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Komijani, Akbar and Gandali Alikhani, Nadiya and Naderi, Esmaeil

Faculty of Economic, University of Tehran, Iran., Department of Economics Science and Research Branch, Islamic Azad University, khouzestan-Iran., Faculty of Economic, University of Tehran, Iran.

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Akbar Komijani
Professor of Economics, Faculty of Economic, University of Tehran,
Komijani@ut.ac.ir

Nadiya Gandali Alikhani
"M.A." Department of Economics Science and Research Branch, Islamic Azad University, khouzestan-Iran, N.G.Alikhani@gmail.com

Esmaeil Naderi
"M.A." student in Economics, Faculty of Economic, University of Tehran,
Naderi.ec@ut.ac.ir

Abstract

Substituting crude oil exports with value-added petrochemical products is one of the main strategies for policy makers in oil-driven economies to isolating the real sectors of economy from oil price volatility. This policy inclination has led to a body of literature in energy economics in recent decades. As a case study, this paper investigates the short-run and long-run relationship between Iran's oil price and methanol price which is one of the most important non-oil exports of the oil-exporting country. To do so, the weekly data from 18 Jan. 2009 to 18 Sep. 2011 in a VECM framework is applied. The results show that in the long-run, oil price hikes leads to proportional increase in methanol price while in the short-run, this impact is not significant.

Key Words: Crude Oil, Methanol, VECM Model
JEL Classification: Q43‹C13‹C32

Introduction

Being a strategic input of economy, energy prices affect the whole economy such that both public and private policy makers in all countries consider energy price as a crucial economic factor. In fact, any increase in the prices of energy leads to a proportional increase in the price consumers pay for goods and services. The direct and indirect impacts of energy prices on economic variables are studied by numerous researchers (See Stern, 2011 as a recent survey).

Though the vast majority of the literature is devoted to mostly energy-importing economies, energy policy in major energy-exporting economies is of a greater importance, also. For example, in Iran, shaping 90 percents of country's export value, crude oil and gas exports constitute approximately 60 percents of government's income (Farzanegan and Mrakwart, 2011); this fact makes price movements of oil an important factor which potentially causes significant durable macroeconomic consequences (Mehrara and Oskoui, 2007). Reviewing the history of oil exporting economies, one realizes that several economic (whether positive or negative) shocks in these countries back to oil price variations. Besides historical data shows that oil price is greatly variable; even more than any other commodity and more importantly, its fluctuations are hardly predictable (Dehn, 2001). This worsens the situation for the oil-driven economies; because suggests that not only the impacts of frequent oil shocks are deep and lasting but also they mostly are unpredictable.

On the other hand, in most of oil exporting countries, government which is the absolutely prominent economic agent, directly receives and spends the oil revenue. So, it’s fiscal and monetary policies completely depend on oil price (Rosser and Sheehan, 1995). Since rises and falls in the oil price are inherently transient, oil revenue variation injects instability to the economy. When the oil price increases, government’s ineffective spending and when the oil price decreases, huge public deficit occurs; and both are unpleasant (Mehrara and Mohaghegh, 2012).

Taught by instructive experiences, nowadays, isolating the real sectors of economy from oil price volatility is one of the goals of policy makers in oil exporting economies. Among others, establishing institutional organizations in the form of national funds to restrict fiscal overspending during oil price booms or fiscal deficit during oil price boosts (Devlin & Lewin, 2004) and replacing crude oil exports with exporting petrochemical products are two main strategies for policy makers in oil-driven economies to achieve this goal.

Petrochemicals –which their price movements are to be studied in this paper- are chemical products derived from petroleum or gas. Petrochemical processes, though totally based on oil and gas, considerably increase the value of inputs. This great portion of added value is an effective incentive for oil exporters to diminish their crude oil exports and replace it with petrochemical exports. Methanol which studying its price movements is the subject of this paper is one of the most important petrochemicals; Methanol is the main component of several valuable chemical products such as Methyl Tertiary Butyl Ether (MTBE), De Methyl Ether (DME), Acetic Acid, Rosin, Formaldehyde and Poly Amide (Masih et al., 2010b).

