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Deluna, Roperto Jr

University of Southeastern Philippines, School of Applied Economics

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Roperto S. Deluna Jr*
School of Applied Economics, University of Southeastern Philippines
F. Inigo Street, Davao City +82 227 8192 loc 231/226
email: rupertdeluna@usep.edu.ph

Abstract

This study was conducted to determine the long-run relationship among world oil price (WOP), Philippine inflation rate (IR) and exchange rate (ER). Results of the Augmented Dickey Fuller (ADF) tests of the variables revealed that all three series are not stationary in the process and were subjected to first differencing. ADF further revealed that the three series are integrated of order 1 or I(1). Therefore, vector error correction model (VECM) was used to examine the relationship of the three variables. VECM revealed a positive long-run relationship between IR and WOP, and IR and ER. A unit increase of the world oil price will increase Philippine inflation by 0.31%. While, a unit increase in exchange rate (PhP: USD) will increase inflation rate by 0.42%. In terms of ER, results revealed that an increase in the past values of WOP will increase ER. However, ER is not affected by the past values of IR. Result of the granger causality shows that all of the other variables jointly granger cause and individually granger cause inflation rate. Changes in ER cannot be predicted by joint and individual changes in the previous periods of WOP and IR.

Key words: VECM, inflation, world oil price, exchange rate

Introduction

As an open economy, the Philippines is integrated with the world. This simply means that it is not free from external shocks. The Philippines is an importer of oil to support domestic demand for energy. This creates a bridge of impact between situations in the international market for oil and several markets in the Philippines. Rising oil prices tend to affect the overall consumer price index (CPI) directly by raising its energy cost component, which includes the prices of energy related items, such as household fuels, motor fuels, gas and electricity. Among these, gasoline and fuel oil are directly derives from crude oil, so their prices follow oil prices very closely. An increase in the price of oil may also affect energy costs through the prices of other items that are close substitutes. The extent to which rising oil prices translate into higher energy costs depends on their persistence. If oil price continue to rise, they may lead to sustained increases in the overall price level, that is, an increase in the overall inflation rate.

If there is depreciation in the exchange rate, this depreciation should cause inflation to increase. Depreciation means the currency buys less foreign exchange, therefore, imports are more expensive and exports are cheaper. Therefore, we get imported inflation. The price of imported goods will go up because they are more expensive to buy from abroad. Cheaper exports increase demand for international exports. Therefore, there is an increase in domestic aggregate demand, and it may get demand pull inflation. Manufacturers who export see an improvement in competitiveness without making any effort. Therefore, depreciation causes both cost push inflation and demand pull inflation (www.economicshelp.org).

For developing countries like Philippines which lack of sufficient amount of oil and energy resources, real exchange rate and real oil prices are important indicators for prices of goods and services and sustainable economic growth rate. The academic accounts focusing on the fluctuation in both factors in the oil exporting and developed countries also show that real oil prices are influential in determining the real exchange rates. In the non-oil exporting-developing countries, real oil price is affected by the fluctuations in the real exchange rate which require changes to the macro-economic policies.

In the face of rising oil prices the balance of payments will worsen as the import bills rises. This effect will be offset by any currency appreciation against the U.S. dollar in which international oil sales are priced. At the same time, there may be other reinforcing import cost increases such as food prices or offsetting benefits from simultaneous increase in the price of export commodities for those countries that are net exporters. It is important to understand the dynamic effect of fluctuations in international crude oil prices to domestic economy through real exchange rate and inflation. It has been widely accepted in the literature that oil prices perform an important role in economic activities, whether in an industrialized developed country or in an emerging market.

Objectives of the Study

The objective of the study is to examine the dynamic relationship among oil price, exchange rate and inflation in the Philippines.

Methodology

Variables and Data Sources

This study used monthly secondary data from March 1983 to February 2013. The following variables was used in this study:

IR_t = inflation rate of the Philippines in peiod t.

WOP_t = world price of crude oil in period t.

ER_t = real exchange rate of the Philippines in period t.

t = monthly observation from March1983 to February 2013.

The real effective exchange rate (PhP:USD) is the weighted average rate under the Philippine Dealing System (PDS) of the Central Bank of the Philippines. The crude oil (Petroleum) is a simple average of three spot prices namely Dated Brent, West Texas Intermediate and the Dubai Fateh. The Crude oil unit is US Dollar per barrel secured from World Bank published by Index Mundi. The inflation rate was taken from the World Bank.

Time Series Analysis

Stationarity test

For this study, the first step in time series analysis is to test for the presence of a unit root through methods of Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests. The DF uses the general regression equation in Enders (1995) expressed as:

$$\Delta y_t = a_o + \gamma y_{t-1} + a_2 t + \epsilon_t \quad (1)$$

where: Δy_t is the first difference of the series y_t, a_o is the intercept or drift term, t is trend component and ϵ_t is the random disturbance term that has an expected value of zero.

