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IMPACT OF OIL PRICES ON THE DOMESTIC CURRENCY IN A SMALL INDUSTRIAL ECONOMY WITHOUT OIL RESOURCES

Mete Feridun*, Grigoris Michailidis**

ABSTRACT

This study aims at investigating the link between international oil prices and the exchange rate in case of a small open industrial economy without oil resources such as Poland. The results of Granger-causality test show that the null hypotheses of Zloty-US dollar exchange rate does not granger cause rejection of Oil Price is not rejected while there exists reverse causality in 3 and 4 year lags at 5% and 10% levels. Therefore, we conclude that increases in oil prices have had a positive impact on the exchange rates over the period between 1982:12 and 2006:05.

Keywords*: Oil Prices, Exchange Rates, Commodity Prices, Cointegration*

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INTRODUCTION

Oil price shocks have negative effects on the exports of a small open industrial economy without oil resources such as the economy of Poland. In order to explain the link between the oil prices and the exchange rates in a small economy, Amano and Van Norden (1998) propose a model with two sectors for tradable and non-tradable goods respectively. Each sector uses both a tradable input (oil) and a non-tradable one (labour). The output price of the tradable sector is fixed internationally; hence the real exchange rate is identified to the output price in the non-tradable sector. A rise in the oil price leads to a decrease in the labour price in order to meet the competitiveness requirement of the tradable sector. If the non-tradable sector is more energy-intensive than the tradable one, its output price rises and so does the real exchange rate. The opposite applies if the non-tradable sector is less energy-intensive than the tradable one. Krugman (1980) and Golub (1983) take both small and big economies into consideration. They focus

* Loughborough University, Department of Economics, Loughborough, UK, E-mail: m.ferdirun@lboro.ac.uk

** University of Macdonia, Economic and Social Sciences, Department of Applied Informatics, Thessaloniki, Greece, E-mail: mgrigoris@hotmail.com

on the balance of payments and, therefore, on the tradable sector and international portfolio choices. A rise in oil prices is viewed as a wealth transfer from oil-importing countries to oil-exporting ones. The impact on exchange rates then depends on the distribution of the oil imports across oil-importing countries and on the portfolio preferences of both oil-importing countries, whose wealth declines, and oil-exporting ones, whose wealth increases. The relationship between oil prices and exchange rates received attention particularly after the 1973-1974 oil crisis (Atukeren, 2003). Impact of the oil prices on the exchange rate movements has been investigated by Golub (1983), McGuirk (1983), Krugman (1983a, 1983b), Hamilton (1983), Shazly (1989), Yoshikawa (1990), Rogoff (1991) and Dotsey and Reid (1992), Throop (1993), Zhou (1995), Dibooglu (1996), DeGrauwe (1996), Akram and Holter (1996), Amano and Van Norden (1998), Chaudhuri and Daniel (1998), Bjorvik et al. (1998), Akram (2004), Bénassy-Quéré et al. (2005). These studies offer mixed support for the assumed covariance between the oil prices and exchange rates.

The present study aims at investigating the link between the international oil prices and the exchange rate in case of a small open industrial economy without oil resources, in Poland. To our knowledge, there exists no study examining the ability of oil prices to account for permanent movements in the Zloty-US dollar exchange rate. The present study aims at contributing to the knowledge in this area by filling this gap in the literature. The rest of the paper is structured as follows: Next section introduces the data and methodology, Section II shows the results, and Section III points out the conclusions that emerge from the study.

DATA AND METHODOLOGY

Data

Data for Crude oil price (in USD per Barrel) was obtained from International Energy Agency (IEA) web site and the data for the exchange Zloty-US dollar exchange rate was obtained from DataStream for the period of 1982:12 – 2006:5. They were transformed into logarithmic returns in order to achieve mean-reverting relationships, and to make econometric testing procedures valid. An examination of the descriptive statistics of the logarithmic transformations of time series data shows that the Zloty-Pounds Sterling, and Zloty-Australian Dollar exchange rates are the most volatile data sets. The measures of skewness and kurtosis as well as the probabilities of the Jarque-Berra tests statistic provide evidence in favour of the null hypothesis of a normal distribution for all data sets.

Table 1: Descriptive Statistics

	OIL PRICES	PLN – USD
Mean	0.05439	0.01221
Std. Deviation	0.0333	0.01998
Skewness	0.13986	0.13653
Kurtosis	3.37884	3.97935
Jarque–Bera	259.9553	82.75494
Probability	0	0

