Growth And Oil Futures Prices In Developing Countries

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ABSTRACT

This paper examines cointegration and causality between oil prices and economic growth for the oil importing developing countries of Turkey, India, Pakistan, The Philippines and Korea. The study finds the absence of cointegrating relationship between oil prices and economic activity but the existence of unidirectional short-run causality running from oil prices to economic growths for The Philippines and Pakistan. Unidirectional causality is also found to exist from six and nine month futures prices to economic growth for India and Turkey in a bivariate vector autoregression framework. The study fails to establish causal relationship between oil prices and economic growth for Korea, while for India and Turkey, non-causality has been established between oil spot price and economic growth. Hence, our results may suggest that oil futures markets will have more of a role to play in the economy as these markets mature and or as oil prices continue to increase.

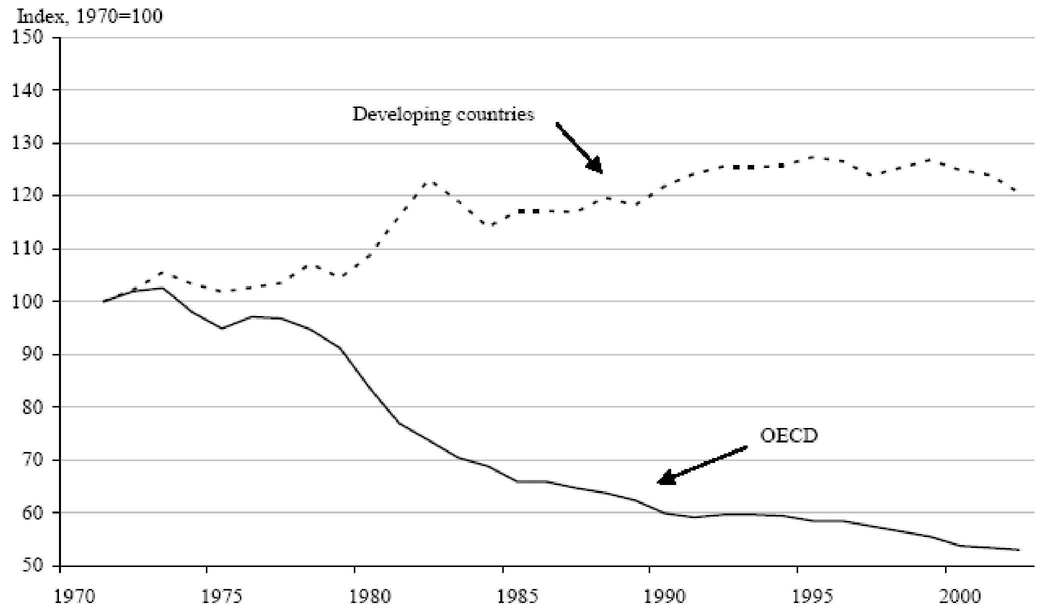
INTRODUCTION

The question of how increases in oil price influence economic growth of oil consuming economies has attracted a great deal of research activities, especially since the publication of the seminal work of James Hamilton (1983). Much of the research in this area has focused on studying the above mentioned issue on the U.S. economy and other developed economies including Japan, Germany, UK, and Canada, [Mork & Hall (1980), Bruno & Sachs (1981), Rasche and Tatom (1981), Bruno and Sachs (1982), Darby (1982), Harkness (1982), Burbidge & Harrison (1984), Gisser & Goodwin (1986), Mork (1989), Mork et al. (1994), Jimenez-Rodriguez (2004) and Jimenez- Lee et al (1995), Ferderer (1996), Hamilton (1996), Bjørnland (2000) Hamilton (2003), Rodriguez & Sanchez (2005), among others].

