The exchange rate-interest differential relationship in six East Asian countries

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Abstract

This study shows that the real exchange rate-real interest differential relation in six East Asian economies changes with the nominal regime. Positive time-varying correlations characterize the relation during pegged regimes. Correlations are negative during freely falling regimes.

Keywords: dynamic conditional correlation; East Asia; real exchange rate; real interest differential

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1 Introduction

This article examines the relationship between the real exchange rate and the real interest differential in six East Asian countries. While this relationship has been analyzed extensively in developed economies, it has not been studied for developing countries mainly because they continued to peg their currencies to the U.S. dollar as the former opted to float in the early 1970s. Regime shifts have not been uncommon in developing countries however. For a number of them, a change to a floating regime during specific periods of their history was forced because of a foreign exchange crisis. This event marks periods which Reinhart and Rogoff (2004) classify as freely falling regimes. The 1997 crisis that temporarily sent most of the East Asian countries to a freely falling status provides an excellent opportunity to analyze the relationship.

In this study, the relationship is examined in six countries by tracking the correlation of the real exchange rate and the real interest differential from 1986 to 2004 and noting the shifts in the nominal exchange rate regime. The analysis makes use of the dynamic conditional correlation multivariate GARCH model (DCC model henceforth) developed by Engle (2002). For each country, a DCC model is estimated to determine the correlation of the two variables over time. These countries are Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand.

2 Theoretical framework

The model of exchange rate determination (see Dornbusch, 1976) predicts a negative relationship between the real exchange rate and the real interest differential. As shown by Meese and Rogoff (1988), the relation may be derived by using some of the model's building blocks shown in (1), (2) and (3):

$$E_t e_{t+1} - e_t = i_t - i_t^* \tag{1}$$

$$E_t\left(q_{t+1} - \bar{q}_{t+1}\right) = \theta\left(q_t - \bar{q}_t\right) \quad ; \quad 0 < \theta < 1 \tag{2}$$

$$E_t \bar{q}_{t+1} = \bar{q}_t \tag{3}$$

Eq. (1) is the uncovered interest parity condition which states that a country should expect its currency to depreciate as the nominal interest differential between home and foreign country widens. Eq. (2) is a mechanism that shows how the real exchange rate (in logs), $q_t = e_t + p_t^* - p_t$, adjusts toward $\bar{q}_t$, the real exchange rate that would prevail at time *t* if prices were fully flexible. θ is the adjustment parameter. Eq. (3) states that ex-ante purchasing power parity holds under perfect price flexibility.

Substituting (3) in (2) and rearranging yields:

$$q_t = -\alpha\left(E_t q_{t+1} - q_t\right) + \bar{q}_t \quad ; \quad \alpha = \frac{1}{1-\theta} > 1 \tag{4}$$

Next, subtracting the expected inflation differential, $\pi_t - \pi_t^* = \left(E_t p_{t+1} - p_t\right) - \left(E_t p_{t+1}^* - p_t^*\right)$, from both sides of (1) yields:

$$E_t q_{t+1} - q_t = r_t - r_t^* \tag{5}$$

where $r_t = i_t - \left(E_t p_{t+1} - p_t\right)$. An analogous expression holds for r_t^*. Substituting (5) in (4) yields:

$$q_t = -\alpha\left(r_t - r_t^*\right) + \bar{q}_t \tag{6}$$

It is clear from (6) that theory predicts a negative relation. Early empirical tests using developed country data were unable to verify the existence of a relation (see Campbell and Clarida (1987), Meese and Rogoff (1988) and Edison and Pauls (1993).) However, subsequent papers by Baxter

(1994) and Wu (1999) showed evidence of a relationship. Recent studies by Nakagawa (2002) and Kanas (2005) accounted for nonlinearities and obtained more empirical support.

For developing economies that use the exchange rate as a nominal anchor, the objective of a peg is to avoid undesirable price movements, dampen expectations and thereby obviate the need to use interest rates to stabilize prices. One of the main interests of this study is: what is the implication of the result in (6) for the relation in the case where the nominal exchange rate is fixed? The answer can be found by re-writing (6):

$$e_t + p_t^* - p_t = \alpha\left[\left(i_t^* - i_t\right) - \left(E_t p_{t+1}^* - E_t p_{t+1}\right) + \left(p_t^* - p_t\right)\right] + \overline{q}_t$$

If movements in expectations and interest rates are held in check by a fixed exchange rate, then it is clear in the above equation that the real exchange rate moves in the same direction as the real interest differential and that price changes drive this co-movement.