Methodology

In the present study, we use Granger causality test to examine the relationship between oil prices and exchange rates. Granger definition of causality is the most widely accepted definition of causality. According to Granger (1969), Y is said to "Granger-cause" X if and only if X is better predicted by using the past values of Y than by not doing so with the past values of X being used in either case. Granger (1969) originally suggested the Granger test, which was improved by Sargent (1976). To implement the Granger test, we assume a particular autoregressive lag length *k (or p)* and estimate Equation (1) and (2) by OLS:

$$X_t = \lambda_1 + \sum_{i=1}^{k} a_{1i} X_{t-i} + \sum_{j=1}^{k} b_{1j} Y_{t-j} + \mu_{1t} \tag{1}$$

$$Y_t = \lambda_2 + \sum_{i=1}^{p} a_{2i} X_{t-i} + \sum_{j=1}^{p} b_{2j} Y_{t-j} + \mu_{2t} \tag{2}$$

F test is carried out for the null hypothesis of no Granger causality $H_0 : b_{i1} = b_{i2} = \cdots = b_{ik} = 0, i = 1,2.$ Where *F* statistic is the Wald statistic for the null hypothesis. If the *F* statistic is greater than a certain critical value for an *F* distribution, then we reject the null hypothesis that *Y* does not Granger-cause *X* (equation (1)), which means Y Granger-causes X. A time series with stable mean value and standard deviation is called a stationary series. If d differences have to be made to produce a stationary process, then it can be defined as integrated of order d. Granger (1981, 1983) proposed the concept of cointegration, and Engle and Granger (1987) made further analysis. If several variables are all I(d) series, their linear combination may be cointegrated, that is, their linear combination may be stationary. Although the variables may drift away from equilibrium for a while, economic forces may be expected to act so as to restore equilibrium, thus, they tend to move together in the long run irrespective of short run dynamics. The definition of the Granger causality is based on the hypothesis that *X* and *Y* are stationary or I(0) time series. However, it is now widely recognized that many macro-economic series appear to contain a (or at least a) unit root in their autoregressive representations, and there are plenty of empirical evidence to indicate that macro-economic series often appear to be I(1). So we can not apply the fundamental Granger method for variables of I(1). We use Augmented Dickey-Fuller (ADF) method to test the order of the series, and Johansen's method to test if any cointegration relationship exists between the series.

EMPIRICAL RESULTS

Unit Root Tests

The first necessary condition to perform Granger-causality tests is to study the stationary of the time series under consideration and to establish the order of integration present. The Augmented Dickey-Fuller (ADF) (1979) unit root test is used in examining the stationarity of the data series. It consists of running a regression of the first difference of the series against the series lagged once, lagged difference terms, and optionally, a constant and a time trend. This can be expressed as:

$$\Delta yt = \beta 1yt\text{-}1 + \beta 2\Delta yt\text{-}1 + \beta 3\Delta yt\text{-}2 + \beta 4 + \beta 5t \qquad (3)$$

The test for a unit root is conducted on the coefficient of yt-1 in the regression. If the coefficient is significantly different from zero then the hypothesis that y contains a unit root is rejected. Rejection of the null hypothesis implies stationarity. If the calculated ADF statistic is higher than McKinnon's critical value, then the null hypothesis is not rejected and it is concluded that the considered variable is non-stationary, i.e. has at least one unit root. Then, the procedures are re-applied after transforming the series into first differenced form. If the null hypothesis of non-stationarity can be rejected, it can be concluded that the time series is integrated of order one, *I*(1). Table 2 summarizes the results of the ADF unit root tests on levels and in first differences of the data. Tests reveal that series, at constant and with trend, are not stationary, at levels. They are, however, found to be stationary after taking the first differences. Therefore, we conclude that the series are *I*(1).

Cointegration Analysis

Cointegration analysis helps to identify long-run economic relationships between two or several variables and to avoid the risk of spurious regression. Cointegration analysis is important because if two non-stationary variables are cointegrated, a VAR model in the first difference is misspecified due to the effect of a common trend. If the cointegration relationship is identified, the model should include residuals from the vectors (lagged one period) in the dynamic Vector Error Correcting Mechanism (VECM) system. In this stage, Johansen cointegration test is used to identify cointegrating relationship among the variables. Within the Johansen multivariate cointegrating framework, the following system is estimated:

$$\Delta z_t = \Pi_1 \Delta z_{t-1} + \ldots + \Pi_{k-1} \Delta z_{t-k-1} + \Pi z_{t-1} + \mu + \varepsilon_t: \quad t = 1, \ldots, T \qquad (4)$$

Where Δ is the first difference operator, *z* denotes vector of variables, $\varepsilon_t \sim$ niid $(0,\Sigma)$, μ is a drift parameter, and Π is a (pxp) matrix of the form $\Pi = \alpha\beta'$, where α and β are both $(p \times r)$ matrices of full rank, with β containing the *r* cointegrating relationships and α carrying the corresponding adjustment coefficients in each of the *r* vectors. The Johansen approach can be used to carry out Granger causality tests as well. In the Johansen framework, the first step is the estimation of an unrestricted, closed p*th* order VAR in *k* variables. Johansen (1995) suggests two tests statistics to determine the cointegration rank: the trace statistic and the maximum eigenvalue test Johansen and Juselius (1990) indicated that the trace test might lack the power relative to the maximum eigenvalue test. Based on the power of the test, the maximum eigenvalue test statistic is often preferred. Table 2 presents results from the Johansen cointegration test among the data sets. Neither maximum eigenvalue nor trace tests rejects the null hypothesis of no cointegration at the 5% level as the calculated t statistics are smaller than the critical values.

