

Interest Rate–Exchange Rate Dynamics in the Philippines: A DCC Analysis

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Abstract

This article examines interest rate-exchange rate interaction using dynamic conditional correlation (DCC) analysis, a multivariate GARCH method proposed by Engle (2000). Weekly Philippine data from 1988 to 2000 are used in the study. The results show that the correlation between these variables is far from constant. Structural changes in the correlation structure are largely seen to be the effects of policies or policy responses to exogenous events. The shift in the direction of correlation, observed after the liberalization of the capital markets in 1993, is shown as evidence. Strong positive correlations observed during the two crisis episodes covered by the study present evidence of ineffective interest rate defense of the currency.

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1 Interest rate–exchange rate relation

The relation among macroeconomic asset prices and the factors influencing their movements are of considerable interest to policymakers because of their effects on the real economy. Foremost among these relations is the link between the interest rate and the exchange rate. This has been the subject of extensive examination because it inextricably links the domestic financial markets to the rest of the world. Uncovered interest parity predicts that a depreciation of the domestic currency leads to a decline in the domestic interest rate because of portfolio substitution, given the foreign interest rate and the expected future level of the exchange rate. This is precisely the relationship that policymakers try to exploit when they pursue an active interest rate policy to defend the domestic currency.

In practice, the direction of relation can go either way because of policies themselves or policy responses to some exogenous event. The recent interest in the relationship of the interest rate and exchange rate is due to the observed reversal of the predicted relation in some less developed economies that adopted an interest rate defense of the currency during the Asian Crisis of 1997. Labeled the “perverse effect” by Basurto and Ghosh (2000), the positive correlation between the interest rate and the change in exchange rate brings into question the effectiveness of using the interest rate to manage the exchange rate. This perverse effect is explained as follows: high interest rates lead to bankruptcies that in turn lead to a higher country risk premium; this induces capital flight and leads to subsequent deterioration of the exchange rate. (See also, Furman and Stiglitz, 1998).

This reversal occurs even in non-crisis periods however. Increased capital inflow, for example, leads to appreciation and lower interest rates. When the Philippine capital markets were fully liberalized in 1993, increased capital mobility induced by the liberalization led to inflows of

foreign money that found their way to the stock market. Left unsterilized, capital inflows led to appreciation and declining interest rates.¹

This article examines the interaction of major macroeconomic rates of return through time using Engle's (2000) dynamic conditional correlation (DCC) multivariate GARCH model or DCC model for short. The method estimates the DCC parameters and the time-varying conditional correlations among the returns. The estimates of correlation are used to analyse significant events that occurred during the period covered by the study, as well as the policy responses to these events. Weekly Philippine data on exchange rate depreciation, interest rate and stock return from January 1988 to October 2000 are used.

2 Engle's DCC model

The DCC model proposed by Engle (2000), belongs to the family of multivariate GARCH models. Developments in multivariate GARCH modeling are driven by the need to reduce computational requirements while simultaneously ensuring that covariance matrices remain positive definite through suitable parameter restrictions. As a result, several methods to parameterize multivariate GARCH models have emerged (See Franses and Van Dijk, 2000). DCC modeling is one of these techniques. The DCC model is a generalization of Bollerslev's (1990) constant conditional correlation (CCC) model, an alternative to the computationally-intensive multivariate VEC model and its variants described in Engle and Kroner (1985). Both the DCC and CCC models ride on the success of univariate GARCH models and in fact make use of univariate estimates as inputs in the second of two stages of the estimation process. Univariate parameters obtained in the first stage are used to estimate the DCC parameters in the second stage.