In contrast to this research, empirical work focusing on the impacts on developing economies has been relatively limited [Hwang & Gum (1992), Asafu-Adjaye (2000), Yang (2000), two reports by the IMF and IEA (2000 & 2004), Fatai, Oxley & Scrimgeous (2004), Bacon, Streifel & Burns (2005), among others]. This neglect is surprising for at least three reasons. First, demand for oil in developed economies has decelerated over the last 30 years or so due to the decease in oil intensity in these economies, which resulted primarily from fuel saving technical changes. However, this oil intensity increased in most developing countries (Figure 1), due to the expansion of their manufacturing sector, which is still energy intensive; the increase in vehicle ownership, and the continuous shift to modern fuels from traditional ones. Second, with rapid growth expected to continue in China, India, and other developing countries over the coming 20 years, examining this issue has a practical and timely value for economic planners in these countries. Third, the majority of developing countries are net oil importers.

This paper, therefore, will extend the empirical literature by examining cointegration and causality between futures oil prices and economic growth for the oil importing developing countries of Turkey, India, Pakistan, The Philippines, and Korea. The remainder of this paper is organized as follows. In section 2, we discuss the data sources, and present the econometric methodology used in the analysis. Results from testing our null hypothesis of a unit root against the alternative hypothesis of stationarity and the Granger causality results for our sample countries are presented in Section 3. The final section includes our concluding remarks.

Figure 1 - Oil Intensity Of Production In Developing Countries And In The OECD Area



Note: Oil intensity is defined as total primary oil use per unit of output (GDP).
Source: OECD Economic Outlook 76 database and International Energy Agency (from OECD Economic Outlook No. 76)

ECONOMETRIC METHODOLOGY & DATA DESCRIPTIONS

If the series X and Y are individually integrated of order one, i.e., I (1) and cointegrated then Granger causality tests may use I (1) data because of the super consistency properties of estimation.

$$X_t = \alpha + \sum_{i=1}^{m} \beta_i X_{t-i} + \sum_{j=1}^{n} \gamma_j Y_{t-j} + u_t \ldots\ldots\ldots\ldots(1)$$

$$Y_t = a + \sum_{i=1}^{q} b_i Y_{t-i} + \sum_{j=1}^{r} c_j X_{t-j} + v_t \ldots\ldots\ldots\ldots(2)$$

Where u_t and v_t are zero-mean, serially uncorrelated, random disturbances.

Secondly, Granger causality tests with cointegrated variables may utilize the I (0) data with an error correction term i.e.

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + \delta ECM_{t-1} + u_t \text{.........}(3)$$

$$\Delta Y_t = a + \sum_{i=1}^{q} b_i \Delta Y_{t-i} + \sum_{j=1}^{r} c_j \Delta X_{t-j} + dECM_{t-1} + v_t \text{.........}(4)$$

Thirdly, if the data are I(1) but not cointegrated, valid Granger type tests require transformation to make them I(0). So, in this case the equations become

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta Y_{t-j} + u_t \text{.....}(5)$$

$$\Delta Y_t = a + \sum_{i=1}^{q} b_i \Delta Y_{t-i} + \sum_{j=1}^{r} c_j \Delta X_{t-j} + v_t \text{......}(6)$$

The optimum lag length m, n, q and r are determined on the basis of Akaike's (AIC) and/or Schwarz Bayesian (SBC) and/or log-likelihood ratio test (LR) Criterion.

Now, for equation (2) and (3), Y Granger causes (GC) X if,
H_0: $\gamma_1 = \gamma_2 = \ldots = \gamma_n = 0$ is rejected
Against H_A: = at least one $\gamma_j \neq 0$, j = 1….. n
and X GC Y if, H_0: $c_1 = c_2 = \ldots = c_n = 0$ is rejected
Against H_A: = at least one $c_j \neq 0$, j = 1….. r
For equation (4) and (5), ΔY GC ΔX if,
H_0: $\gamma_1 = \gamma_2 = \ldots = \gamma_n = 0$ is rejected
Against H_A: = at least one $\gamma_j \neq 0$, j = 1….. n, or $\delta \neq 0$
and ΔX GC ΔY if, H_0: $c_1 = c_2 = \ldots = c_n = 0$ is rejected
Against H_A: = at least one $c_j \neq 0$, j = 1….. r, or $d \neq 0$
For equation (6) and (7), ΔY GC ΔX if,
H_0: $\gamma_1 = \gamma_2 = \ldots = \gamma_n = 0$ is rejected
Against H_A: = at least one $\gamma_j \neq 0$, j = 1….. n,
and ΔX GC ΔY if, H_0: $c_1 = c_2 = \ldots = c_n = 0$ is rejected
Against H_A: = at least one $c_j \neq 0$, j = 1….. r,