Considering the potential effects of Methanol price on Iran economy, this paper studies the relationship between methanol and Iran heavy crude oil price. To do so, two broadly used econometric models, Vector Autoregressive (VAR) and Vector Error Correction Model (VECM), are applied to analyze this relationship based on the weekly data from 18 Jan. 2009 to 18 Sep. 2011. The remaining part of this paper is organized as follows; section 2, briefly reviewing previous papers which have studied this subject matter, refers to some theoretical basis for the relationship between oil and methanol prices. Section 3 introduces the data and explains the empirical findings of this study and eventually, section 4 proposes some policy implication and conclusions.

Crude Oil Price and Methanol Price

Though all kinds of energy are essential inputs for production processes; oil plays a distinguishable role. Oil price whether as an important manufacturing input -for energy importers- or a valuable source of income –for energy exporters- has significant effects on the macroeconomic situation in almost all countries. In particular, oil price not only affects major economic indicators i.e. GDP, unemployment and exchange rate but also has direct and indirect impacts on its rare alternatives like gas (Ji, 2011). Various dependant downstream industries, increasing demand for energy (caused by both rapid population and economic growth rate) as well as technological limits has made oil a strategic substance which hardly can be substituted. As Bachmeier and Grifen (2006) argue, the only substance that may replace oil in the modern economies is natural gas because it not only is more productive but environmentally speaking is less polluting than oil. However, in addition to its applications as a fossil fuel, several petrochemical -including methanol- are derived from natural gas. And more interestingly, the majority of the economic value is related to the role natural gas plays in petrochemicals industry (Liu et al., 2011)

In comparison with other industrial petrochemical products, the very simple chemical structure and its application in producing a great number of goods have made methanol an important product. Though natural gas is the main source for producing methanol, it can be produced from other substances such as wood, crude oil, coal and carbon dioxide. Therefore, considering the global concerns about carbon dioxide emissions, developing CO_2-based methanol production technologies is a potential solution for improving environmental quality (Methanex, 2011).

The volume of methanol production doubled in less than 25 years, has increased from 15.9 million tons in 1983 to more than 32 million tons in 2006 (Vora and et al., 2009). This demand enlargement proves the rising inclination toward and demand for methanol in the world market. So, determining the factors which affect methanol price has a significant importance. According to Nexant (2009), these factors can be classified to three categories:

- Technological Changes
- Market Condition
- Natural Gas Price (as the main source of methanol)

This paper investigates the relationship between oil price and methanol. So, considering the Nexant (2009) classification, oil through two channels may affect methanol price; market condition and natural gas price.

The first mechanism is elaborately studied in the literature. In fact, numerous researchers have studied the effects of oil price changes on economic activity and discussed the mechanisms through which these effects transmit to other macroeconomic indicators (e.g. Hamilton, 1983, 1996; Pindyck & Rotemberg, 1983; Bernanke and et al., 1997; Bernanke, 2004; Devlin & Lewin, 2004; Cologni & Manera, 2007). In addition to these papers which are focused on industrialized oil importing economies, some have studied developing -or recently developed- oil importing countries (e.g. Ziramba, 2010 in South Africa, Bashiri & Manso, 2012 in Portugal, Ghosh, 2011 in India and Ou and et al., 2012 in China) as well as oil exporting countries (e.g. Dibooğlu & Aleisa, 2004 in Saudi Arabia; Mehrara & Oskui, 2007 in four oil exporters; Lescaroux & Migno, 2008 in OPEC members; and Mehrara & Mohaghegh, 2012 in oil exporting countries). All these studies have confirmed that oil price change is an important source of macroeconomic fluctuations both in national and global level. In brief, as He et al. (2010) assert, oil price movements systematically change economic indicators in the world market in both short- and long-run (He and et al., 2010). So, evidently oil price affects both supply and demand sides of the methanol world market.

On the other hand, since gas-driven petrochemicals like ethanol and methanol are substitutes for oil-driven fuels such as petroleum and gasoline, there is a mutual relationship between oil price and gas-driven petrochemicals – including methanol. Joets and Mignon (2006) show that oil and gas act as substitutes in the market. Masih and et al. (2010a) have investigated the interconnection between oil price and ethylene price in the US and confirmed the existence of such a substitution relationship. Masih and et al. (2010b) also, highlight the role of oil price as the major instigator of methanol price movements in Europe, US and Far East. Moreover, some researchers suggest that oil price affect gas price which as a main source for producing methanol affects its price. Stephen and et al. (2008) claim that oil price variations are the major source of gas price movements. Highlighting this relationship, Rosthal (2010) confirms that in the US there is a long-run relationship between oil and gas prices. So, we can conclude that oil price -via affecting natural gas price or by determining the price of its substitutes- has a significant impact on methanol price. Though this conclusion seems robust, our literature review showed that no study has investigated this relationship empirically; what we do in this paper.

