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The Causality Analysis of the Effect of Oil and Natural Gas Prices on Ukraine Stock Index

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ABSTRACT

Since petroleum and natural gas are the main energy source, it is important for all countries in the world. Oil and natural gas reserves in the world are not evenly distributed; some countries are important oil and natural gas exporters while the others import these energy sources. For this reason, both exporting and importing countries have to pay close attention to oil and gas prices. For Ukraine, which imports more than 90% of its oil and natural gas needs, it makes the investigation of macroeconomic effects of the change in oil and natural gas prices extremely vital. There are many domestic and foreign studies investigating the interaction between oil and gas prices and both macro and micro economic variables in Ukraine. In this study, the effects of changes in oil and natural gas prices on the returns of the PFTS national index of the Ukrainian Stock Exchange were investigated. The study includes monthly data for January 2008-September 2019 period. The Johansen cointegration test was conducted to determine whether the energy prices and PFTS index are cointegrated in the long run. According to the causality test, it was found that the change in oil price by 1 dollar and the change in natural gas price by 1 dollar cause the change in RFTS by 0.56 and by 0.31, respectively.

Keywords: Ukraine, Stock Exchange, Index, Return, Oil, Natural Gas, Price
JEL Classifications: F30, F65, G12, G15

1. INTRODUCTION

Oil and natural gas are the main energy sources. While oil constitutes the main raw material utilized in the production stage, natural gas is the main energy. Therefore, economies, whether developed or developing, are directly or indirectly dependent on oil and natural gas. Oil and natural gas prices are also important for all economies as countries depend on these energy sources.

Oil accounts for 33.27% of the world's energy consumption. World oil consumption reached 96.55 million barrels in 2017, while world oil production was 92.15 million barrels/day (BP, 2018). Oil prices have fluctuated over the years. As an example, price rose to $ 132 per barrel in 2008 and reached its peak in 2008, declining by about 77% in January 2016 to $30 (International Energy Agency, 2018). In December 2019, the average price of Brent oil was 65 dollars.

The first major shock in oil prices was the result of the OPEC embargo in 1973. After the first oil crisis, the relationship between the change in oil prices and the macroeconomic system began to be investigated (Hamilton, 1983; Burbidge and Harrison 1984; Gisser and Goodwin, 1986). One of the pioneering studies on this subject belongs to Hamilton (1983), and the author argues that the change in oil prices leads to recession in the American economy. After this study, the relations between oil prices and macroeconomic variables were analyzed by different methods for various countries and country groups. However, there has been an increase in the number of studies examining the effects of changes in prices on stock market prices and returns in recent years (Syzdykova, 2019. p. 248).

It is stated in the literature that changes in oil prices may affect stock prices through various channels. For example, increased risk and uncertainty in oil prices may have negative effects on global

economic growth rates, which may lead to decreases in stock indices (Basher and Sadorsky, 2006. p. 225; Dagher and El Hariri, 2013. p. 366). Increase in oil prices may also lead to increase in inflation rates. Increase in inflation rates may push central banks to increase interest rates. This situation may lead to an increase in the discount factors used in the valuation of stocks and may cause the present value of cash flows to decrease (Basher et al., 2012. p. 229; Narayan and Narayan, 2010. p. 357). In addition, increase in oil prices leads to increase in the production costs of the companies and consequently the decreasing company profits may lead to decrease in the stock markets (Narayan and Narayan, 2010. p. 357; Syzdykova, 2019. p. 248-249).

Ukraine is one of the most important mineral producing countries in the world both in terms of the size of its reserves and its range. About half of all known layer areas are in operation. Ukraine has a coal reserve of 47.1 billion tons. Coal as fuel is able to meet 85% of annual domestic demand by domestic production and is about 100 million tons. Ukraine has oil and gas fields, which cover 10% of oil and 20% of gas consumption, respectively. Ukraine has natural gas reserves of 39.6 trillion cubic feet, but only 20% of the country's needs are met by domestic production. It is observed that Ukraine have consumed 68.8 natural gas in 2011, 28.8 in 2015 and 29.8 in 2018.

In this study, the studies that analyze the relationship between oil and natural gas prices and capital market indices and stock returns are included. Then, the data set and method used in the study were explained and the results of the model were analyzed according to the analysis and findings.