Table 2: Unit Root Test

	Test with an intercept		Test with an intercept and trend		Test with no intercept or trend	
	ADF (Levels)	ADF (1st differences)	ADF (Levels)	ADF (1st differences)	ADF (Levels)	ADF (1st differences)
Zloty-US dollar	-0.1833	-16.3485	-1.9147	-16.3583	-0.2931	-16.2264
Oil Price	-1.7171	-12.5353	-2.2071	-12.6622	0.1743	-12.5489
CV* (1%)	-3.4535	-3.4535	-3.9911	-3.9911	-2.5732	-2.5732
CV* (5%)	-2.8716	-2.8716	-3.4259	-3.4259	-1.9419	-1.9419

*MacKinnon (1996) one-sided p-values.
The lag length was determined using Schwartz Information Criteria (SIC)

Granger-Causality Test

Essentially, Granger's definition of causality is framed in terms of predictability. Granger (1969) originally suggested the Granger test, which was improved by Sargent (1976). To implement the Granger test, we assume a particular autoregressive lag length *k (or p)* and estimate Equation (7) and (8) by OLS:

$$X_t = \lambda_1 + \sum_{i=1}^{k} a_{1i} X_{t-i} + \sum_{j=1}^{k} b_{1j} Y_{t-j} + \mu_{1t} \quad (7)$$

$$Y_t = \lambda_2 + \sum_{i=1}^{p} a_{2i} X_{t-i} + \sum_{j=1}^{p} b_{2j} Y_{t-j} + \mu_{2t} \quad (8)$$

Table 3: Cointegration Test

Null Hypothesis	Trace Statistic	Maximum Eigenvalue Statistic	5% Critical Value
r = 0	9.471519	0.033411	17.19912
r < = 1	0.071817	0.000222	4.264065

r is the number of cointegrating vectors under the null hypothesis.
A linear deterministic trend is assumed.
Appropriate lag lengths are determined using standard likelihood ratio tests with a finite-sample correction.

F test is carried out for the null hypothesis of no Granger causality $H_0 : b_{i1} = b_{i2} = \cdots = b_{ik} = 0, i = 1,2.$ where *F* statistic is the Wald statistic for the null hypothesis. If the *F* statistic is greater than a certain critical value for an *F* distribution, then we reject the null hypothesis that *Y* does not Granger-cause *X*, which means Y Granger-causes X. The classical approach to deal with integrated variables is to take their first-differences to make them stationary. Hassapis et al. (1999) show that in the absence of cointegration, the direction of causality can be decided upon via standard *F*-tests in the first differenced VAR. The VAR in the first difference can be written as:

$$\Delta X_t = \lambda_1 + \sum_{i=1}^{k} a_{1i} \Delta X_{t-i} + \sum_{j=1}^{k} b_{1j} \Delta Y_{t-j} + \mu_{1t} \quad (9)$$

$$\Delta Y_t = \lambda_2 + \sum_{i=1}^{p} a_{2i} \Delta X_{t-i} + \sum_{j=1}^{p} b_{2j} \Delta Y_{t-j} + \mu_{2t} \quad (10)$$

The F-test is: $F_{(r,\ n-m-k)} = [(ESS_r - ESS_u)/r]/[ESS_u/(n-m-k)]$ where ESS is the residual sum of squares. Since, maximum eigenvalue and trace tests do not reject the null hypothesis of no cointegration at the 5% level, aforementioned VAR method can be used. Table 3 shows the results of these regressions.

Table 4: Granger Causality Test

Null Hypothesis	F-Statistics				
	Lag 1	**Lag 2**	**Lag 3**	**Lag 4**	**Lag 5**
Exchange Rate =/=> Oil Price	0.6486	0.3475	0.3247	0.3613	0.7731
Oil Price =/=> Exchange Rate	0.7753	0.1168	3.4348**	3.5502*	2.7841

* Reject the null hypothesis at the 10% level.
** Reject the null hypothesis at the 5% level.

The results of Granger-causality test show that the null hypothesis of Exchange Rate does not granger cause Oil Price and is not rejected in 1, 2 and 3 while results show the evidence of reverse causality in 3 and 4 year lags at 5% and 10% levels. Therefore, we conclude that increases in oil prices had a positive impact on the exchange rate over the period between 1982:12 and 2006:05.

CONCLUSION

We find that international oil prices have an impact on long-term Zloty-US dollar real exchange rate. An important possibility to consider is that the oil prices and the exchange rates are jointly determined by some common macroeconomic variables. Hence, we believe that important insights are likely to be gained from a search of a co-determinant of Zloty-US dollar exchange rate and oil prices.

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