3 The DCC model

Let $\mathbf{r}_t = \left[r_{1,t} \; \ldots \; r_{k,t}\right]'$ be the vector of mean-zero variables in a DCC model (See Engle, 2002). The following set of equations describes the model:

$$\mathbf{r}_t \middle| \mathbf{\Phi}_{t-1} \sim N\left(\mathbf{0}, \mathbf{D}_t \mathbf{R}_t \mathbf{D}_t\right) \tag{7}$$

$$h_{i,t} = \omega_i + \alpha_i r_{i,t-1}^2 + \beta_i h_{i,t-1} \qquad ; \qquad i = 1, \ldots, k \tag{8}$$

$$\boldsymbol{\varepsilon}_t = \mathbf{D}_t^{-1} \mathbf{r}_t \tag{9}$$

$$\mathbf{R}_t = \text{diag}\left(\mathbf{Q}_t\right)^{-½} \mathbf{Q}_t \text{diag}\left(\mathbf{Q}_t\right)^{-½} \tag{10}$$

$$\mathbf{Q}_t = \left(1 - a - b\right)\overline{\mathbf{Q}} + a\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}_{t-1}' + b\mathbf{Q}_{t-1} \tag{11}$$

In (7), $\mathbf{R}_t$ is a k x k matrix of time-varying correlations and $\mathbf{D}_t$ is a diagonal matrix of standard deviations, $\sqrt{h_{i,t}}$, that can be obtained from univariate GARCH models (or from GARCH variants) as in (8). The variables in a DCC model are standardized by dividing them by their respective standard deviations as shown in (9). This standardization permits the specification of the correlation estimator in (10) and (11). $\overline{\mathbf{Q}} = E\left(\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t'\right)$ is the unconditional covariance matrix of the standardized variables. The DCC parameters are estimated through maximum likelihood methods (or quasi-ML methods if variables are not normal) using a two-step procedure described in Engle's paper. Basically, the first step estimates the GARCH parameters in (8) that are in turn used in the second step to estimate the DCC parameters in (11).

4 Data and estimation results

All the monthly data used in this study come from the International Monetary Fund's January 2005 IFS CD-ROM. The study uses the lending rate (IFS line 60p) as the interest rate variable. The foreign country is the U.S. The exchange rate, defined as the domestic currency price of the U.S. dollar, and the wholesale/producer price index (IFS line 63) are used in the study. For this set of variables, the available sample is from September 1986 to August 2004.

ADF tests rejected the unit root hypothesis for ex-post real interest differentials. On the other hand, the null of a unit root could not be rejected for the real exchange rate. The study thus used the first difference of its logarithm, which is stationary. ADF tests with GLS detrending due to Elliott et al (1996) largely confirmed the findings, but with less rejections of the unit root hypothesis. Tests for constant correlation due to Engle and Sheppard (2001) were conducted for the models presented below. In most cases, the null of constant correlation, $R_t = R$, was rejected.[1]

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[1] The alternative is expressed as a VAR of the form $vech(R_t) = vech(R) + \gamma_1 vech(R_{t-1}) + \ldots + \gamma_p vech(R_{t-p})$. Lag lengths from 1 to 12 were specified. It is noted here that the CPI which is normally used as the price variable, performed poorly in the tests for constant correlation and hence, the use of the WPI in the estimation. Because of space constraint, all the tests conducted are not presented here but are available from the author.

Table 1 shows that most of the GARCH and DCC estimates are significantly different from zero. It can be observed in Figure 1 that positive time-varying correlations dominate the relation between the real depreciation rate and the real interest differential in all countries. This result is not inconsistent with the theory discussed in Section 2 and is obtained because, in practice, these countries were in soft peg regimes for a long time prior to the 1997 Asian crisis.

An abrupt change in the correlation structure occurred when the Asian crisis commenced and a shift in the nominal exchange rate regime was forced. In Indonesia where the crisis is greatest and most prolonged, a reversal took place from a long pre-crisis period of positive to negative correlations that continued until February 2003. Correlations also turned negative in other countries but only for very short periods.[2]

It could be observed from the diagrams that pre-crisis correlation patterns were quickly reproduced in most countries after the crisis. In the Philippines, Thailand and South Korea, soft pegging to stabilize the exchange rate was resumed as soon as their currency's free fall ended. Pre-crisis correlation patterns were restored most quickly in the Philippines, the economy least affected by the crisis. Singapore, the only non-crisis economy in the group, did not experience any regime shift. It nonetheless depreciated its currency moderately during the crisis and had the shortest duration of negative correlations. In the case of Indonesia, positive relationships were not immediately re-established after currency attacks in the region ended in 1998. As shown in the diagram, the relation again went negative in mid-2004 after turning positive in most of 2003. This seems to indicate difficulties in stabilizing the exchange rate in the post-crisis era. If the upper limit of perfect positive correlation is taken as an indicator of a fixed rate regime, the results show that the countries did not adopt a hard peg in the post-crisis period except Malaysia. As seen in Figure 1, Malaysia reached near perfect positive correlation after authorities fixed the nominal exchange rate during the post-crisis period to attain exchange market stability. To summarize, the pattern of relationship during the pre-crisis period is clearly different from the post-crisis period only in Indonesia and Malaysia.

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[2] With this result, empirical support for the negative relationship implied by the theory of floating exchange rates is difficult to claim because one of its assumptions, the PPP, can be expected to hold only in the long-run and is not likely to hold during short (and particularly non-normal) periods.