If the series at level is found to be nonstationary, differencing proceeds. The number of times d a nonstationary series is differenced to become stationary is called the order of integration denoted by *I(d)*.

Testing for Cointegration: The Johansen Methodology

The existence of a stationary linear combination of nonstationary variables that are integrated of the same order is referred to as cointegration (Enders, 1995). The linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables (EVIEWS Ver. 5.0 Manual). The deviations from the equilibrium must be temporary within any equilibrium structure. Thus, there must be at least one variable in the error correction model that must respond by way of correcting the deviation from the long-run equilibrium or the equilibrium error (Enders, 1995).

Lag Length Determination

To determine the appropriate lag length, choose the model which has the lowest Akaike Information Criterion (AIC) or the Schwartz Bayesian Criterion (SBC). The lag length derived in the estimation of the Vector Autoregressive (VAR) using the data in levels are used in estimating the Vector Error Correction Model (VECM), as well as in determining the cointegrating rank.

Vector Error Correction Model (VECM)

The VECM is a restricted form of VAR. It expresses the short-run changes of the variables in the system as a function of their short-run dynamics (lagged changes) and the long-run dynamics (the error correction term) (Rambaldi *et al.*, 1995). Following Enders (1995), the error correction representation for higher order AR process is of the form:

$$\Delta x_t = \pi_o + \sum_{i=1}^{p-1} \pi_i \Delta x_{t-i} + \pi x_{t-p} + \epsilon_t \quad (2)$$

where: $p =$ predetermined lag length from VAR analysis, $\pi = -\left(I - \sum_{i=1}^{p} A_i\right)$; A_i is a matrix of coefficients of the error correction term, $\pi_i = -\left(I - \sum_{j=1}^{i} A_j\right)$; A_j is a matrix of coefficients of the short-run changes, and $\pi_o =$ an *(n x 1)* vector of intercept terms with element π_{jk} on the *jth* row and *kth* column.

The cointegrating rank r of π in the error correction model is the number of cointegrating relationships or equations in the system. For cointegration to hold, the cointegrating rank must only lie within $0 < r < n$.

Rank and Cointegrating Vector

The next step is to analyze the estimates of the cointegrating vectors normalized with respect to IR and ER. Note that the π in Equation (2) is also equal to $\alpha\beta'$ where α is the matrix of the speed of adjustment parameter of x_t to the previous period's deviation from the long-run equilibrium while β' is the matrix of the cointegrating vectors straightforwardly interpreted as long-run elasticities.

Granger Causality

The Granger causality test is used in determining whether one time series is useful in forecasting another (Granger, C.W.J., 1969 as cited in www.wikipedia.com). To say that X Granger causes Y implies that past values of X could be used for predicting Y (not that Y is caused by X). More technically, a test for causality is a test whether or not the lags of one variable enter into the equation for another variable. Shazam Version 11.0 and EViews Version 5.0 were used for all the estimations needed in the study.

Results***Stationarity Test***

To formally test whether the series is stationary or not, the study used three regression equations of the Augmented Dickey-Fuller test. Results point out that the three series are not significant under mixed process, random walk with a drift and random walk which fails to reject the null hypothesis that these variables contain unit root. Hence, all series are found to be non-stationary. Since the results of the ADF test fails to reject the null hypothesis, differencing was applied to arrive at stationary series. Results point out that the differenced values of the three series are significant under random walk, random walk with a drift and mixed process. Thus, the series are now stationary. Therefore, all variables had an order of integration of 1 or *I(1)*.

The Vector Autoregression analysis was initially performed to determine the lag length p to be used in the cointegration analysis and error correction model. Result revealed inconsistent lag length based on AIC, and SC. This study followed AIC for lag length determination of lag order 14 (1 year and 2 months) since the study used monthly data.

Rank and Error Correction Model

The ranks r of π in the ECM for all of the models were determined to know if long-run relationships or cointegration exist among the variables. All variables contain a unit root, after the first differencing so there is the possibility of cointegration. The Johansen Cointegration test or the Unrestricted Cointegration Rank Trace (λ_{trace}) *and* Maximum Eigenvalue (λ_{max}) tests were used. Hence, we are simply interested in the hypothesis that the variables are not cointegrated $(r = 0)$ against the alternative of having one or more cointegrating vectors $(r > 0)$. Result revealed (Table 1) that the λ_{trace} is greater than the critical value at 5%. This denotes rejection of the null hypothesis that there is no cointegration.