Empirical Results

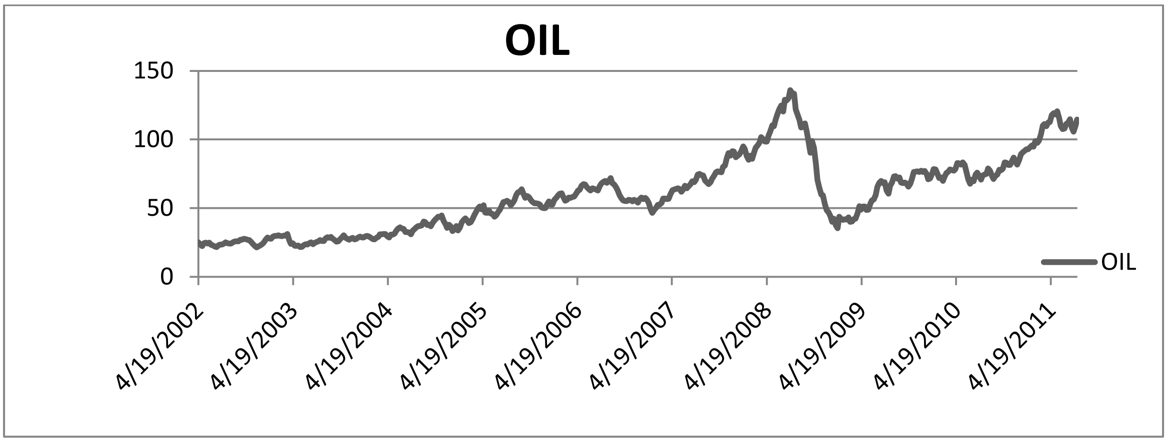
Data

As stated, the aim of this paper is to study the interaction between oil price and methanol price. To do so, we have used the weekly data of methanol price and Iran's heavy oil price from 18 Jan. 2009 to 18 Sep. 2011. Iran's heavy oil price time series is provided by US Energy Information Administration[1] (EIA). For the methanol price in Iran, we have used the reports of Iran's good exchange[2].

Figure 1 portrays the fluctuations of Iran's heavy oil price in US$ in past decade. Sep. 11 attacks and aftermath reduced the oil price to less than 20 US$ per barrel. As seen, from 2002 to 2008, Iran's heavy oil price increases to roughly 140 US$ per barrel. This increase caused due to several reasons including considerable increase in the demand of some developing countries like China, India and Brazil and rising the tension between Russia and Ukraine about the exporting gas prices as the important instigator of the demand side of the oil market as well as political conflict in the Middle East, strikes in Nigeria, Katrina hurricane in the US Gulf Coast, Iran's nuclear issue, reduction in US strategic reservoirs which affect the supply side of the market (EIA, 2011). After a boost period, financial crisis of 2008 sharply decreased the oil price to less than one third of its maximum. But after it, oil price, though smoothly, again, began to rise. Figure 2, also, shows both methanol and oil prices and movements in the sample period. As seen, though we elaborate this result in following section, co-movement between crude oil price and methanol price is distinguishable.