Following Engle (2000), the vector of k asset returns is the demeaned vector, $r_t = r_t' - \mu$, and is assumed to be conditionally multivariate normal:

$$(1) \quad r_t | \Phi_{t-1} \sim N(0, H_t)$$

$$H_t \equiv D_t R_t D_t$$

H_t is the conditional covariance matrix; R_t is the $k \times k$ time varying correlation matrix. D_t is a $k \times k$ diagonal matrix of time varying standard deviations obtainable from univariate GARCH specifications:

$$(2) \quad h_{i,t} = \omega_i + \sum_{p_i} \alpha_{p_i} r_{i,t-p_i}^2 + \sum_{q_i} \beta_{q_i} h_{i,t-q_i} \quad i = 1, \dots, k$$

Dividing each return by its conditional standard deviation, $\sqrt{h_{i,t}}$, one gets the vector of standardized returns, $\varepsilon_t = D_t^{-1} r_t$ where $\varepsilon_t \sim N(0, R_t)$. This may be used to write Engle's specification of a dynamic correlation structure for the set of returns:

$$(3) \quad Q_t = \left(1 - \sum_m \alpha_m^* - \sum_n \beta_n^* \right) \bar{Q} + \sum_m \alpha_m^* (\varepsilon_{t-m} \varepsilon_{t-m}') + \sum_n \beta_n^* Q_{t-n}$$

$$R_t = \tilde{Q}_t^{-1} Q_t \tilde{Q}_t^{-1}$$

\tilde{Q}_t is a diagonal matrix containing the square root of the diagonal entries of Q_t . \bar{Q} is the matrix of unconditional covariances of the standardized returns from the first stage estimation.

Equation (3) is referred to as a DCC(m, n) model.

Engle shows that the loglikelihood of the estimator may be written as:

$$(4) \quad L = -\frac{1}{2} \sum_{t=1}^T \left[k \log(2\pi) + 2 \log |D_t| + \log |R_t| + \varepsilon_t' R_t^{-1} \varepsilon_t \right]$$

The first stage of the estimation process replaces R_t with the $k \times k$ identity matrix to get the first stage likelihood. This reduces (4) to the sum of the loglikelihoods of univariate GARCH equations. The second stage estimates the DCC parameters in (3) using the original likelihood in (4) conditional on the first stage univariate parameter estimates. This estimation procedure and

the theoretical and empirical properties of the estimator are extensively discussed in Engle and Sheppard (2001). The next section estimates a DCC(1, 1) model to track asset price relationships.

3 Data and estimation results

Weekly data on the exchange rate, the 91-day treasury bill rate and the stock market price index from January 1988 to October 2000 were used in this paper. The exchange rate data were obtained from the *Bangko Sentral ng Pilipinas*; the stock price data came from the Philippine Stock Exchange while interest rate data were obtained from the Bureau of Treasury of the Philippines. The exchange rate depreciation (E) and the stock price inflation (S) were computed as 100 times the first difference of the logarithms. The annual treasury bill rate was converted to weekly rates, i.e., $I = [(1 + I_A/100)^{(1/52)} - 1]*100$. Lagrange multiplier tests revealed the presence of ARCH effects at various lags in all variables under study. The study also tested for constant correlation among the returns using Engle and Sheppard's (2001) test. The null of constant correlation, $R_t = R$, for the full sample period was rejected by the test in favor of a time varying correlation matrix.²

Table 1 presents estimates of a DCC(1, 1) model. The last 2 rows of the Table show estimates of the DCC(1, 1) parameters. The left panel of the Table shows the estimate that excludes the stock return. The right panel shows a significant improvement in the t -statistics when it is included. Hence, the subsequent discussion focuses on this result. The other rows show parameter estimates of univariate GARCH(1, 1) models of the individual assets. As can be seen, most of the estimated parameters are statistically significant.

The interest rate, the depreciation rate and their time varying correlation are shown in Figure 1. It is clear from the diagram that significant structural changes in the correlation structure occurred within the sample period. The shaded areas mark bust (or low growth) periods determined in Bautista (2002a) through a three-state univariate Markov regime-switching regression of quarterly GDP growth.³ The first low growth period from the second quarter of 1990 to the third

quarter of 1993 covers the effects of the gulf war, the fiscal crisis and the power crisis in 1992. The second low growth period covers the effects of the 1997 Asian crisis that lasted up to the first quarter of 1999.