2. UKRAINE STOCK MARKET

After Ukraine declared its independence, it experienced a period of stagnation before the social-economic development. In the process of transition from social to market economy, the country's economy has been drawn to a serious decline. As a new independent state, the country had to go through some erroneous periods in terms of economic, social, political and legal aspects in order to investigate its own development paths. It was during the preparation phase of its own development programs that it experienced the erroneous periods and some economic reforms were made. The Stock Market also has an important role in these reforms (Tatarinov and Reziapov, 2019).

Table 1: List of the variables

Variable	Value
LOGPFTS (Independent)	Index
LOGGAS	USD
LOGPETROL	USD

The Ukrainian Stock Market was established in October 2008 and has become one of the fastest growing stock markets in the world. Today, it offers the opportunity to trade with a wide range of financial instruments, from stocks to other futures and options. Initially, RTS was a major shareholder of the Ukrainian Stock Market, where it held a 43% stake in the Moscow Stock Exchange. In March 2016, the Moscow Stock Market sold its shares to Ukrainian market participants. Today, more than 50% of the shares are controlled by two companies under Dragon Capital and UNIVER Investment Group. Percentage of floating shares is distributed among domestic and foreign investment institutions and individuals. On March 26, 2009, the UX Index, the first real-time stock index in Ukraine, was announced. It monitors local shares with high liquidity and is considered as the main criterion for the Ukrainian stock market.

In Ukraine (according to the Ukrainian Stock Exchange Infrastructure Development Agency) 11 stock exchanges operate in 3 cities: Kiev, Nikolaev and Dnepropetrovsk (in other cities only stock exchange branches are available). The listed Ukrainian stock exchanges are listed as follows:

- PFTS Exchange
- Kiev International Stock Exchange (KMSE)
- Ukrainian Stock Exchange (UBB)
- Ukrainian Interbank Currency Exchange (UICE)
- INEX Stock Exchange
- South Ukraine Trade and Information System "Pivden Server" (PTIS)
- Pridneprovsk Stock Exchange (PFB)
- Ukraine International Stock Exchange (UMSE)
- Trade and Information System "Perspective"
- Eastern European Stock Exchange (СЄФБ)
- Ukrainian Stock Exchange (UB).

3. LITERATURE REVIEW

There are many studies in the literature that investigate the effects of oil prices on stock markets. Most of the studies have investigated this relationship for developed country groups. The number of studies for developing countries has recently started to increase. However, relatively few studies have been conducted on the effects of oil prices on sectors.

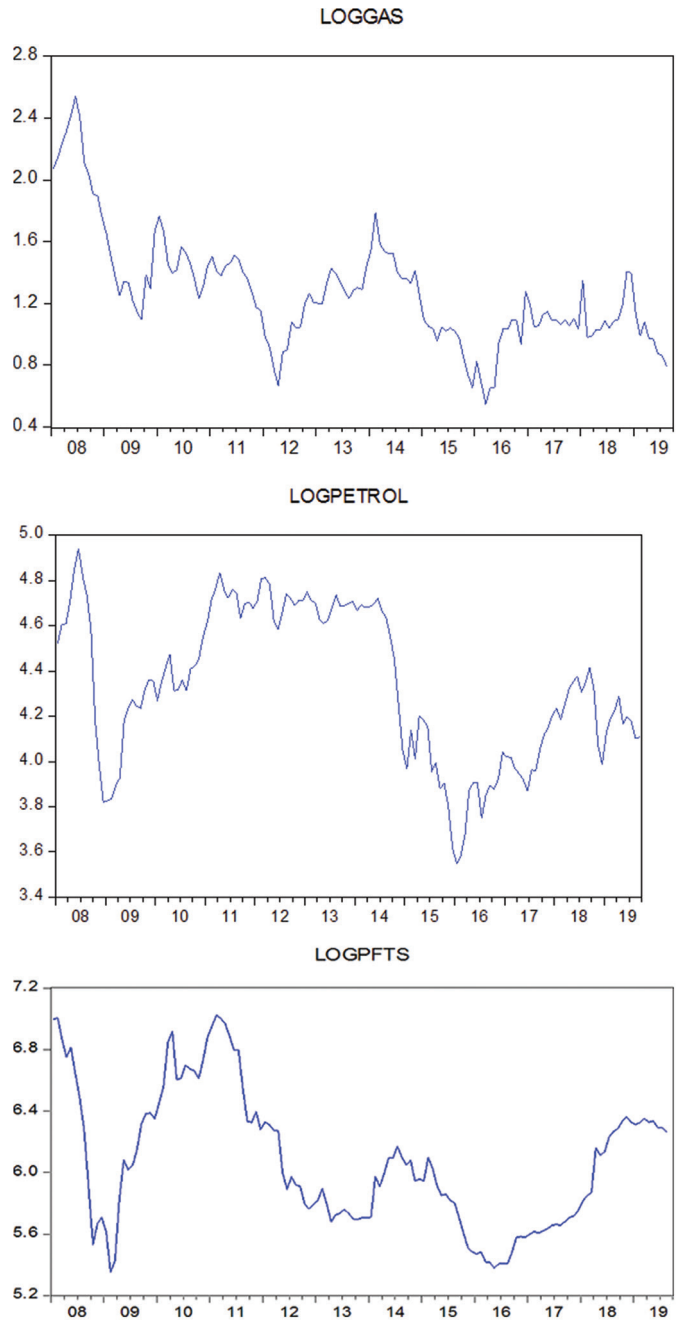
The stock exchange market is the relationship of a number of financial markets related to the issuance and circulation of stock exchanges, as well as the forms and methods of such circulation. This concept also includes a system of institutions and economic mechanisms, which serves the circulation of stock exchanges (Gonçar, 2001. p. 826; Kravchenko, 2001. p. 356).

