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Causality between Natural Gas Prices and Stock Market Returns : Evidence From Emerging Markets

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Abstract- This study emprically examines the long-run relationship between stock prices and natural gas prices for Brazil, Russia, Turkey and South Africa using monthly data for the period from 1999:Q1 to 2014:Q2. The main finding of the paper is that that there is a unique long-term equilibrium relationship between natural gas prices, industrial production and stock prices in Brazil, Russia, South Africa and Turkey. According to the Granger causal relationship between stock returns, industrial production growth and natural gas price increase, As a result, increase in industrial production growth seem to impact at natural gas prices the first place and stock returns appears to affect industrial production growth in the short term.
The results reveal that there is a unique long-term equilibrium relationship between natural gas prices, industrial production and stock prices in Brazil, Russia, Turkey and South Africa.

Keywords: natural gas prices, stock prices, economic activity,cointegration, VECM.

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1. Introduction

Natural gas is one of the major energy resources like oil and coal. It has numerous uses in the petroleum refining, metal, chemical, plastic, food processing, glass and paper industries . Natural gas is used to produce steel, glass, paper, clothing, brick, electricity, and as an essential raw material for many common products. Some products that use natural gas as a raw material are: paints, fertilizer, plastics, antifreeze, dyes, photographic film, medicines, and explosives (EIA, 2014). Natural gas prices and stock prices have become an important issue in the literature. Analysis of the industrial sector as a whole reveals strong links between natural gas prices and industrial production (Sendich, 2014). Natural gas prices may also be linked to the price of crude oil and/or petroleum products

Most studies tested and analyzed the influence of natural gas on change in economic activity. (Kliesen, (2006), Costello et al. (2006), Weber, 2012).

Vipin and Lieskovsky, 2014 analyzed that the relationship natural gas and US economic activity using VAR method in the period 1993M11-2012M12. They found that natural gas does affect U.S. economic activity, primarily through changes in its production. The shale gas revolution has changed this relationship – a one percentage point increase in natural gas supply raises total U.S. industrial production by more after 2008 than before.

There are also many studies the evidence on the relation between stock prices and economic activity (Schwert (1990), and Choi et al, (1999). In addition to that, some studies have connected with oil prices and stock, consistent with this conclusion, they found that the relationship between oil prices and stock market returns. (Jones and Kaul, 1996; Filis (2010), Basher and Sadorsky, 2006).

There are very limited studies on the effects of natural gas prices on stock prices. For instance, Kandir et al (2013) searched the long-run relationship between natural gas prices and stock returns in Turkey by using Johansen and Juselius, and bounds testing approach of cointegration tests using quarterly data from 1995 : Q1 to 2009 :Q3. According their results, there is no a unique long-term equilibrium relationship between natural gas prices, real GDP, real exchange rates and stock returns. On the other hand, Toda - Yamamoto causality approach results indicate that a unidirectional Granger causal relationship from stock prices to real GDP and natural gas prices and a unidirectional Granger causal relationship from real GDP to real exchange rates seem to exist in Turkey.

The rest of the paper is organized as follows. The next section presents the methodology and data. The third section reports the empirical results. The last section concludes the paper.

2. Methodology and Data

The data used in this paper is the monthly data of the stock prices, natural gas prices and industrial production the period from 1999:Q1 to 2014:Q2. for Brazil, Russia, Turkey and South Africa developing countries.

The standard log-linear functional specification of long-run relationship between the stock prices, industrial production and natural gas prices can be expressed as:

$$sp_t = \alpha + \beta_1 + ip_t + ntg_t + \varepsilon_t$$

(1)

Where sp_t is the stock price index (2010=100), whereas ip_t is the industrial production index (2010=100) as a proxy of real economic activity. Stock price index and industrial production index data are obtained from OECD Statistic website. Economic activity is added to the analysis as a control variable. ntg_t is the natural gas price index (2010=100). Natural gas prices (in US dollars) are proxied by the Russian Natural Gas border price in Germany and obtained from IMF website.

First, we conducted ADF and PP unit root tests to examine the stationarity of the variables. Second, we employed the Johansen cointegration method to examine any long run cointegration relationship between between stock prices industrial production and natural gas prices. Third, we estimated vector error correction model (VECM). Fourth, we ran the granger causality test to determine any short run relationship of the variables in the model.