The tests are conducted on monthly data covering the period January 1985 to January 2005 for India, Turkey, Korea and The Philippines and June 1994 to January 2005 for Pakistan. Data on Index of Industrial Production (IIP), as a proxy to economic growth, have been collected from the International Financial Statistics (IFS) database. Monthly crude prices are WTI (spot, three, six and nine month's futures prices) and are taken from the Energy Information Administration and the New York Mercantile Exchange (NYME). X (i) [*i*= India (I), Pakistan (Pa), Turkey (T), Korea (K) & The Philippines (Ph)] and P (j) [j = spot (S), t=3 (3), t=6 (6), t=9 (9)) represent IIP and WTI spot and futures prices respectively, after their logarithmic transformation.

EMPIRICAL RESULTS

In the first stage the order of integration of the data is investigated. ADF test is conducted with the following model:

$$\Delta X_t = \alpha_0 + (1\text{-}k)\,\beta t - (1\text{-}k)\,X_{t-1} + \Sigma\gamma_j\,\Delta X_{t-j} + \varepsilon_t; \qquad (j: 1, 2, \ldots, p)$$

Where X_t is the underlying variable at time t, ε_t is the error term and α_0,β k and γ_j are the parameters to be estimated.

Table 1 presents the results of unit root tests on the natural logarithms of the levels and the first differences of the variables. On the basis of ADF statistics, the null hypothesis of a unit root cannot be rejected at 5 per cent level of significance. Stationarity is obtained by running the similar test on the first difference of the variables, indicating that all the series are I (1) in nature.

Table 1- Augmented Dickey-Fuller (ADF) unit root Tests

Variable	Const, Trend	Const, No Trend
Level		
X (T)	-2.6461	-.93078
X (I)	-1.9377	-.82318
X (Ph)	-2.2323	-2.4205
X (Pa)	.13440	1.9498
X (K)		
P(s)	-3.3322	-1.8301
P (3)	-3.1507	-1.6527
P (6)	-3.0213	-1.4638
P (9)	-2.6825	-1.1282
1st Difference		
DX (T)		-5.7022*
DX (I)		-4.7624*
DX (Ph)		-12.1347*
DX (Pa)		-5.6733*
DX (K)		
DP(S)		-12.1563*
DP (3)		-14.8796*
DP (6)		-14.0921*
DP (9)		-13.5782*

95% critical value for the ADF statistic (Const, Trend) = -3.4306
95% critical value for the ADF statistic (Const, No Trend) = -2.8742
**represents rejection of null hypothesis at 5% level of significance*

In the second stage, the Johansen maximum likelihood procedure is used to detect cointegration. This provides a unified framework for estimation and testing of cointegrating relations in the context of a VAR error correction model. The cointegration rank, r, of the time series was tested using two test statistics. Denoting the number of cointegrating vectors by r_o, the maximum Eigen value (λmax) test is calculated under the null hypothesis that $r_o = r$, against the alternative of $r_o > r$. The trace test is calculated under the null hypothesis that $r_o \leq r$, against $r_o > r$.