The rising trend in the interest rate from 1988 to 1990 can be seen in Figure 1. As observed by De Dios (1993), the government's pump-priming activities that led to growth in the last half of the 1980 decade brought pressure on domestic interest rates as these were financed mainly by domestic borrowings. At the same time, persistent current account imbalances hounded the economy - high import bill added to foreign debt service and sluggish export growth. Active interest rate defense of the currency began in the middle of 1990. On 2 November 1990, a large discrete devaluation of the peso, from 25.75 to 28 pesos per U.S. dollar, took place despite the active interest rate policy. High positive correlation was seen prior to and after the devaluation.

With the high interest rate policy, interest payments on government debt ballooned and a fiscal crisis ensued. To make the fiscal deficit manageable, the government curtailed spending and imposed new taxes. GDP growth stood at 3 percent in 1990 and -0.6 percent in 1991. The recession, prolonged by the 1992 power crisis that crippled several industries, lasted until the middle of 1993.⁴

Full capital account liberalization, achieved by the start of the last quarter of 1993 right after the first low growth period, led to capital inflows that were not sterilized by the monetary authorities. This led to an appreciating currency (from 27.70 pesos per U.S. dollar by the end of 1993 to as low as 23.78 in November 1994) accompanied by declining interest rates (from 15.87 to 9.63 percent, annual rates) and as shown in Figure 1, a positive correlation that was highest in July of 1994. Continued investor confidence resulted in a stable exchange rate and a low interest rate in the mid-90s until the commencement of the 1997 Asian crisis.

On 15 July 1997, a 12 percent peso devaluation reversed the correlation as can be seen in Figure 1. Steep declines in the value of the peso continued until the end of the year. After some time of active defense, Philippine monetary authorities, having gone through several crisis episodes in the past, concluded that not much could be done to reverse the depreciation, and that further raising interest rates by any means is futile. Beginning 1998, the authorities relaxed credit and allowed the interest rate to seek its appropriate level.

The nature and causes of the 1990-93 recession were quite different from this more recent one. The former was viewed by authorities as an internal problem that was within their power to solve. The latter was perceived (though only towards the middle of the crisis period) as a problem with an external origin that was beyond their control. Arguably, the consequences of previous policies that led to the fiscal crisis may have also tempered the interest rate response to the Asian crisis. The reaction of the authorities relative to the magnitude and frequency of depreciation can be compared in Figure 1. In both cases, active interest rate policy to defend the exchange rate was unsuccessful.

Figure 2 shows that the correlation of the stock index and exchange rate is largely negative throughout the sample period except for some weeks in the early 1990s when the capital account liberalization programme was being implemented. The negative relationship became more pronounced during the second crisis and reached peak levels in 1998 at the height of the Asian crisis. No pattern of relationship vis-à-vis events and policies mentioned above is discernible in the correlation between the stock index and the interest rate. This result is not unexpected as policymakers have not clearly designated the stock market as a target of intervention to attain policy objectives.

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Table 1
DCC(1, 1) estimates

Coeff.	Assets: <i>L, E</i>			Assets: <i>L, E, S</i>		
	Estimate	S.E.	T-value	Estimate	S.E.	T-value
ω_l	0.00	0.00	0.05	0.00	0.00	0.05
α_{1l}	0.48	0.25	1.90	0.48	0.25	1.90
β_{1l}	0.52	0.34	1.54	0.52	0.34	1.54
ω_E	0.11	0.08	1.34	0.11	0.08	1.34
α_{1E}	0.13	0.06	2.15	0.13	0.06	2.13
β_{1E}	0.83	0.01	64.53	0.83	0.01	64.70
ω_S				0.50	0.19	2.66
α_{1S}				0.10	0.02	5.24
β_{1S}				0.88	0.00	237.85
α_1^*	0.07	0.04	1.78	0.05	0.02	2.18
β_1^*	0.86	0.07	12.40	0.88	0.06	15.59