2.1. Unit Root Test

The long run relationship between the variables the economic time series must be stationary at same level. The unit root test is used to detect the stationarity of the stock price, natural gas price and industrial production. We used the Augmented Dickey Fuller (ADF-1979) and conducted unit root tests in level and difference form.

The most commonly used test to examine the existence of a unit root is the Dickey-Fuller (1979) test. ADF unit root test of the null hypothesis of non-stationarity is conducted in the form of the following regression equation:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \lambda_t + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t$$

(2)

Where, ΔY is the first difference time series variable and ε is a white noise error term. Testing procedure of ADF test is examination of the null hypothesis of $\beta = 0$ which is equivalent to Y is a non-stationary process. We also used Phillips and Perron (1988) unit root test.

2.2 Johansen Cointegration Test

In order to proceed for the cointegration analysis, one must establish that the variables possess the same order of integration. Granger (1986) and Johansen and Juselius (1990) introduced cointegration analysis as a way to determine the existence of long-term equilibrium among selected variables.

The Johansen-Juselius, (JJ), procedure utilizes two test statistics to determine the number of cointegrating vectors. These are trace and maximum eigenvalue test statistics. Johansen and Juselius (1990) consider the following model in the vector autoregression (VAR) of order p given by :

$$\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + ... + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-p} + \mu_t$$

(3)

Where λ is vector containing the variables that are integrated of order one-commonly denoted $I(1)$.

$$\lambda_{\max} = -T \ln(1 - \lambda r + 1)$$

(4)

Where λ are the $r+1, ...\lambda n$ smallest squared canonical correlations and T = the number of observations.

The trace (Tr) test shown in equations ;

$$\lambda_{trace} = -T \Sigma \ln(1-\lambda i)$$
(5)

2.3.Granger Causality and Vector error correction model and Exogeneity

C. W. J. Granger (1969) proposed a time-series data is based on approach in order to determine causality. The Granger causality test estimates the pair regressions as below:

$$y_t = \beta_{1,0} + \sum_{i=1}^{p} \beta_{1,i} y_{t-i} + \sum_{j=1}^{p} \beta_{1,p+j} x_{t-j} + \varepsilon_{1t}$$
(6)

$$x_t = \beta_{2,0} + \sum_{i=1}^{p} \beta_{2,i} y_{t-i} + \sum_{j=1}^{p} \beta_{2,p+j} x_{t-j} + \varepsilon_{1t}$$
(7)

p is the number of lags that adequately models the dynamic structure so that the coefficients of further lags of variables are not statistically significant and the error terms ε are white noise. If the p parameters $\beta_{1,p+j}$ are jointly significant then the null that x does not Granger cause y can be rejected. If the p parameters $\beta_{2,i}$ are jointly significant then the null that y does not Granger cause x can be rejected. Engle and Granger (1987) introduced the notion of cointegration and tied it closely to the VAR model.

If the time series are not stationary then the VAR framework needs to be modified to allow consistent estimation of the relationships among the series. The vector error correction (VEC) model is just a special case of the VAR for variables that are stationary in their differences (i.e., I(1)). The VEC can also take into account any cointegrating relationships among the variables. The VECM model equation is as follows:

$$\Delta Y_t = \alpha_1 + p_1 e_1 + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \lambda_i Z_{t-i}$$
(8)

$$\Delta X_t = \alpha_2 + p_2 e_{i-1} + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \lambda_i Z_{t-i}$$
(9)

The VECM approach allows us to distinguish between 'short-run' and 'long-run' Granger causality. When the variables are cointegrated, then in the short-term, deviations from this long-run equilibrium will feed back on the changes in the dependent variable in order to force the movement towards the long-run equilibrium. The F-tests of the "differenced" explanatory variables give us an indication of the 'short-term' causal effects, whereas the 'long-run' causal relationship is implied through the significance or otherwise of the "t" test(s) of the lagged error-correction terms which contains the long-term information since it is derived from the long-run cointegrating relationships (Masih and Masih, 1996).

3. Empirical results

The test is applied to both the original and to the first differences. According to the unit root test results which are given in Table 1 all the variables that are used in models are observed as stationary. To account for the sensitivity of results using this approach to cointegration to the choice of lag length, Akaike's information criterion (AIC) and the schwarz information criterion (SIC) are used.

According to results, all the variables are integrated I(1). In other words all the variables are non-stationary in levels and become stationary at first differences.

We used Akaike Information Criterion and Schwarz Information Criterion to estimate optimal lag length in VAR model. After VAR model we applied Johansen cointegration approach The Johansen cointegration results are displayed in Table 2.