Table 2. Johansen-Juselius Likelihood Cointegration Tests

Null	**Alternative**	**Statistic**			
		X(I) & P(S)	**X(I) & P(3)**	**X(I) & P(6)**	**X(I) & P(9)**
			Turkey		
Trace Tests					
r = 0	**r = 1**	12.4144	11.5957	11.040	11.0318
r<= 1	**r = 2**	2.8041	2.4522	1.8776	1.5279
Eigen Value Tests					
r = 0	**r>= 1**	15.2184	14.0479	12.9181	12.5597
r<= 1	**r = 2**	2.8041	2.4522	1.8776	1.5279
			India		
Trace Tests					
r = 0	**r = 1**	12.1160	11.0756	10.1566	9.8679
r<= 1	**r = 2**	0.82535	**0**.57401	0.28520	0.14119
Eigen Value Tests					
r = 0	**r>= 1**	12.9413	11.6496	10.4418	10.0091
r<= 1	**r = 2**	0.82535	0.57401	0.28520	0.14119
			Pakistan		
Trace Tests					
r = 0	**r = 1**	40.8695	114.0175	107.2836	103.4876
r<= 1	**r = 2**	28.9857	68.2997	63.5563	60.8367
Eigen Value Tests					
r = 0	**r>= 1**	69.8552	182.3171	170.8399	164.3243
r<= 1	**r = 2**	28.9857	68.2997	63.5563	60.8367
			The Philippines		
Trace Tests					
r = 0	**r = 1**	5.6555	4.6936	4.5456	4.5979
r<= 1	**r = 2**	3.9401	3.1240	1.6522	0.82476
Eigen Value Tests					
r = 0	**r>= 1**	9.5956	7.8176	6.1978	5.4226
r<= 1	**r = 2**	3.9401	3.1240	1.6522	0.82476
			Korea		
Trace Tests					
r = 0	**r = 1**	11.6781	10.8127	10.1070	10.0213
r<= 1	**r = 2**	1.4509	1.2188	0.89281	0.61278
Eigen Value Tests					
r = 0	**r>= 1**	13.1290	12.0316	10.9998	10.6341
r<= 1	**r = 2**	1.4509	1.2188	0.89281	0.61278
90% critical value		13.8100	7.5300	17.8800	7.5300
		13.8100	7.5300	17.8800	7.5300
		12.9800	6.5000	15.7500	6.5000

The null hypothesis of no cointegration, i.e. r = 0 can not be rejected at 10 per cent level of significance for countries like India, Turkey, Korea & The Philippines, while for Pakistan, both trace and Eigen value statistics reveal that r = 0 and r ≤ have been rejected against r = 1 and r = 2. These imply the absence of cointegration among IIPs and crude prices.

Consequently the bivariate system of the first difference series, which defines the growth of the respective variable, can be modeled as an unrestricted VAR.

On the basis of Schwarz Bayesian (SBC) and adjusted log-likelihood ratio (LR) Test Criteria, the optimal lag order of the VAR is chosen as 1 in all the cases. The absence of residual serial correlation of the individual equations has also confirmed the correct order of VAR selection.

Finally, the Granger-causality test has been examined as shown in Table 3 below.