In their study, Tatarinov and Reziapov (2019) examined the main external factors affecting the functioning of Ukrainian stock

Table 2: Ukraine stock exchange market - LOGPFDS

Test	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
ADF	−0.603018 [0.4545]	−2.364719 [0.3963]	−8.519731 [0.0000]	−8.585916 [0.0000]
PP	−0.588611 [0.4608]	−2.300918 [0.4303]	−8.455948 [0.0000]	−8.513853 [0.0000]

Significance level (%)	Constant	Constant and trend
1	−3.524233	−4.092547
5	−2.902358	−3.474363
10	−2.588587	−3.164499



exchanges and showed the situation of these factors in Ukraine. They made recommendations to improve the situation of the factors affecting the development of the stock exchange market in Ukraine.

In her study, Syzdykova (2019) analyzed the relationship between the changes in oil prices with the BIST 100 national index and the indexes of transport, chemical and industrial sectors (XULAS, XKMYA and XUSIN), which are closely related to oil, using impulse-response and variance decomposition methods based on VAR method. According to the findings, the effect of oil price changes varies according to the sectors. Analysing the result of impulse-response analysis, we can see that XKMYA and XUSIN index returns react positively to shocks in oil prices during the first 5 months. The response of BİST 100 and XULAS variables were similar and it was found that positive and negative values returned to positive in the 1st month.

Nandha and Faff (2008) analyzed the impact of oil price shocks on the 35 global industry indices in the period April 1983-September 2005. As a result of the study, they found that the change in oil prices had a negative effect on stock returns in all sectors except mining, oil and gas sectors. In addition, the authors emphasized that investors wishing to take advantage of diversification should necessarily include the asset class that has a positive correlation with oil in their portfolios or develop synthetic hedging methods using petroleum derivatives.

In their study, Narayan and Narayan (2010) investigated whether there is a cointegration relationship between oil prices and stock prices and exchange rate by using daily data for Vietnam between July 28, 2000 and June 16, 2008. According to the results of the analysis, the relationship between oil prices and stock prices and exchange rates was found in the long run. In addition, the effect of oil prices on stock prices turned out to be positive.

Sugra et al. (2019) examined the effect of the oil factor on the Azerbaijani economy. They concluded that the fluctuations in oil prices between 2007-2009 and 2014-2016 had a high impact on the "economic concept."

4. EMPIRICAL ANALYSIS

In the empirical analysis of the study, the effect of the changes in oil and natural gas prices on the PFTS, the important stock index of Ukraine, was analyzed. In order to investigate whether changes in oil and natural gas prices are cointegrated with the stock market index in the long run, a co-integration test was conducted with Johansen method. Below are the variables in the model (Table 1).

In the empirical part, time series analysis was performed using data covering the period from January 2008 to September 2019. The data sets forming the variables in the model were taken as raw data, then seasonally adjusted and included in the model by taking the logarithm to reach the same percentage levels. The data was collected from "investing.com." The following is a graph of all three variables:

In all three variables, randomness and shocks in certain periods are observed. In the time series models, the variables are generally not stationary. Regression with non-stationary variables often leads to spurious regression. Futhermore, the economic interpretation of analysis or estimation with non-stationary variables is inconsistent. For this reason, before proceeding to a statistical analysis of a series, it is necessary to look at whether the process that created the series is stable over time, i.e. its stationarity.