Cointegration analyzes long-run relationships between variables, in this case the long-run relationships between stock prices, industrial production and natural gas prices and derive the error correction terms from the cointegrated variables. We applied the Johansen Juselis cointegration test in order to find any long-term stochastic relationships. In order to apply the Johansen procedure, a lag length must be selected for the VAR. The results of JJ cointegration rank tests in Table 2 indicate that there is a unique long-term or equilibrium relationship between stock prices, natural gas prices and industrial production in Brazil, Russia, South Africa and Turkey.

In VECM the cointegration rank shows the number of cointegrating vectors. A negative and significant coefficient of the ECM indicates that any short-term fluctuations between the independent variables and the dependant variable will give rise to a stable long run relationship between the variables.

We employed Granger causal relationship between the variables by using vector error–correction based Granger causality models which are weak (short-run) Granger causality and long-run Granger causality.

The results of both Granger causality models (see Table 3 and Table 4) can be summarized as follows:

i. There is a long-run Granger causal relationship from industrial production growth and natural gas price to stock returns in Brazil, Russia,South Africa and Turkey.
ii. There is a long-run Granger causal relationship from stock returns and natural gas price to industrial production growth in Brazil, Russia and South Africa.
iii. There is a long-run Granger causal relationship from stock returns and industrial production growth to natural gas price in Brazil, South Africa and Turkey
iv. There is a short-run unidirectional Granger causal relationship from natural gas price to stock return in Brazil,
v. There is a short-run bidirectional Granger causal relationship from natural gas price to stock return in Turkey,
vi. There is a short-run unidirectional Granger causal relationship from stock returns to industrial production growth in Brazil, Russia, South Africa and Turkey.
vii. There is a short-run bidirectional Granger causal relationship from industrial production growth to natural gas price in Brazil, South Africa and Turkey.
viii. There is a short-run unidirectional Granger causal relationship from industrial production growth to natural gas price in Russia.
ix. There is a short-run unidirectional Granger causal relationship from natural gas inflation to industrial production in Russia
x. There is a short-run unidirectional Granger causal relationship from stock returns to natural gas price in South Africa.

4. Conclusion

The study investigates the long-run relationship betweennatural gas prices and stock prices for Brazil, Russia, Turkey and South Africa applying analysis of unit root tests, Johansen cointegration and Granger causality and VECM. Monthly data covers the period from January 1999 to February 2014. According to results, that there is a unique long-term equilibrium relationship between natural gas prices, industrial production and stock prices in Brazil, Russia, South Africa and Turkey. The findings from Granger causality based on the VECM indicate different results between industrial production index, stock market price and natural gas price in Brazil, Russia, South Africa and Turkey for short-run.

We found that granger causal relationship between stock returns, industrial production growth and natural gas price increase, As a result, increase in industrial production growth seem to impact at natural gas prices the first place and stock returns appears to affect industrial production growth in the short term. The present study confirms the relationship between natural gas and stock market. A logical extension of the study can be done by including more variables and analyzing different countries.

References

A., Acaravcı, S. Y. Kandır, and I. Ozturk "Natural gas prices and stock prices:evidence from EU-15 countries", Economic Modelling, vol. 29, issue.5, 2012, pp.1646-1654.

A.M.M. Masih, and R. Masih, "Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error–correction modeling techniques", Energy Economics,vol. 18, 1996, pp. 165–183.

A. Vipin, and J. Lieskovsky, "Natural Gas and U.S. Economic Activity", MPRA Paper No. 50197, 2014, pp. 1-20.

C. W.J Granger, "Investigating causal relations by econometric models and cross spectral methods." Econometrica, vol.37, 1969, pp. 424-438.

C. W.J Granger (1986). Developments in the study of cointegrated economic variables. Oxford Bulletinof economics and statistics, 48(3), 213-228.

D. Costello, L. J., Frederick and P. Leesombatpiboon, "Natural Gas Prices and Industrial Sector Responses: An Experimental Module for STIFS", 2006.

D.A. Dickey and W.A. Fuller, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", Journal of American Statistical Association, vol. 74 issue 366, 1979, pp. 427-31.

E. Sendich, "Effects of lower natural gas prices on projected industrial production", Annual Energy Outlook 2014, http://www.eia.gov/forecasts/aeo/ngp_indus.cfm.

EIA "Natural Gas" http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_use , 2014.