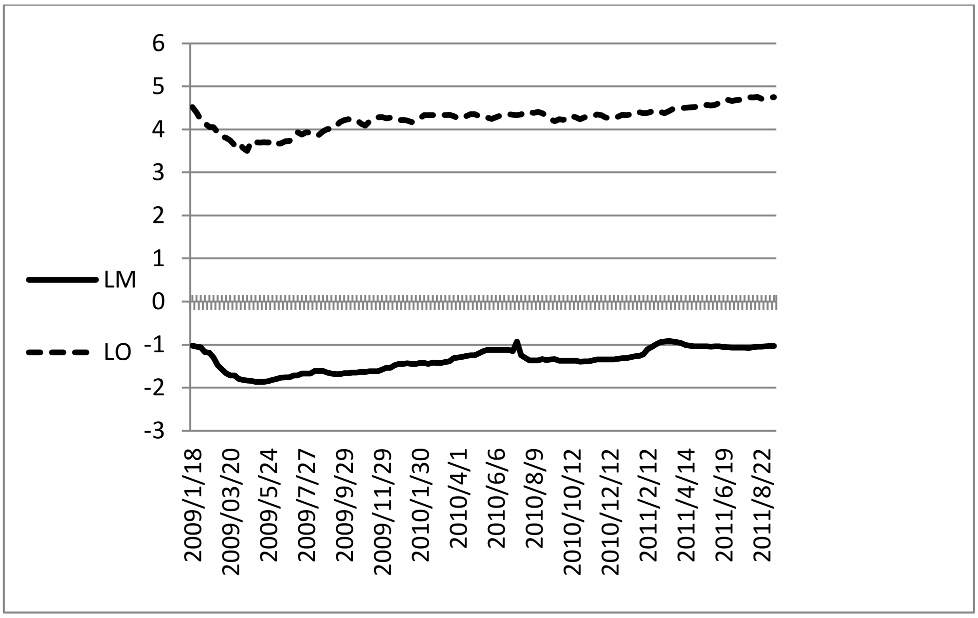
1. U.S. Energy Information Administration (www.eia.org)
2. WWW.Boursekala.com

Figure 1: Iran's heavy oil price per barrel (US $)



Source: www.eia.org

Figure 2: Logarithm of Oil and Methanol Prices (US $)



Source: www.Boursekala.com

Table 1 reports the descriptive statistics for logarithm of oil and methanol prices series. According to Jardue-Bera statistics for normality test, the oil prices series is normally distributed in the sample period and the methanol prices series is not normally distributed in the sample period in 98% level of the significance. Besides, the correlation coefficient of 0.82 suggests a strong positive interconnection between methanol and oil prices.

Table 1: Descriptive Statistics

	Oil Price	Methanol Price
Number of Obs.	139	139
Mean	72.77	0.27
Median	73.12	0.26
Maximum	116.57	0.40
Minimum	33.16	0.15
Standard Deviation	19.39	0.07
Skewness	0.18	0.16
Kurtosis	2.94	1.89
Jarque-Bera (P-value)	0.78 (0.67)	7.64 (0.02)
Correlation	0.82	

Source: Study Findings

Econometric Model

To reach our goals in this study, we have used the Vector Error Correction Model (VECM). This model, assuming a static long-run equilibrium, investigates the reactions of the model into short-run shocks which detour the model from its long-run path. VECM is a combination of Vector Autoregressive (VAR) model and the dynamic Error Correction Model (ECM). To estimate such a model, the numbers of lags included, stationarity of the time series and the result of the cointegration tests are of crucial importance. Eq. (1) shows the general specification of VECMs.

$$\Delta X_t = C + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-(k-1)} + \Pi X_{t-1} + e_t \quad (1)$$

In this study, X_t is a 2×1 vector consisted of logarithm of Iran's methanol and heavy oil prices and X_{t-1} stands for error correction term which indicates the deviation from long-run equilibrium. In the first step, using KPSS[1] unit root test, the stationarity of the series (after log transformation) were examined. The result which are reported in Table 2, prove that both series are integrated of order one (I(1)).

Econometric theory asserts that for non-stationary series, traditional regression analysis is not necessarily valid. To verify the existence of long-run relationship between non-stationary variables, cointegration tests are applied. In this study we implement Johansen-Juselius cointegration test. Since this test is sensitive to the number of lags assigned to the VAR specification, in the next step using information criteria, optimal lag length is estimated[2].

Table 2: KPSS unit root test

	Level		First Diff.		Result
	Stat.	**LM-Stat.**	**Stat.**	**LM-Stat.**	
LMET*	0.99	0.46	0.25	0.46	I(1)
LOIL**	1.11	0.46	0.33	0.46	I(1)

*: Log of Methanol Price; **: Log of Oil Price
Source: Study Findings

1. Kwiatkowski, Phillips, Schmidt, Shin
2. In Addition, to estimate VAR/VECM model, we need this optimal lag length.

The Schwarz-Bayesian Information Criteria (SBIC) suggests 2 as the best lag length for our estimation. Table 3 reports the results of Johansen-Juselius Cointegration test based on maximum eigenvalue and trace test statistics. As seen in the Table 3, both tests significance approve the existence of a long-run equilibrium between methanol and oil prices in 96% of. Table 4 reports this equilibrium equation and the estimated VECM. As seen, the long-run coefficient of oil price on methanol price is positive and significant.

Table 3: Johansen-Juselius Cointegration test

Null Hyp.	Maximum Eigenvalue Test			Trace Test		
	Stat.	**Critical Value**	**P-Value**	**Stat.**	**Critical Value**	**P-Value**
r = 0	15.32	14.26	0.03	14.48	14.26	0.04
r ≤1	0.004	3.84	0.42	0.004	3.84	0.42

Source: Study Findings

The Maximum Eigenvalue statistics suggest that in the 95% level of confident, there is one cointegrating equation while trace test in same level of confidence shows no long-run equilibrium[1]. Following these findings, the normalized equilibrium equation is estimated. As Table 4 reports, the estimated long-run elasticity of methanol price with respect to oil price is significant and its numeric value of 0.95 in line with theoretical expectations, suggests that any increase in oil price leads to proportionate increase in methanol price.

On the other hand, according to short-run VECM model estimations, oil price's effect on methanol price in short-run is not significant. Besides, the coefficient of error correction term significantly equals -0.11 which approves that if any shock detours methanol price from its equilibrium path, damping approximately 10 percents of the deviation, in long-run, methanol price returns to its equilibrium path. Moreover, in short-run, methanol price, expectedly, does not have any significant impact on oil price.

1. In the 90% level of confident, trace test also approves the existence of at least one cointegrating equation.

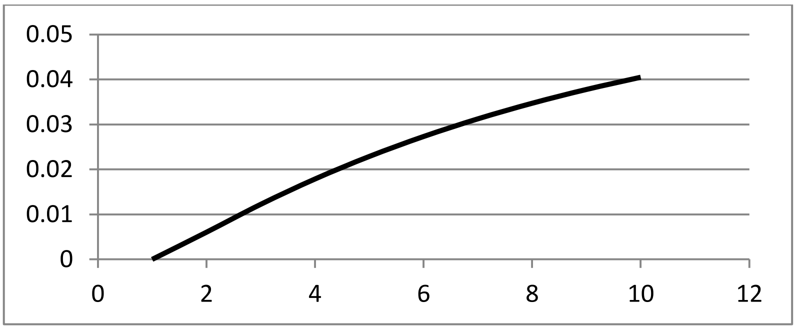
Table 4: Estimated Models

Equilibrium Equation: LMET(-1) = 5.4 + 0.95 LOIL(-1) t-stat: (7.43)						
	D(LMET)			D(LOIL)		
	Coef.	**t-stat.**	**P-Value**	**Coef.**	**t-stat.**	**P-Value**
C	0.00008	0.02		0.002	0.54	
D(LMET (-1))	0.1	1.2		0.16	1.85	
D(LOIL (-1))	0.02	0.27		0.23	2.71	
ECT(-1)	-0.11	-3.76		0.02	0.59	
Log likelihood	230.578			222.285		
Normality	2228.574 (0.0000)			90.537 (0.0000)		
Schwarz criteria	-3.22			-3.10		
White test	74.573 (0.0000)					

Source: Study Findings

In the final step, to study the dynamics of the effects of oil price shocks on methanol price, we have used Impulse Response Function (IRF) Analysis. Figure 3 depicts the Impulse Response Function of methanol price to one generalized standard deviation shock in oil price. Takaendesa (2006) specifies that if IRF of a variable to an exogenous variable's shock is strictly increasing (or decreasing), one can conclude that such a shock has permanent effects on endogenous variable. Knowing this, we can say that according to Figure 3, a positive oil price shock, though in short-run does not affect methanol price, after one period, leads to long-lasting increase in methanol price. This finding, in line with estimation results, suggests that, only in long-run, oil shocks effects on methanol price will be significant.

Figure 3: IRF of methanol price to oil price shock



Source: Study Findings

Conclusion

This paper, using the weekly data of oil and methanol price from 18 Jan. 2009 to 18 Sep. 2011 in a VECM framework, studied the dynamic short-run and long-run effects of Iran's heavy oil price on methanol price in Iran. KPSS unit root test result showed that (logarithm of) oil and methanol price have unit root in the level but after first differencing both become stationary. So, the Johansen-Juselius Cointegration test was applied. The result approved the existence of one equilibrium equation in 95 % of significance. The normalized long-run equation confirmed that expectedly, there is a significant positive relationship between oil and methanol price such that if one percent increase in oil price, ceteris paribus, leads to approximately 0.95 percent increase in methanol price.

Besides, the estimated VEC models suggested that oil price and methanol price, in short-run, do not significantly affect each other while analyzing the coefficients of error correction terms in two possible ECMs proved that methanol price, if being deviated by any oil shock from its equilibrium path, will return to its equilibrium value, roughly, after 9 periods. Finally, IRFs of methanol price to oil shocks, confirming these findings, showed that a positive oil price shock, having no effect in the first period, leads to permanent increase in methanol price.

Two reasons may cause this positive relationship between oil price and methanol price. Firstly, oil price rise, increases the demand for its alternative, natural gas, and increases its price. Since natural gas is the main source of methanol, this process raises the methanol price, also. Secondly, previous studies have shown that in oil-dependent economies, oil price hikes, usually leads to high inflation rates (e.g. Dibooglu and Aleisa, 2004; Jimenez-Rodriguez and Sanchez, 2005). So, oil price rise via inflation, increases the production costs and results in higher methanol prices.

Another interesting finding of this study is that though oil price in long-run, in spite of short-run, significantly affects methanol price. To explain the reason why there is such a considerable difference between various times spans, one can refer to some facts. Firstly, it should be noted that though petrochemicals, in essence, are substitutes for oil; due to technological limits, replacing oil with such chemical substances, in practice, in short-run, is impossible. So, oil price hike, in first year, does not increase the demand for methanol while in long-run, does. Secondly, as stated in the paper, market situation is one of the channels through which oil affects methanol price. This process, as explained in section 2 of the paper, takes time and postpones these impacts to long-run.

Finally, as a policy implication, co-movement of oil price and methanol price can be used as a way to reduce Iran's export income. When oil price hikes, methanol price also hikes; then the volume of methanol exports which is one of the most important non-oil exports of Iran, decreases. On the other side, when oil price decreases, though the methanol price decreases, too; since oil exports are limited by international agreements, Iran can earn more money by increasing the volume of its methanol exports. In sum, increasing the share of methanol exports can hedge Iran's income volatility.

References

1. Bachmeier LJ, Grifen JM. (2006), "Testing for market integration: crude oil, coal, and natural gas", The Energy Journal, Vol. 27, No. 2, PP. 55-72.

2. Bashiri Behmiri, N., Manso, J.R.P., (2012), "Does Portuguese economy support crude oil conservation hypothesis?", Energy Policy, Vol. 45, PP. 628-634.

3. Bernanke, B.S. (2004) "Oil and the Economy". Remarks at the Distinguished Series, Darton College, Albany, Georgia.

4. Bernanke, B.S., Gertler, M., Watson, M. (1997) "Systematic monetary policy and the effects of oil price shocks". Brookings Papers on Economic Activity 1: 91–142.

5. Cologni, A., Manera, M. (2007) "Oil Prices, Inflation and Interest Rates in A Structural Cointegrated VAR Model for The G-7 Countries". Energy Economics 30, 856–888.

6. Dehn, J. (2001) "The effects on growth of commodity price uncertainty and shocks". World Bank, Development Research Group, Policy Research Working Paper, vol. 2455.

7. Devlin, J., Lewin, M. (2004) "Managing Oil Booms and Busts in Developing Countries". Draft Chapter for Managing Volatility and Crises, A Practitioner's Guide.

8. Dibooğlu, S., Aleisa, E. (2004) "Oil Prices, Terms of Trade Shocks, and Macroeconomic Fluctuations in Saudi Arabia". Contemporary Economic Policy 22(1): 50-62.

9. Farzanegan, M., Markwardt, G. (2009) "The Effect of Oil Price Shocks on Iranian Economy". Energy Economics 31: 134-151.

10. Ghosh, S., (2011), "Examining crude oil price – Exchange rate nexus for India during the period of extreme oil price volatility", Applied Energy, Vol. 88, Issue. 5, PP. 1886-1889.

11. Hamilton, J. D. (1983) "Oil and the macroeconomy since World War II". Journal of Political Economy 91: 228–248.

12. Hamilton, J.D. (1996) "This is what happened to the oil price-macroeconomy relationship". Journal of Monetary Economics 38: 215–220.

13. He, Y., Wang, SH., Lai, K.K., (2010), "Global economic activity and crude oil prices: A cointegration analysis", Energy Economics, Vol. 32, Issue. 4, PP. 868-876.

14. Ji, Q. (2011) “System analysis approach for the identification of factors driving crude oil prices”, Computers & Industrial Engineering, In Press, Corrected Proof, Available online.

15. Jimenez-Rodriguez, R., Sanchez, M. (2005) “Oil price shocks and real GDP growth: empirical evidence for some OECD countries”. Applied Economics 37: 201–228.

16. Joets, M, Mignon, V., (2011), “On the link between forward energy prices: A nonlinear panel cointegration approach”, Universities de Paris Ouest Nanterre La Defense, No. 7235, PP. 1-16.

17. Lescaroux, F., Mignon, V. (2008) “On the influence of oil prices on economic activity and other macroeconomic and financial variables”. OPEC Energy Review 32(4): 343-380.

18. Liu, M.H., Margaritis, D., Tourani-Rad, A., (2010), “Is there an asymmetry in the response of diesel and petrol prices to crude oil price changes? Evidence from New Zealand”, Energy Economics, Vol. 32, Issue. 4, PP. 926-932.

19. Masih, M., Albinali, K., Demello, L., 2010 A, " price dynamics of natural gas and the regional methanol markets", Energy policy, Vol 38, PP. 1372–1378.

20. Masih, M., Algahtani, I., Demello, L., 2010 B, "price dynamics of crude oil and the regional ethylene markets", Energy Economics, Vol 38, PP. 1435-1444.

21. Mehrara, M., Oskoui, N. K. (2007) “The sources of macroeconomic fluctuations in oil exporting countries: A comparative study”. Economic Modeling 24: 365–379.

22. Mehrara, M., Mohaghegh, M. (2012) “Macroeconomic Dynamics in the Oil Exporting Countries: A Panel VAR study”. International Journal of Business and Social Science; 2(21): 288-295.

23. Nexant, November (2009), “Methanol Strategic Business Analysis”, Chemsystems.

24. Ou, B., Zhang, X., Wang, Sh., (2012), “How does China’s macro-economy response to the world crude oil price shock: A structural dynamic factor model approach”, Computers & Industrial Engineering, In Press, Accepted Manuscript, Available online.

25. Pindyck, R.S., Rotemberg, J.J. (1983) “Dynamic factor demands and the effects of energy price shocks”. American Economic Review 73: 1066–1079.

26. Rosser, J. B., Sheehan, G. R. (1995) “A Vector AutoRegressive Model for Saudi Arabian Economy”. Journal of Economics and Business 47(1): 79-90.

27. Rosthal. Jennifer Elizabeth, (2010). "The Relationship between Crude Oil and Natural Gas Prices and its Effect on Demand", A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy.

28. Stephen P.A., Brown, M., Yucel, K., (2008), “What Drives Natural Gas Prices?”, The Energy Journal, Vol. 29, No. 2, PP. 43-58.

29. Stern D. I. (2011), “The role of energy in economic growth”, Annals of the New York Academy of Sciences 1219: 26-51.

30. Takaendesa, P., (2006), “The Behaviour and Fundamental Determinants of the Real Exchange Rate in South Africa”, Rhodes University, Masters in Commerce (Financial Markets).

31. Vora, B., Chen, J.Q., Bozzano, A., Glover, B., Barger, P., (2009), “Various Routes to Methane Utilization—SAPO-34 Catalysis Offers the Best Option”, Catalysis Today, Vol. 141, PP. 77–83.

32. Ziramba, E., (2010), “Price and income elasticities of crude oil import demand in South Africa: A cointegration analysis”, Energy Policy, Vol. 38, Issue. 12, PP. 7844-7849.