4.1. Unit Root Tests

In empirical studies, unit root tests are performed to make non-stationary series stationary. The most commonly used unit root

Table 3: Oil prices (USD) - LOGPETROL

Test	Level		First difference	
	Constant	Constant trend	Constant	Constant and trend
ADF	−0.504165 [0.4964]	−1.787384 [0.7058]	−8.572025 [0.0000]	−8.540113 [0.0000]
PP	−2.014710 [0.2803]	−2.268792 [0.4477]	−8.548533 [0.0000]	−8.516239 [0.0000]

Anlamlılık düzeyi (%)	Sabit	Sabit ve trend
1	−3.524233	−4.092547
5	−2.902358	−3.474363
10	−2.588587	−3.164499

tests in practice are Augumented Dickey Fuller (ADF), Philips-Perron and Dickey Fuller tests (Yurdakul, 2000. p. 23). Augmebted Dickey-Fuller (1981) and Phillips-Perron (1988) unit root tests were applied in the study.

Dickey-Fuller (1979) test has a structure that shows whether variables are expressed by autoregressive process in time series. Dickey-Fuller test least squares method for the y = 0 hypothesis unit root test is applied and should be decided according to t statistic. Dickey-Fuller developed the test called Extended Dickey-Fuller (1981) test by including the delayed values of the dependent variable into the model as an independent variable. In this test, while determining the appropriate delay order for the delayed variable is found using the Schwarz and Akaike criteria (Göktaş, 2005. p. 67). Below are the models of the test without constant fixed and trend, with constant and with trend, with constant and trend, respectively:

$$\Delta Y_t = \delta Y_{t-1} + \sum \delta_i \Delta Y_{t-1} + \varepsilon_t \quad (1)$$

$$\Delta Y_t = \mu + \delta Y_{t-1} + \sum \delta_i \Delta Y_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta Y_t = \mu + \beta_T + \delta Y_{t-1} + \sum \delta_i \Delta Y_{t-1} + \varepsilon_t \quad (3)$$

Phillips and Perron (1988) developed unit root tests that are commonly used in financial time series. This test differs from ADF in dealing with the problem of serial correlation and changing variance in errors. Instead of adding delayed values in order to prevent autocorrelation in the ADF equation, the authors re-arranged t statistics by estimating the DF equation (Francıs, 1999. p. 12). Below are the models of the test without constant fixed and trend, with constant and with trend, with constant and trend, respectively:

$$Y_t = \delta Y (t-1) + \mu_t \quad (4)$$

$$Y_t = \beta_{1+} \delta Y (t-1) + \mu_t \quad (5) \text{ [Constant Term]}$$

$$Y_t = \beta_1 + \delta Y (t-1) + \beta_2 (t - T/2 + \mu_t) \quad (6) \text{ [Constant Term and Trend Coefficient]}$$

The following Tables 2 and 3 show the stability test results of variables according to ADF and PP unit root tests.

According to the results of both ADF and PP tests, it was concluded that all three series contain unit root at the level values (H_0 hypothesis cannot be rejected) (Table 4). After taking the first difference, the unit root disappeared (H_0 hypothesis rejected). Since the test statistics in the level values of the series were greater than the critical value, it was concluded that the series contained unit root. When the series' first differences were taken, it became stationary. The cointegration test was conducted by considering that the series are in the same order as I (1).

4.2. Johansen Co-integration Test

Co-integration is used to determine and test the long-run relationship between economic variables. Variables that are assumed to have long-term equilibrium relationships are tested by this method. Co-integration is concerned with the linear combination of non-stationary variables. According to the cointegration condition, all variables should be integrated in the same order (Göktaş, 2005. p. 115).

In Johansen cointegration analysis, it is necessary to know the rank of π matrix. Here the coefficients are in the form of ($N \times N$) dimensional matrix. This matrix is written as $\pi = \alpha\beta$. β represents the cointegration matrix and α represents the weights of the parameters of each cointegrating vector. In Johansen cointegration test: If $r(\pi) = 0$, there is no cointegration. If $r(\pi) = 1$, there is 1 cointegrating vector, if $r(\pi) = 2$, there are 2 cointegrating vectors (Bierens, 1997. p. 384).