G. Filis "Macro economy, stock market and oil prices: Do meaningful relationships exist among their cyclical fluctuations?", Energy Economics, vol. 32, issue 4, 2010, pp. 877-886.

IMF (2014) Natural gas http://www.imf.org/external/np/res/commod/index.aspx

J. Choi, S. Hauser, and K. Kopecky, (1999), Does the stock market predict real activity? Time series evidence from the G-7 countries, Journal of Banking and Finance 23,1771-1792.

J. G. Weber, "The Effects of a Natural Gas Boom on Employment and Income in Colorado, Texas, and Wyoming," Energy Economics, vol. 34, 2012, pp. 1580–1588.

K. L. Kliesen, "Rising natural gas prices and real economic activity," Federal Reserve Bank of St. Louis Review, vol. 88, issue 6, 2006, pp. 511–526.

M.C. Jones, and G. Kaul, "Oil and stock markets," Journal of Finance, vol.51, issue. 2, 1996, pp. 463-491.

S.Y. Kandır, I. Ozturk, and A. Acaravcı, (2013), "Causality between natural gas prices and stock market returns in turkey", Economia Politica, issue 2, 2013 pp. 203-220.

OECD (2014) "Stock price and Industrial Production" data' http://stats.oecd.org/

Phillips, P.C.B. and Perron, P. (1988), "Testing for a unit root in time series regression", Biometrika, Vol.75 No. 2, pp. 335–46.

R. F. Engle, and C. W.J. Granger, "Cointegration and error-correction: representation, estimation and testing." Econometrica: Journal of the Econometric Society, vol. 55, 1987, pp. 251-276.

S. A., Basher, and P. Sadorsky, "Oil price risk and emerging stock markets", Global Finance Journal, vol. 17, 2006, pp. 224–251.

S. Johansen, and K. Juselius, "Maximum likelihood estimation and inference on cointegration with applications to the demand for money ", Oxford Bulletin of Economics and statistics, vol. 52, issue. 2, 1990, pp. 169-210.

Schwert, W., (1990), Stock returns and real economic activity: A century of evidence, Journal of Finance 45, 1237-1257.

Appendix

Table 1: Augmented Dickey-Fuller (ADF) unit-root test and Philips Peron unit root test results

Variables	ADF				PP			
	Level		**First difference**		**Level**		**First difference**	
	Intercept	Intercept +Trend	Intercept	Constant +Trend	Intercept	Intercept +Trend	Intercept	Intercept +Trend
stockbrazil	-1.473713 (1)	-1.910347 (1)	-9.683062 (0) *	-9.694994 (0) *	-1.480312 (4)	-1.710721 (5)	-9.683062 (0) *	-9.694994 (0) *
stockrussia	-1.535333 (1)	-2.318087 (1)	-9.280832 (1) *	-9.268600 (1) *	-1.460345 (4)	-2.155475 (4)	-9.254475 (2) *	-9.242474 (2) *
stocksafrica	0.049926 (1)	-1.992837 (1)	-10.63563 (0) *	-10.65741 (0) *	0.048447 (5)	-1.998349 (5)	-10.62208 (2) *	-10.64290 (2) *
stockturkey	-1.011577 (0)	-2.309486 (0)	-11.56943 (0) *	-11.53933 (0) *	-1.116886 (4)	-2.837059 (5)	-11.57002 (2) *	-11.54006 (2) *
Natural gas	-1.923523 (4)	-4.551180 (3)	-4.914061 (3) *	-4.908930 (3) *	-1.614654 (8)	-2.825430 (8)	-10.87181 (7) *	-10.85083 (7) *
ipBrazil	-1.571665 (0)	-2.926822 (0)	-12.94495 (0) *	-12.93934 (0) *	-1.570423 (4)	-3.034786 (1)	-12.93755 (5) *	-12.93236 (5) *
iprussia	-1.351612 (0)	-2.212086 (0)	-15.54678 (0) *	-15.56315 (0) *	-1.328422 (5)	-2.081362 (6)	-15.61228 (5) *	-15.65551 (5) *
ipsouth africa	-2.027849 (3)	-2.234094 (3)	-8.270979 (2) *	-8.271355 (2) *	-2.520769 (4)	-2.991669 (2)	-22.23532 (4) *	-22.23181 (4) *
ipturkey	-0.371173 (1)	-2.758651 (1)	-14.29789 (1) *	-14.27601 (1) *	-0.845804 (8)	-6.721838 (8)	-31.18114 (4) *	-31.17396 (4) *

Note: *,** and *** indicate the existing one cointegration relationship between variables at 1%,%5 and %10 Significance levels, respectively.
%5 and %10 significance levels, respectively.
The numbers within parenthesis represent lag length.