Figure 1
Interest Rate, Depreciation Rate and their Correlation

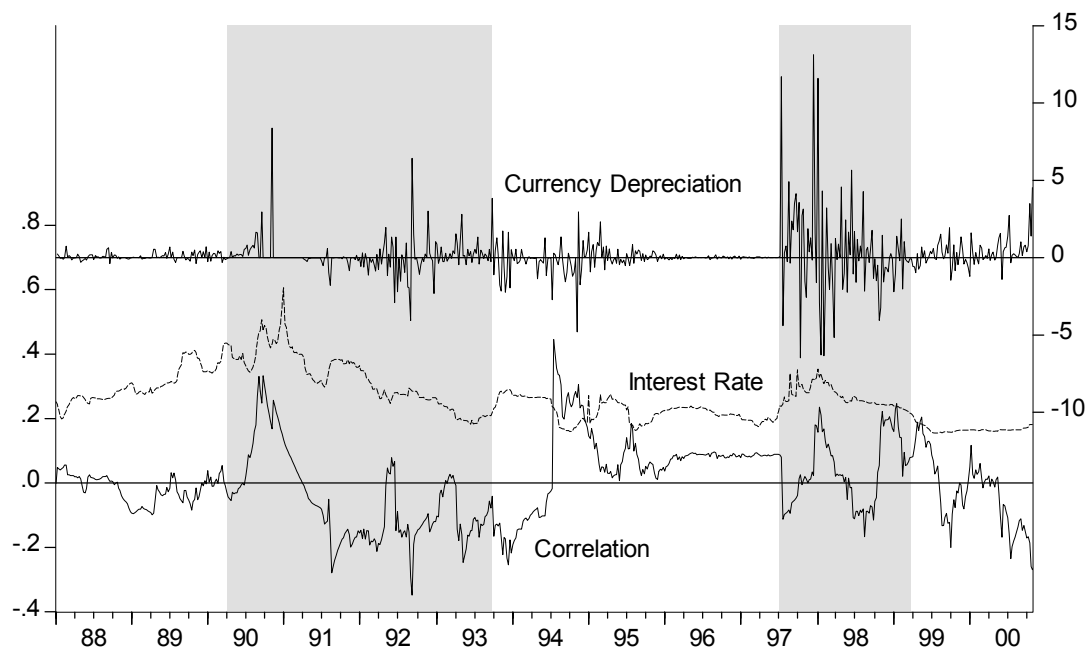
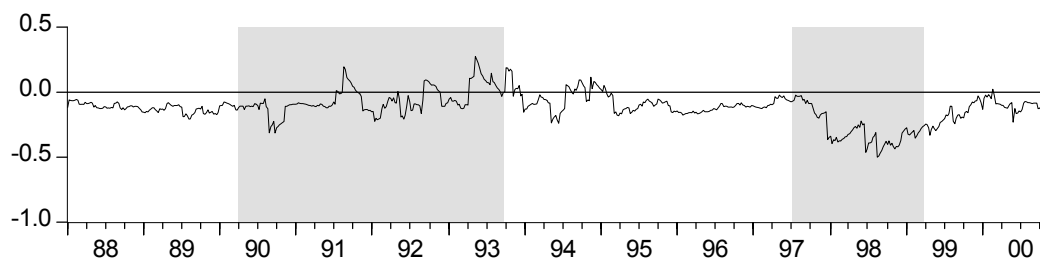


Figure 2
Stock Price Inflation-Depreciation Rate Correlation



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Endnotes

¹ Regardless of the state of the Philippine economy, currency appreciation does not elicit a strong interventionist response from policymakers as a depreciation does. This asymmetric response to exchange rate movements is not surprising because key Philippine manufacturing industries are highly dependent on imported inputs.

² The alternative hypothesis is $vec(R_t) = vec(R) + \gamma_1 vec(R_{t-1}) + \dots + \gamma_p vec(R_{t-p})$. The test procedure which involves a restricted VAR of outer products of standardized residuals is detailed in Engle and Sheppard (2001). The test is implemented in the present study using up to 4 lags in the VAR. The UCSD-GARCH toolbox for MATLAB 6 is used in the test and the estimation.

³ These bust period dates were also used in Bautista (2002b) to analyse stock market volatility in the Philippines.

⁴ After the worst foreign debt crisis in Philippine history in 1983-86, the government embarked on a massive effort to convert national debt from foreign to domestic by reducing dependence on the former; the government also assumed most of private debt. The 1990-93 recession itself brought down interest rates and helped solve the fiscal problem but at the cost of declining output. Welfare effects of the fiscal crisis are discussed in De Dios (1993).