Before proceeding with the Johansen Cointegration test, the VAR (1) model was established to determine the number of lags of interactions among the series, LR (sequential modified LR test statistic), Final Prediction Error (FPE), Akaike Information Criteria (AIC). It was decided that the optimum lag length was 3 according information criteria (Table 5)

LM test was performed to find out whether autocorrelation was found at the optimal lag length. The 3rd the presence of autocorrelation was tested in lag length 3 (Table 6)

According to the hypothesis of the LM autocorrelation test, the H_0 hypothesis means no autocorrelation and the H_1 hypothesis means autocorrelation at a significance level of 5%. As a result of the test, 10.31326 value which is calculated for the 3rd lag length is at 5% significance level and it is smaller than the table value in accordance with the degree of freedom 4 ($\chi^2_{0.005;\,4} = 9.488$). In this case, the H_0 hypothesis cannot be rejected.

Heteroscedacity (changing variance) test was performed to test whether the variance of the error term is the same for all periods to ensure the stability condition (Table 7).

In the table, χ^2 is Chi-square and Df is the degree of freedom. According to the results of the White test, it was found that there was no change in variance at 5% significance level ($\chi^2_{0.005;\,38} = 53.38$). The H_0 hypothesis cannot be rejected because the calculated value is smaller than the table value.

Table 4: Natural gas price (USD) - LOGGAS

Test	Level		First difference	
	Constant	Constant and trend	Constant	Constant and trend
ADF	−2.361450 [0.1546]	−2.780439 [0.2071]	−11.31549 [0.0000]	−11.29375 [0.0000]
PP	−2.417568 [0.1388]	−2.854045 [0.1809]	−8.548533 [0.0000]	−11.30790 [0.0000]

Anlamlılık düzeyi (%)	Sabit	Sabit ve trend
1	−3.524233	−4.092547
5	−2.902358	−3.474363
10	−2.588587	−3.164499

*T-stat values and probability values in brackets were given for the ADF test. Adjusted T-stat values were given in PP test

Table 5: Determining the optimal lag lentgh

Lag lentgh	LogL	LR	FPE	AIC	SC	HQ
0	−1678.332	NA	23233125	25.47472	25.54024	25.50134
1	−1195.789	935.8399	17787.64	18.29983	18.56191*	18.40633*
2	−1183.295	23.66330	16874.51	18.24689	18.70552	18.43326
3	−1173.755	17.63516*	16746.53*	18.23870*	18.89389	18.50494
4	−1166.654	12.80227	17253.61	18.26749	19.11922	18.61359
5	−1161.891	8.370669	18428.46	18.33169	19.37998	18.75767
6	−1152.950	15.30882	18489.99	18.33258	19.57742	18.83842
7	−1149.740	5.350119	20253.61	18.42030	19.86170	19.00602
8	−1142.805	11.24257	20991.05	18.45160	20.08955	19.11719

Table 6: Autocorrelation test

Lag	LM-Stat	Prob.
1	13.15070	0.1559
2	15.21575	0.0852
3	10.31326	0.3257
4	7.561442	0.5789
5	15.49914	0.0781
6	10.09251	0.3430
7	6.379983	0.7014
8	2.017304	0.9912
9	4.373142	0.8852
10	17.54503	0.0408
11	15.07624	0.0889
12	6.108068	0.7291

The position of the inverted roots of the AR characteristic polynomial in the unit circle was examined in terms of whether the esimated VAR model contains a unit root.

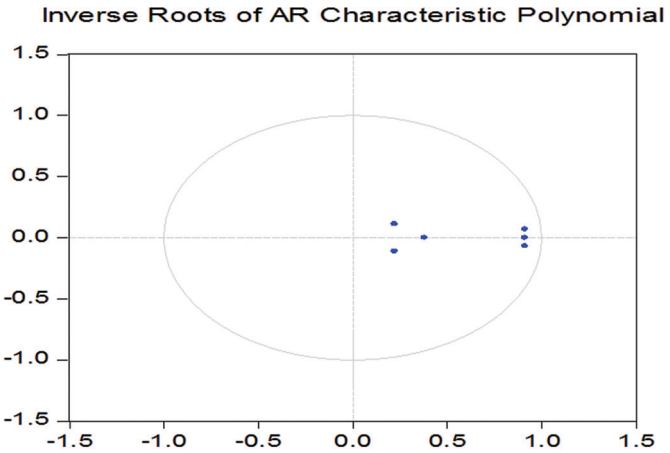


Table 7: Heteroscedacity test

χ^2	Df	Probability value
32.52745	38	0.1187

All diagnostic tests were performed for the estimated VAR model and stability was achieved. In this case, the result of the cointegration test, if the cointegration is detected, the interpretation of the long-term relationship coefficients is significant.