Table 2 Johansen and Juselis Cointegration test result

Countries	**r**	**Trace**	**CV**	**P-value**	**λ max**	**CV**	**P-value**
Brazil	r = 0	190,96	29,79	0,0001	99,51	21,13	0.0000
	r ≤ 1	91,45	15,49	0.0000	64,41	14,26	0.0000
	r ≤ 2	27,03	3,84	0.0000	27,03	3,84	0.0000
Russia	r = 0	93,8	29,79	0.0000	42,28	21,13	0.0000
	r ≤ 1	51,52	15.49	0.0000	31,15	14,26	0,0001
	r ≤ 2	20,36	3,84	0.0000	20,36	3,84	0.0000
South Africa	r = 0	96,03	29,79	0.0000	43,72	21.13	0.0000
	r ≤ 1	52,31	15,49	0.0000	34,29	14,26	0.0000
	r ≤ 2	18,01	3,84	0.0000	18,01	3,84	0.0000
Turkey	r = 0	96,6	29,79	0.0000	44.54	21,13	0.0000
	r ≤ 1	52,06	15,49	0.0000	27,46	14,26	0,0003
	r ≤ 2	24,6	3,84	0.0000	24,6	3.84	0.0000

Notes: r is the number of cointegrating vectors %5 and %10 significance levels, respectively*,** and *** indicate the existing one cointegration relationship between variables at 1%, %5 and %10 significance levels, respectively.

Table 3 The long run causality for the VECM

Brazil	**ECT**	**P-value**
sp (dependent variables) ip, ntg (independent variables)	-0.5544	(0.0004) *
ip (dependent variable)	-1.6297	(0.0000) *
sp, ntg (independent variables)		
Ntg (dependent Variables	-0.1771	(0.0000)*
sp, ip (independent variables)		
Russia		
sp (dependent variables)	-0.7040	(0.0000) *
ip, ntg (independent variables)		
ip (dependent variable)	-1.4506	(0.0001) *
sp, ntg (independent variables)		
ntg (dependent variables	-0.5397	(0.0000) *
sp, ip (independent variables)		
South Africa		
sp (dependent variables)	-0.6315	(0.0047) *
ip, ntg(independent variables)		
ip (dependent variable)	-2.0920	(0.0000) *
sp, ntg(independent variables)		
Ntg (dependent variables	-0.5913	(0.0000) *
sp, ip (independent variables)		
Turkey		
sp (dependent variables	-0.3133	(0.0003) *
ip, ntg (independent variables)		
ip (dependent variable)	0.0026	(0.0099) *
sp, ntg (independent variables)		
ntg (dependent variables	-0.3852	(0.0015) *
sp ,ip (independent variables)		

Note: *, indicate the existing one cointegration relationship between variables at 1%,

Table 4 The short run causality for the VECM

Short Run Causality			
Brazil			
Variables	*sp*	*ip*	*ntg*
sp	-	0.5774 (0.6794)	2.3676 (0.0549) **
ip	8.0528 (0.0000) *	-	7.6442 (0.0000) *
ntg	1.0720 (0.3722)	22.211 (0.0000) *	-
Russia			
Variables	*sp*	*ip*	*ntg*
sp	-	0.0299 (0.9705)	0.5836 (0.5591)
ip	4.1868 (0.0006) *		1.9946 (0.0697) **
ntg	1.1831 (0.3182)	5.7059 (0.0000) *	
South Africa			
Variables	*sp*	*ip*	*ntg*
sp		2.1749 (0.0483)	2.0964 (0.0567) **
ip	4.8501 (0.0001)	-	0.4417 (0.8499)
ntg	1.8403 (0.0948) ***	3.3278 (0.00419) *	-
Turkey			
Variables	*sp*	*ip*	*ntg*
sp		1.6079 (0.1610)	2.0543 (0.0740) ***
ip	3.1725 (0.0093) *	-	1.8480 (0.1066)
ntg	4.1327 (0.0015) *	4.0170 (0.0019) *	

Note:*,** and *** indicate the existing one cointegration relationship between variables at 1%, %5 and %10 significance levels, respectively.