Table 1. Unrestricted Cointegration Rank Test (Trace) results.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic (λ trace)	0.05 Critical Value	Prob.**
None *	0.162628	117.4774	29.79707	0.0000
At most 1 *	0.093370	56.42208	15.49471	0.0000
At most 2 *	0.063866	22.70277	3.841466	0.0000

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Table 2. Unrestricted Cointegration Rank Test (Maximum Eigenvalue).

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.162628	61.05536	21.13162	0.0000
At most 1 *	0.093370	33.71930	14.26460	0.0000
At most 2 *	0.063866	22.70277	3.841466	0.0000

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

This means that the three series of the study are cointegrated. It indicates that IR, ER and WOP have long run relationship with 3 cointegrating equations. Results of the λ_{max} (Table 2) support the results of the aforementioned test. λ_{max} for the at most 2 hypothesis exhibits a greater value than the critical value at 5% level of significance, which also implies the presence of cointegration.

Long-run relationship

To further examine the result of the cointegration test, the study employed the unrestricted Vector Error Correction (VEC) with lag order 14. This is used to determine the coefficients and test the long-run relationship between IR, ER and WOP. It could be recall that the π in Equation (2) is also equal to $\alpha\beta'$ where β' is the matrix of cointegrating vector. This can be straightforwardly interpreted as long-run elasticities. This study estimated two equations for long-run effect, (a) long-run effect of WOP and ER to IR and, (b) the long-run effect of WOP, IR to ER. Estimation of the effect of domestic ER and IR to WOP was not pursued due to the fact that the Philippines is a small country which cannot affect WOP.

Table 3 shows the estimated long-run relationship of the variables. This shows that in the long-run, a unit increase of the world oil price will increase Philippine inflation by 0.31%. While, a unit increase in exchange rate (PhP: USD) (depreciation of peso) will increase inflation rate by 0.42%.

The relationships of these variables are very clear in economic theories. An increase in world oil price will create pressure in the domestic foreign currency market; this pressure will appreciate exchange rate of PhD to USD making imports more expensive. This in turn, causes cost-push inflation. In terms of the long run effect of WOP and IR to ER, results revealed that WOP significantly affects ER. A unit increase in WOP will increase exchange rate (PhP:USD) by 0.73. Inflation rate turn out not significantly affecting exchange rate.

Table 3. Coefficient of the cointegration vector (β') for inflation rate and exchange rate in the Philippines.

Variable	IR	Variable	ER
IR (-1)	1.000000	ER(-1)	1.000000
WOP(-1)	0.308117*	WOP(-1)	0.725680*
	(0.05155)		(0.15898)
ER(-1)	0.424590*	IR(-1)	2.355211^{ns}
	(0.15783)		(1.58422)
C	-0.093165	C	-0.219424

Standard errors in ( ), *significant at 5% level, ^{ns} not significant at 5% level

Granger Causality Test

The Granger causality shown in this study considers all the variables under the null hypothesis of no Granger causality and at 10% significance level. Results are summarized in Table 4. Results revealed that all of the other variables jointly granger cause and individually granger cause inflation rate. This means that both changes in the previous periods of WOP and ER can predict changes in inflation rate. Furthermore, changes in WOP, can be jointly and individually predicted by other variables like changes in previous periods of inflation rate and exchange rate. However, changes in ER cannot be predicted by joint and individual changes in the previous periods of WOP and IR.

Table 4. VEC Granger causality/block exogeneity Wald test

Excluded	Chi-sq	Prob.	Conclusion
Dependent variable: Δ (IR)			
Δ (WOP)	144.5445*	0.0000	ΔWOP→ΔIR
Δ (ER)	21.4594*	0.0904	ΔER→ΔIR
All	180.9055*	0.0000	ΔALL→ΔIR
Dependent variable: D(ER)			
Δ (IR)	12.3292 ^{ns}	0.5799	ΔIR ⊗ΔER
Δ (WOP)	16.6032 ^{ns}	0.2779	ΔWOP⊗ΔER
All	24.2732^{ns}	0.6670	ΔALL⊗ΔER

Null hypothesis of no Granger causality at alpha=10%

Recommendations

Results of the study provide strong empirical evidence on the already known vulnerability of the Philippines to external shocks in the form of oil price fluctuations in the world market. Thus, the following are recommended: (1) the country should maintain manage float exchange rate as the adapted monetary system. This is to manage negative effect of world oil price fluctuations. This can be done by maintaining the anchored policy like inflation targeting. This approach will lessen the transmission mechanism of oil price shock to inflation via exchange rate appreciation. (2)The country should start to explore other alternative form of energy available in the country, though not explicitly examined in the study, to lessen importation of oil and avoid adversity in world oil price uncertainties.

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