To determine the presence of cointegration and the number of vectors, trace (λtrace) and maximum Eigen (λmax) values are examined from the test results. Where trace and maximum eigenvalues are greater than critical values at 5% significance level, it is judged that cointegration occurs. Here H_0 hypothesis supports that there is no cointegration (r = o) and H_1 alternative hypothesis supports that there is cointegration relation (r > 0). Within the framework of these hypotheses, the findings of the cointegration test are given in the Table 8.

According to the results of the test, trace and maximum eigenvalues are >5% critical values (Table 9). That is, there is at least one co-integrating relationship. Normalized cointegration coefficients and long-term analysis can be interpreted if the cointegration relationship between variables is determined.

The following equation shows the long-term relationship:

LOGPFTS = 70 + 0.56 * LOGPETROL + 0.31 * LOGGAS (7)

According to the results of cointegration analysis, 0.1 increase in oil prices increases PFTS by 0.56 and 0.1 increase in natural gas prices increases PFTS by 0.31.

4.3. Causality Test

We conducted a weak exogeneity test to investigate the direction of the relationship between the variables and whether the cointegrating vector is a dependent variable in order to normalize the interpretations. In the long-term response matrix $\pi = \alpha\beta$, the model was restricted by showing that the α value of both α to LOGYTSK and LOGDVZ variables is equal to 0. The H_0 hypothesis of the test states that the variable is weak exogenous and the H_1 hypothesis is that the vector is H` = [1: 0]. The weak exogeneity statistic follows asymptotically a χ^2 distribution with r (n-m) degrees of freedom. Where n-m is the number of constraints on b; m x n is the dimensions of the constraint vector; r shows the number of co-integrating vectors (Johansen, 1995: 19). Weak exogeneity test results are given in Table 10

According to the results of the test, H_0 hypothesis was rejected for LOGPFDS variable at 1%, 5% and 10% significance level. However, for LOGPETROL and LOGGAZ variables, H_0 could

Table 8: Analyzing hypothesis according to Λ_{trace} values

Null hypothesis H_0	Alternative hypothesis H_1	Λ_{trace} value	0.05 critical value	Probability value
r=0	r>0	31.70302	29.79707	0.0298
r<1	r>1	13.34124	15.49471	0.1029
R<2	r>2	6.140782	9.164546	0.1801

Table 9: Analyzing hypothesis according to Λ_{max} values

Null hypothesis H_0	Alternative hypothesis H_1	Λ_{trace} value	0.05 critical value	Probability value
r=0	r>0	15.68202	11.22480	0.0135
r<1	r>1	1.391159	4.129906	0.1442
r>2	r>2	6.140782	9.164546	0.1801

Table 10: Weak exogeneity test

Değişken	LR testi (χ^2)	Olasılık değeri
LOGPFDS	9.859339	0.001690
LOGGAZ	1.245432	0.115447
LOGPETROL		

not be rejected. In other words, LOGPFDS is accepted as endogeneous, LOGGAS and LOGPETROL as weak exogeneous. In other words, the significance of the interpretetations we made by accepting the LOGPFDS variable as a dependent variable was confirmed.

There are many studies in the literature on the effects of oil and gas prices on capital and money markets. Most of the studies were conducted for developed country groups. The number of studies for developing countries is very small, but it has started to increase in recent years. In addition, econometric modelling has been conducted for the effects of oil and natural gas prices on the index of Ukraine. This makes the study important for research.

5. CONCLUSION

As a result, the fact that all three variables are stationary of the same order showed that there is a possible cointegration relationship between the series. Therefore, VAR model was estimated and diagnostic tests such as variance, autocorrelation and AR were performed on this model. After finding no diagnostic problems in lag length, Johansen method was used for cointegration test and long-term relationship between variables was determined. According to the results of weak externality test, the direction of causality relationship between the variables was confirmed. Economically, the long-term relationship between variables can be interpreted as follows:

- The $ 1 increase in natural gas prices increases the PFTS stock market by 0.31
- A $ 1 increase in oil prices increases the PFTS exchange by 0.56.

The results were statistically, econometrically and economically significant.

Changes in oil and natural gas prices have little importance in explaining PFTS index returns. These results indicate that PFTS index returns are affected by oil and natural gas prices. Therefore, stock market investors should pay attention to oil and natural gas prices in their investment decisions.

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