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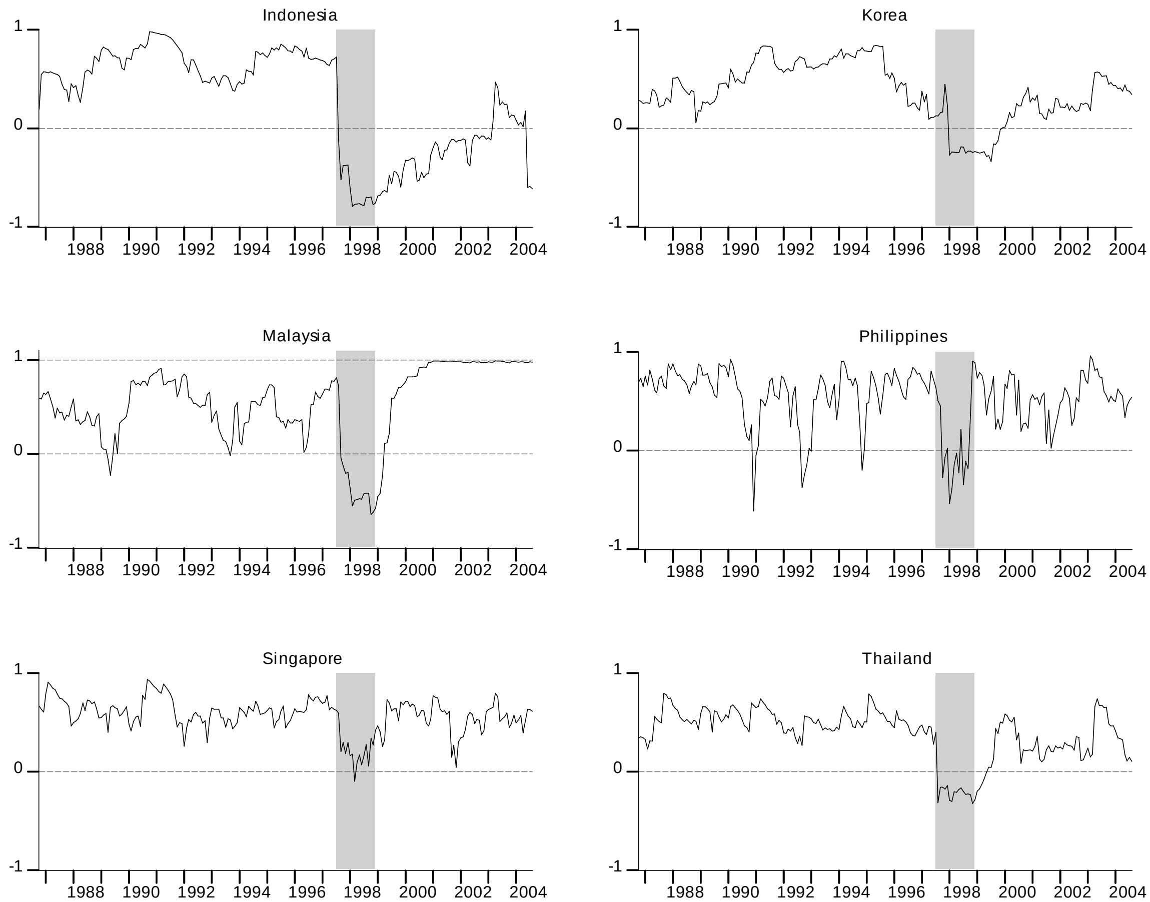
Table 1
GARCH (1, 1) and DCC(1, 1) estimates

	Estimate	T-stat	Estimate	T-stat	Estimate	T-stat
GARCH parameters						
	Indonesia		Korea		Malaysia	
Real depreciation rate						
ω	0.267	1.538	0.513	2.523	0.447	2.514
α	0.404	3.048	0.748	3.572	0.355	2.893
β	0.596	5.943	0.252	1.972	0.558	6.902
Real interest differential						
ω	0.238	1.362	0.457	1.060	0.112	1.153
α	0.558	3.705	0.125	2.066	0.249	2.534
β	0.442	3.110	0.251	0.606	0.695	5.385
	Philippines		Singapore		Thailand	
Real depreciation rate						
ω	0.898	1.721	0.767	0.321	2.147	1.233
α	0.171	2.580	0.564	0.504	0.665	0.763
β	0.730	9.795	0.395	0.323	0.295	0.934
Real interest differential						
ω	2.136	2.512	0.454	2.415	0.546	4.669
α	0.103	1.429	0.569	2.026	0.498	2.348
β	0.068	0.260	0.308	2.103	0.036	0.380
DCC parameters						
	Indonesia		Korea		Malaysia	
a	0.162	5.595	0.101	2.651	0.175	3.781
b	0.825	49.371	0.899	23.139	0.822	17.144
	Philippines		Singapore		Thailand	
a	0.375	1.900	0.176	2.006	0.154	1.954
b	0.458	1.541	0.650	4.703	0.805	16.583

Figure 1: Real interest rate-real exchange rate correlation*



*The shaded portion in the diagrams covers the Asian crisis period from July 1997 to December 1998.