846444	11.18480	11.24097	11.20542
2	-10980	289.9747	0.743184	11.05470	11.15580*	11.09183
3	-10945.6	68.45889	0.729548	11.03618	11.18222	11.08981*
4	***-10915.3***	***59.99769****	***0.719185****	***11.02187****	***11.21285***	***11.09201***

SENSEX						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-32585.6	NA	1.88e+09	32.70404	32.71527	32.70816

1	-15898	33291.50	101.7338	15.97387	16.03004	15.99450
2	-15741.7	311.1876	88.37305	15.83308	15.93418*	15.87021*
3	-15709.4	64.14553	86.94076	15.81673	15.96278	15.87037
4	***-15679.9***	***58.54955****	***85.76867****	***15.80316****	***15.99414***	***15.87330***
SSE						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-28569.9	NA	33357524	28.67430	28.68554	28.67843
1	-12690	31680.23	4.067881	12.75463	12.81080	12.77526
2	-12548.6	281.4376	3.587031	12.62883	12.72994*	12.66596*
3	-12517.1	62.72574	3.531427	12.61321	12.75925	12.66684
4	***-12490.5***	***52.76510****	***3.494031****	***12.60256****	***12.79354***	***12.67270***

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion