OIL PRICES AND EXCHANGE RATES: THE CASE OF OPEC

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Abstract

This paper has studied the relationship between oil price and exchange rate in OPEC members.

In this paper, we investigate the long-run relationship between real oil prices and real exchange rates by using monthly panel of seven countries of OPEC members from 2000:01 to 2007:12. We first test whether or not exchange rates are cointegrated with real oil prices. Stationary and cointegration tests for pooled series obviously have shown the high power of pooled tests for unit root and cointegration.

It is shown that real oil prices may have been the dominant source of real exchange rate movements. Finally, the results shown that, there is a long-run linkage between real oil prices and real exchange rates.

Introduction

The exchange rate is arguably the most difficult macroeconomic variable to model empirically. Many papers have previously suggested that oil prices may have an important influence on exchange rates. The suggestion, however, that oil prices might be sufficient to explain all long-run movements in real exchange rates appears to be new. Structural time-series work on the determinants of real exchange rate fluctuations indicates that real shocks or permanent components play a major and significant role in explaining real exchange rate fluctuations.

The potential importance of oil prices for exchange rate movements have been noted by, McGuirk (1983), Krugman (1983a, 1983b), Golub (1983) and Rogoff (1991).

Univariate and multivariate Beveridge-Nelson decompositions by Huizinga (1987) and Baxter (1994) find that, even though real exchange rates may not follow a random walk, most of their movements are due to changes in the permanent components.

Lastrapes (1992) by using the Blanchard and Quah (1989) decomposition, find that much of the variance of both real and nominal exchange rates from a number of countries over both short and long horizons is due to real shocks. The conclusions from the structural time-series literature therefore seem to be robust to both decomposition methods and currencies. This has led some to suggest that an unidentified real factor may be causing persistent shifts in real equilibrium exchange rates.

Clarida and Gali (1994) use the Blanchard–Quah identification strategy to estimate the share of exchange rate variability that is due to different shocks by using quarterly US–Canada, US–Germany, US–Japan, and US–UK real exchange rate data from 1974:Q3 to 1992:Q4. They find that real shocks can account for more than 50% of the variance of real exchange rate changes over all time horizons.

Different sources of real shocks have been investigated in Zhou (1995). Among many sources of real disturbances, such as oil prices, fiscal policy, and productivity shocks, it has been shown that oil price fluctuations play a major role in explaining real exchange rate movements.

Moreover, Chaudhuri and Daniel (1998) investigate 16 OECD countries and find that the non-stationary behavior of US dollar real exchange rates is due to the non-stationary behavior of real oil prices.

Similar results are obtained by Amano and Norden (1998a, b). By using data on real effective exchange rates for Germany, Japan, and the US, they find that the real oil price is the most important factor determining real exchange rates in the long run. Camarero and Tamarit (2002) use panel cointegration techniques to investigate the relationship between real oil prices and the Spanish peseta's real exchange rate.

Yousefi and Wirjanto (2004) adopts a novel empirical approach to the crude-oil price formation for the purpose of understanding the price reactions of OPEC member countries to changes in the exchange rate of the US dollar against other major currencies and prices of other members. The results are broadly consistent with the view of the absence of a unified OPEC determined price in the international crude market literature. In addition, the results also highlight a cross-regional dimension of the crude oil market.

Chen and Chen (2007) investigate the long-run relationship between real oil prices and real exchange rates by using a monthly panel of G7 countries from. They found that real oil prices may have been the dominant source of real exchange rate movements and that there is a link between real oil prices and real exchange rates. They then examine the ability of real oil prices to forecast future real exchange returns. Finally, they found that Panel predictive regression estimates suggest that real oil prices have significant forecasting power.

The rest of the paper is organized as follows: In Section 2, we present a simple theoretical model. In Section 3, the sources of data and notations are described. In Section 4, we report the country-by-country results. In section 5, the panel results are reported. Concluding remarks are provided in Section 6.

A Theoretical Model

Based on Chen and Chen (2007), Supposed that the home and foreign country consumer price indices be as follows:

$$\begin{aligned} &cpi_h = (p^t)^{\alpha}(p_n)^{1-\alpha} \\ &\Rightarrow p_l = \log(cpi_h) = \alpha\log(p^t) + (1-\alpha)\log(p^n) \\ &\Rightarrow p_l = \alpha p_l^t + (1-\alpha)p_l^n \end{aligned} \quad (1)$$

$$\begin{aligned} &cpi_f = (p^{t*})^{\alpha*}(p^{n*})^{1-\alpha} \\ &\Rightarrow p_l^* = \log(cpi_f) = \alpha*\log(p^{t*}) + (1-\alpha*)\log(p^{n*}) \\ &\Rightarrow p_l^* = \alpha + p_l^{t*} + (1-\alpha+)p_l^{n*} \end{aligned} \quad (2)$$

where p_l^t (p_l^{t*}) and p_l^n (p_l^{n*}) are prices of traded and non-traded goods in the home (foreign) country, respectively. Also cpi_h and cpi_f are home and foreign consumer price indices, respectively.

α and $\alpha*$ weights correspond to the expenditure shares on traded goods near the point of approximation for the home and foreign countries, respectively. The log of the real exchange rate, is defined as

$$\begin{aligned} &ex_r = \frac{p*}{p}ex_n \\ &\Rightarrow \log(ex_r) = \log(ex_n) + \log(p*) - \log(p) \\ &\Rightarrow lex_r = lex_n + P_l^* - P_l \end{aligned} \quad (3)$$

Where ex_r and ex_n are real and nominal exchange rates, respectively. Thus, by notice to (1), (2) and (3), the real exchange rate can be rewritten as

$$\begin{aligned} &lex_r = (lex_n + p_l^{t*} + p_l^t) \\ &+(1-\alpha)(p_l^t - p_l^n) \\ &-(1-\alpha*)(p_l^{t*} - p_l^{n*}) \end{aligned} \quad (4)$$

According to (4), if $\alpha \cong \alpha*$ a rise in the relative price of domestic tradables, depreciates the real exchange rate, while the magnitude of the rise exceeds that of the rise in the relative price of foreign tradables. That is, if the home country is more dependent on imported oil, a real oil price rise may increase the prices of tradable goods in the home country by a greater proportion than in the foreign country, and thereby cause a real depreciation of the home currency. Moreover, in order to improve competitiveness when an oil price shock worsens the term of trade, the home country would have to raise the nominal exchange rate, which would lead to a further real depreciation. In this paper, we empirically investigate the link between real exchange rates and real oil prices. We study whether the real exchange rate is positively related to the real oil price as predicted by the above model. We also investigate whether real oil prices can predict movements in real exchange rates.

It is well known that real exchange rate fluctuations can be attributed primarily to nonmonetary shocks. Numerous of researchers have reviewed the relationship between oil prices and exchange rates.

Data and Notations

We use data on the seven countries of OPEC members, Algeria, Indonesia, Iran, Kuwait, Nigeria, Saudi Arabia, and Venezuela. Monthly data, from 2000:01 to

2007:12, are used. Data on nominal exchange rates (domestic currency per unit of foreign currency), consumer price indices, and the British price of oil (Brent), the United Arab Emirates price of oil (Dubai), the West Texas Intermediate (WTI) and the world price of oil (World) were obtained from International Financial Statistics (IFS), published by the International Monetary Fund (IMF). The Spot OPEC Reference Basket oil prices were obtained from OPEC annual reports. Real exchange rates are constructed by following formula:

$$ex_r = \frac{p_w}{cpi} ex_n \quad (5)$$

where p_w is the world export index and cpi is the consumer price index of each country. Real oil prices are defined as the US dollar prices of oil converted to the domestic currency and then deflated by the domestic consumer price index (CPI).

Table 1: Variable names, notations and data source

Variables	Notation	Source
Nominal Exchange Rates	Ex_n	IFS
Real Exchange Rates	ex_r	IFS
Consumer Price Index	cpi	IFS
World Export Index	p_w	IFS
United Kingdom (Brent)	Brent	IFS
United Arab Emirates (Dubai)	Dubai	IFS
West Texas Intermediate (WTI)	WTI	IFS
World average crude price	World	IFS
Spot OPEC Reference Basket price	OPEC	OPEC Annual Reports

All variables are measured in logarithms. Variable names, their notations and sources of data are provided in Table 1.

Country-by-Country Results

Stationary Test:

Given no evidence of the presence of structural breaks, we test for unit roots. We examine each individual series by using the Augmented Dickey–Fuller (ADF) test. Results are based on the inclusion of an intercept and trend. The results of augmented Dickey-Fuller unit root test are presented in Table 2.

Clearly, according to the ADF tests, all real oil prices are integrated of order one, I(1), but real exchange rates of Algeria and Indonesia are stationary at level, and real exchange rates of Iran and Venezuela are integrated of order one, I(1). Finally, real exchange rates of Kuwait, Nigeria and Saudi Arabia are integrated of order two (calculated but not reported). It is evident that real oil prices are nonstationary.

This confirms the findings of Amano and Norden (1998a), who have shown that German and Japanese real WTI prices are I(1) series. These results are also consistent with those of Chaudhuri and Daniel (1998), who find that real Dubai oil prices for Canada, Germany, Italy, Japan, and the UK are I(1). Finally, the results are also consistent with those of Chen and Chen (2007), who show that real Dubai, Brent, WTI and World oil prices for G7 countries are I(1), too.

Table 2: The results of augmented Dickey-Fuller unit root test

Real Exchange rates	Algeria	Indonesia	Iran	Kuwait	Nigeria	Saudi Arabia	Venezuela
Series in level:	-4.07 (0.00)**	-3.47 (0.04)*	-2.42 (0.36)	-2.20 (0.48)	-2.60 (0.28)	-3.33 (0.06)	-3.01 (0.13)
Series in first differences:	---	---	-10.95 (0.00)**	-2.88 (0.17)	-2.73 (0.22)	-2.73 (0.22)	-9.63 (0.00)***
Real Oil Prices	**Brent**	**Dubai**	**WTI**	**World**	**OPEC**		
Series in level:	-0.80 (0.96)	-0.37 (0.98)	-0.79 (0.96)	-0.64 (0.97)	-0.58 (0.97)		
Series in first differences:	-9.85 (0.00)***	-9.41 (0.00)***	-9.32 (0.00)***	-9.55 (0.00)***	-9.52 (0.00)***		

Note: The null hypothesis is that the series is a unit root process. An intercept and trend are included in the test equation. p-values are provided in parentheses. The lag length was selected by using the Schwarz Information Criterion.

* Significant at 0.05 level

** Significant at 0.01 level

Cointegration Test:

We apply the Johansen (1988) test for cointegration and investigate the results from the trace and max-eigenvalue statistics. Results are based on the inclusion of linear deterministic trend in data. The results of Johansen cointegration test are provided in Table 3.

In all cases, real exchange rates and real oil prices are not cointegrated. These results on cointegration are consistent with the findings of Amano and Norden (1998a), Chaudhuri and Daniel (1998)and Chen and Chen (2007). As shown in this section, our country-by-country results are consistent with other empirical studies. Given the notoriously low power of individual country-by-country tests for unit roots and cointegration, it may be preferable to pool the currencies and conduct panel analysis.

Panel Results

Panel Unit Root Test

We implement five different types of panel unit root tests: the Lin et al. (2002) test (LLC), the Breitung (2000) test, the Im et al. (2003) test (IPS), and the Fisher-type ADF and Phillips–Perron (PP) tests. Results are based on the inclusion of an intercept and trend. The results of panel unit root tests in level and one order of differentiation are reported in Table 4.

It is clear that the real exchange rates are I(0) and the oil prices are I(1). The evidence for exchange rates is relatively weak because the Breitung (2000) test suggests stationary in one case.

However, significant evidence of nonstationary is suggested by the Fisher-type statistics (Fisher–PP), which have been shown to be superior to IPS tests by Maddala and Wu (1999). Also, significant evidence of nonstationary is suggested by the LLC test statistic. These results are consistent with Chen and Chen (2007). For panel cointegration test, we apply the Pedroni (2004) tests.

Panel Cointegration Test

We then implemented the panel cointegration tests proposed by Pedroni

(2004). This is a residual-based test for the null of no cointegration in heterogeneous panels. Two classes of statistics are considered in the context of the Pedroni test.

Table 3: The results of Johansen cointegration test

Country	Hypothesized Rank (r)	Brent		Dubai		WTI		World		OPEC	
		Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen
Algeria	r=0	18.69	11.37	18.53	11.31	16.24	9.65	18.17	10.83	18.48	11.23
	r ≤1	7.31	7.31	7.40	7.40	6.58	6.58	7.34	7.34	7.25	7.25
Indonesia	r=0	15.15	9.40	14.42	9.03	14.53	9.54	14.85	9.39	14.66	8.73
	r ≤1	5.75	5.75	5.39	5.39	4.99	4.99	5.51	5.51	5.93	5.93
Iran	r=0	19.43	10.95	19.01	10.67	18.72	11.30	19.27	10.95	19.20	10.78
	r ≤1	8.47	8.47	8.34	8.34	7.41	7.41	8.32	8.32	8.41	8.41
Kuwait	r=0	17.42	10.74	16.38	10.10	17.84	11.04	17.18	10.55	16.80	10.62
	r ≤1	6.67	6.67	6.28	6.28	6.80	6.80	6.62	6.62	6.18	6.18
Nigeria	r=0	19.00	11.35	18.43	11.15	18.49	11.49	18.77	11.35	18.59	11.33
	r ≤1	7.64	7.64	7.27	7.27	6.99	6.99	7.41	7.41	7.26	7.26
Saudi Arabia	r=0	17.29	9.80	16.77	9.74	17.08	9.87	17.13	9.79	16.83	9.78
	r ≤1	7.49	7.49	7.03	7.03	7.21	7.21	7.33	7.33	7.05	7.05
Venezuela	r=0	21.07	12.07	20.82	11.68	19.80	12.01	20.94	12.08	21.63	12.32
	r ≤1	8.99	8.99	9.14	9.14	7.78	7.78	8.86	8.86	9.31	9.31

Note: Trace statistic critical value at 0.05 level for $r=0$ is 25.87

Trace statistic critical value at 0.05 level for r≤1 is 12.51

Max-Eigen statistic critical value at 0.05 level for $r=0$ is 19.38

Max-Eigen statistic critical value at 0.05 level for r≤1 is 12.51

Table 4: Panel unit root tests

	Real Exchange Rates	Real Oil Prices				
		Brent	Dubai	WTI	World	OPEC
Series in level:						
Levin, Lin, and Chu	-3.41 (0.00)**	2.49 (0.99)	4.41 (1.00)	3.87 (0.99)	3.76 (0.99)	3.95 (1.00)
Breitung	2.27 (0.60)	4.91 (1.00)	6.01 (1.00)	4.97 (1.00)	3.31 (1.00)	5.41 (1.00)
Im, Pesaran, and Shin	-2.91 (0.00)**	4.70 (1.00)	6.17 (1.00)	4.74 (1.00)	5.25 (1.00)	5.45 (1.00)
Fisher–ADF	30.85 (0.00)**	0.54 (1.00)	0.17 (1.00)	0.53 (1.000	0.36 (1.00)	0.31 (1.00)
Fisher–PP	36.93 (0.00)**	0.20 (1.00)	0.08 (1.00)	0.34 (1.00)	0.19 (1.00)	0.14 (1.00)
Series in first differences:						
Levin, Lin, and Chu	---	-29.47 (0.00)**	-29.60 (0.00)**	-29.94 (0.00)**	-28.59 (0.00)**	-29.74 (0.00)**
Breitung	-8.75 (0.00)**	-9.82 (0.00)**	-9.26 (0.00)**	-10.24 (0.00)**	-9.82 (0.00)**	-9.55 (0.00)**
Im, Pesaran, and Shin	---	-26.23 (0.00)**	-24.74 (0.00)**	-24.42 (0.00)**	-25 20 (0.00)**	-25.09 (0.00)**
Fisher–ADF	---	370.13 (0.00)**	349.28 (0.00)**	344.48 (0.00)**	355.90 (0.00)**	354.23 (0.00)**
Fisher–PP	---	375.88 (0.00)**	347.49 (0.00)**	341.91 (0.00)**	355.06 (0.00)**	353.68 (0.00)**

Note: The null hypothesis is that the series is a unit root process. An intercept and trend are included in the test equation. p-values are provided in parentheses .Probabilities for Fisher-type tests were computed by using an asymptotic $\chi 2$ distribution. All other tests assume asymptotic normality. The lag length was selected by using the Schwarz Information Criterion.

* Significant at 0.05 level, ** Significant at 0.01 level

The first type is based on pooling the residuals of the regression along the within-dimension of the panel, where as the second type is based on pooling the residuals of the regression along the between-dimension of the panel. For the first type, the test statistics are the panel ν-statistic, the panel ρ-statistic, the panel PP-statistic, and the panel ADF-statistic. These statistics are constructed by taking the ratio of the sum of the numerators and the sum of the denominators of the analogous conventional time-series statistics across the individual members of the panel. The tests for the second type include the group ν-statistic, the group PP-statistic, and the group ADF-statistic. They are simply the group mean statistics of the conventional individual time-series statistics. All statistics have been standardized by the means and variances so that they are asymptotically distributed N(0,1) under the null of no cointegration. As one-sided tests, large positive values of the panel ν -statistic reject the null hypothesis of no cointegration. For the remaining statistics (the panel ρ, the panel PP, the panel ADF, the group ρ, the group PP, and the group ADF tests), large negative values reject this null. See Pedroni (2004) for a detailed discussion.

The results are based on the inclusion of an intercept and trend and inclusion an intercept only. The results of panel cointegration tests (between exchange rates and each of oil price indices) are provided in Table 5

The group ρ and the group PP (based on the inclusion of an intercept only) and all panel statistics, except for panel ν, (based on the inclusion of an intercept and trend) indicate fairly strong support for the hypothesis that oil prices are cointegrated with real exchange rates in the context of world, Dubai, Brent, WTI and Spot OPEC Reference Basket prices.

Given the evidence that real exchange rates and real oil prices may be cointegrated, we conclude that there is a long-run relationship between them. Thus we estimate the cointegrating coefficients between real exchange rates and real oil prices. Consider the following regression.

$$ex_{it} = \alpha_i + \beta\, op_{it} + \varepsilon_{it} \qquad (6)$$

Table 5: The results of Pedroni (2004) Panel cointegration tests

	Brent		Dubai		WTI		World		OPEC	
	No trend	Trend	No trend	Trend	No trend	Trend	No trend	Trend	No trend	Trend
Panel ν	-0.22 (0.38)	1.42 (0.14)	-0.20 (0.39)	1.69 (0.09)	-0.06 (0.39)	1.45 (0.13)	-1.18 (0.35)	1.46 (0.13)	-0.20 (0.39)	-1.46 (0.13)
Panel ρ	0.26 (0.38)	-5.03 (0.00)**	0.40 (0.36)	-4.88 (0.00)**	0.25 (0.38)	-4.54 (0.00)**	0.32 (0.37)	-4.88 (0.00)**	0.35 (0.37)	-4.88 (0.00)**
Panel-PP	0.10 (0.39)	-4.10 (0.00)**	0.21 (0.38)	-4 01 (0.00)**	0.11 (0.39)	-3.77 (0.00)**	0.16 (0.39)	-4.00 (0.00)**	0.20 (0.39)	-4.00 (0.00)**
Panel-ADF	0.37 (0.37)	-3.11 (0.00)**	0.50 (0.35)	-3 08 (0.00)**	0.41 (0.36)	-2.81 (0.00)**	0.45 (0.36)	-3.01 (0.00)**	0.48 (0.35)	-3.01 (0.00)**
Group ρ	-4.07 (0.00)**	-6.52 (0.00)**	-3.37 (0.00)**	-6.09 (0.00)**	-4.27 (0.00)**	-6.35 (0.00)**	-3.87 (0.00)**	-6.37 (0.00)**	-3.65 (0.00)**	-6.37 (0.00)**
Group-PP	-3.00 (0.00)**	-6.10 (0.00)**	-2.45 (0.01)*	-5.78 (0.00)**	-3.02 (0.00)**	-5.96 (0.00)**	-2.78 (0.00)**	-5.98 (0.00)**	-2.60 (0.01)*	-5.98 (0.00)**
Group-ADF	-1.82 (0.07)	-4.07 (0.00)**	-1.24 (0.18)	3.75 (0.00)**	-1.69 (0.09)	-3.90 (0.00)**	-1.53 (0.12)	3.89 (0.00)**	-1.38 (0.15)	-3.89 (0.00)**

Note: The null hypothesis is that there is no cointegration.

* Significant at 0.05 level, ** Significant at 0.1 level

Where is the log of the real exchange rate and is the log of the real oil price. The Restricted F test statistic, Hausman's specification test statistic and estimation results for Eq. (6) are provided in Table 6.

The coefficients are estimated by using a panel OLS estimator. Clearly, the results comfortably reject the null hypothesis of no long run relationship between the real exchange rate and the real oil price for all measures of oil prices.

Table 6: The Results of Panel Estimation

	Brent Oil Prices	Dubai Oil Prices	WTI Oil Prices	World Oil Prices	OPEC Oil Prices
β	0.34	0.34	0.35	0.34	0.35
P-Value	(0.00)**	(0.00)**	(0.00)**	(0.00)**	(0.00)**
Adj. R^2	0.51	0.51	0.52	0.52	0.52
Restricted F Test:					
F- statistic	175.75	174.57	177.92	176.41	176.93
(P-Value)	(0.00)**	(0.00)**	(0.00)**	(0.00)**	(0.00)**
Hausman's Specification Test:					
Chi^2-statistic	0.00	0.00	0.00	0.00	0.00
(P-Value)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)

Note: The regression is where is the log of the real exchange rate and is the log of the real oil price.
** Significant at 0.01 level

Conclusion

In this paper we studied the long-linkage between real oil price and real exchange rate in OPEC members and investigated the long-run relationship between them by using a monthly panel of seven countries of OPEC members from 2000:01 to 2007:12. We first test whether or not exchange rates are cointegrated with real oil prices. The country-by-country results reject the cointegration between oil prices and exchange rates, but stationary and cointegration tests for pooled series obviously had shown the high power of panel analysis for unit root and cointegration between exchange rates and oil prices. It is shown that real oil prices may have been the dominant source of real exchange rate movements.

Finally, results show that, there is a long-run and positive linkage between real oil prices and real exchange rates. Since the real exchange rate of OPEC members depends on oil price movements severely, thus we suggest to the economists and governments of these countries that consider this powerful relationship and oil shocks in their economic planning and decision making.

References

Amano, R.A. and Norden, S. (1998a), "Exchange rates and oil prices", Review of International Economics, Vol. 6 No. 4, pp. 683–694.

Amano, R. and Norden, S. (1998b), "Oil prices and the rise and fall of the US real exchange rate", Journal of International Money and Finance, Vol. 17 No. 2, pp. 299–316.

Baxter, M. (1994), "Real Exchange Rates, Real Interest Differentials, and Government Policy. Theory and Evidence", Journal of Monetary Economics, Vol. 33, pp. 5-37.

Breitung, J. (2000), The local power of some unit root tests for panel data. In: Baltagi, B. (Ed.), Advances in econometrics, nonstationary Panels, Panel Cointegration, and Dynamic Panels, JAI Press, Amsterdam, pp. 161–178.

Camarero, M. and Tamarit, C. (2002), "Oil prices and Spanish competitiveness: a cointegrated panel analysis", Journal of Policy Modeling, Vol. 24 No. 6, pp. 591–605.

Chaudhuri, K. and Daniel, B.C. (1998), "Long-run equilibrium real exchange rates and oil prices", Economic Letters, Vol. 58 No. 2, pp. 231–238.

Chen, Sh. and Chen, Hu. (2007), "Oil prices and real exchange rates", Energy Economics, Vol. 29, pp. 390-404.

Clarida, R. and Gali, J. (1994), "Sources of real exchange-rate fluctuations: how important are nominal shocks?", Carnegie–Rochester Conference Series on Public Policy, Vol. 41, pp. 1–56.

Golub, S.S. (1983), "Oil Prices and Exchange Rates", Economic Journal, No. 93, pp. 576-93.

Huizinga, J. (1987), "An empirical investigation of the long-run behavior of real exchange rates", Carnegie-Rochester Series on Public Policy, Vol. 27, pp. 149-215.

Im, K.S., Pesaran, M.H. and Shin, Y.C. (2003), "Testing for unit roots in heterogeneous panels", Journal of Econometrics, Vol. 115 No. 1, pp. 53–74.

Johansen S. (1988), "Statistical Analysis of Cointegrating Vectors", Journal of Economic Dynamics and Control, Vol. 12, pp. 231-54

Krugman, P. (1983a), Oil and the dollar In Economic Interdependence and Flexible Exchange Rates, Cambridge: MIT Press.

Krugman, P. (1983b), Oil shocks and exchange rate dynamics In Exchange Rates and International Macroeconomics, University of Chicago Press.

Lastrapes, William D. (1992), "Sources of fluctuations in real and nominal exchange rates", Review of Economics and Statistics, Vol. 74 No. 3, pp. 530–539.

Levin, A., Lin, C. and Chu, C. (2002), "Unit root tests in panel data: asymptotic and finite-sample properties", Journal of Econometrics, Vol. 108 No. 1, pp. 1–24.

Maddala, G.S. and Wu, S. (1999), "A comparative study of unit root tests with panel data and a new simple test", Oxford Bulletin of Economics and Statistics, Vol. 61 No. 0, pp. 631–652.

McGuirk, A.K. (1983), "Oil price changes and real exchange rate movements among industrial countries", International Monetary Fund Staff Papers, Vol. 30, pp. 843-83.

Pedroni, P. (2004), "Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis", Econometric Theory, Vol. 20 No. 3, pp. 597–625.

Rogoff, K. (1991), "Oil, productivity, government spending and the real yen-dollar exchange rate", Working Paper, Federal Reserve Bank of San Francisco, San Francisco, CA.

www.imf.org/external/np/ds/matrix.htm.

Yousefi, A. and Wirjanto, T. (2004), "The empirical role of the exchange rate on the crude-oil price formation", Energy Economics, Vol. 26, pp. 783–799.

Zhou, Su. (1995), "The response of real exchange rates to various economic shocks", Southern Economic Journal, Vol. 61 No. 4, pp. 936–954.