Table 3 - Granger Causality Tests

Null Hypothesis	**Chi-Sq (χ^2)**	**DOF***	**P-value****
Non-causality DX (T)→ DP(S)	0.11960	1	0.729
Non-causality DP(S) → DX (T)	2.1714	1	0.14
Non-causality DX (T)→ DP (3)	0.26396	1	0.607
Non-causality DP (3) → DX (T)	2.7811	1	0.095
Non-causality DX (T)→ DP (6)	0.71592	1	0.397
Non-causality DP (6) → DX (T)	3.3267	1	0.068
Non-causality DX (T)→ DP (9)	0.72249	1	0.395
Non-causality DP (9) → DX (T)	3.8371	1	0.050
Non-causality DX (I) →DP(S)	0.013527	1	0.907
Non-causality DP(S)→ DX (I)	2.1243	1	0.145
Non-causality DX (I)→ DP (3)	0.053898	1	0.816
Non-causality DP (3)→ DX (I)	3.1397	1	0.076
Non-causality DX (I)→ DP (6)	0.094600	1	0.758
Non-causality DP (6)→ DX (I)	4.3374	1	0.037
Non-causality DX (I)→ DP (9)	0.19388	1	0.660
Non-causality DP (9) → DX (I)	3.7390	1	0.053
Non-causality DX (Pa) →DP(S)	0.035733	1	0.850
Non-causality DP(S)→ DX (Pa)	6.5387	1	0.011
Non-causality DX (Pa)→ DP (3)	0.31386	1	0.575
Non-causality DP (3) → DX (Pa)	6.6246	1	0.010
Non-causality DX (Pa)→ DP (6)	0.99867	1	0.318
Non-causality DP (6) → DX (Pa)	6.9575	1	0.008
Non-causality DX (Pa)→ DP (9)	1.4645	1	0.226
Non-causality DP (9) → DX (Pa)	6.4774	1	0.011
Non-causality DX (Ph)→ DP(S)	0.061894	1	0.804
Non-causality DP(S)→ DX (Ph)	5.5331	1	0.019
Non-causality DX (Ph)→ DP (3)	0.41467	1	0.520
Non-causality DP (3) → DX (Ph)	5.4272	1	0.020
Non-causality DX (Ph)→ DP (6)	0 .51343	1	0.474
Non-causality DP (6) → DX (Ph)	4.6975	1	0.030
Non-causality DX (Ph)→ DP (9)	0.51438	1	0.473
Non-causality DP (9) → DX (Ph)	4.0745	1	0.044
Non-causality DX (K)→DP(S)	0.43700	1	0.509
Non-causality DP(S)→ DX (K)	0.26541	1	0.606
Non-causality DX (K)→ DP (3)	0.11828	1	0.73
Non-causality DP (3)→ DX (K)	0.13150	1	0.717
Non-causality DX (K)→ DP (6)	0.11905	1	0.730
Non-causality DP (6)→ DX (K)	0.085795	1	0.770
Non-causality DX (K)→ DP (9)	0.0077805	1	0.930
Non-causality DP (9)→ DX (K)	0.0087122	1	0.926

*degrees of freedom

**acceptance probability.

The results could be summarized as follows:

- Korea: Non causality among economic growth and prices (spot, n=3,6,9)
- The Philippines: Unidirectional causality from prices to economic growth
- Pakistan: Unidirectional causality from prices to economic growth
- India: Non causality between economic growth and spot price, unidirectional causality from prices (n=3, 6, 9) to economic growth
- Turkey: non causality between economic growth and spot price and economic growth and price n=3, unidirectional causality from prices (n=6, 9) to economic growth

CONCLUSION

The study finds the absence of cointegrating relationship between oil prices and economic activity in a bivariate vector auto-regression framework, which suggests that the impact of oil shocks is limited to the short-run for the countries of India, Pakistan, Korea, The Philippines and Turkey.

When analyzing short-run relationships between oil prices and economic growth rates, our empirical results show that a unidirectional causation runs from 6 and 9 month futures prices of oil to economic growth in four of the five countries included in our sample. Furthermore, in the case of The Philippines, Pakistan, and India, our study shows that the higher oil vulnerability of a country results in wider unidirectional causation that includes spot price of oil and 3 month futures price (see Table 4). In addition, higher oil dependency and higher net oil exports (Absolute value) of a country cause similar results.

Table 4: Oil Vulnerability, Dependency and Net Oil Export /GDP

Country	Oil Vulnerability	Oil Dependency	Net Oil Exports as % of GDP
Korea Republic	1.00	0.579	-3.50
The Philippines	0.98	0.596	-3.80
Pakistan	0.83	0.425	-4.40
India	0.64	0.321	-3.30
Turkey	0.92	0.416	-2.40

Source: The Impact of Higher Oil Prices on Low Income Countries and on the Poor (March 2005) UNDP/ESMAP (United Nation Development Program/ World Bank Energy Sector Management Assistant Programme).

$$\text{(1) Oil Vulnerability} = \frac{\text{Oil consumption - Oil Production}}{\text{Oil Consumption}}$$

$$\text{(2) Oil Dependency} = \frac{\text{Oil Consumption}}{\text{Total Primary Energy Consumption}}$$

Results of our study are very interesting in that they show that producers in our sample countries seem to rely more on oil futures prices in forming their future production decisions than on oil spot prices. This is not to suggest that they do not include other variables in forming their expectations about future oil prices, such as political stability in oil producing countries and expert opinions about futures level of oil prices. However, it may suggest that oil futures prices will have a greater role to play in our economy as these markets mature and or as oil prices continue to increase.

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