Economics Bulletin

Volume 30, Issue 2

A Note on Short-Run and Long-Run Relationships between Parallel and Official Exchange Rates: The Case of Cambodia

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Abstract

By employing an Autoregressive Distributed Lag (ARDL) approach to cointegration, this paper presents the results of a new empirical study on short-run and long-run relationships between the Cambodian parallel and the official exchange rates. Tests to confirm the stability of the estimated model are conducted. The causality relationships between the parallel and official exchange rates are also examined, by applying the Toda and Yamamoto (1995) approach. From the empirical results, we find that there exists a stable long-run relationship between the two exchange rates in Cambodia. Moreover, the causality tests provide the evidence of the mutual directions between them.

I would like to thank Sovannarith Nget and Socheat Hem of the National Bank of Cambodia (NBC) for their helps on data. The financial supports from the Japan Society for the Promotion of Science (JSPS) are gratefully acknowledged. I also wish to thank Associate Editor, Robert Driskill and an anonymous referee of this journal for their helpful comments. However, all mistakes in this paper are my own responsibility.

Citation: Sovannroeun Samreth, (2010) "A Note on Short-Run and Long-Run Relationships between Parallel and Official Exchange Rates: The Case of Cambodia", *Economics Bulletin*, Vol. 30 no.2 pp. 1044-1053.

Submitted: Jan 05 2010. **Published:** April 21, 2010.

1. Introduction

This paper investigates the short-run and long-run relationships between the parallel and official exchange rates[1] for the case of Cambodia using the Autoregressive Distributed Lag (ARDL) approach to cointegration. We also adopt the Toda and Yamamoto (1995) approach to test the Granger causality between the two variables.

The existence of the parallel market for the exchange rate is widely observed in developing countries because of various factors, such as limited access to official markets for foreign exchange and foreign exchange restrictions on international transactions (Moore and Phylaktis, 2000).[2] The information on long-run relationship between the parallel and official exchange rates is very important for both policy makers and financial agents for managing the exchange rate risks (Caporale and Cerrato, 2008). As a result, many researchers have investigated the relationship between the parallel and official exchange rates for the cases of developing countries (Booth and Mustafa, 1991; Agénor, 1992; Agénor and Taylor, 1993; Baghestani and Noer, 1993; Bahmani-Oskooee and Goswami, 2004; Moore and Phylaktis, 2000; Diamandis and Drakos, 2005; Love and Chandra, 2007; Caporale and Cerrato, 2008).

Prior to this study, Joyex and Worner (1998) conduct a study on the relationship between parallel and official exchange rates for the period of 1991:01 to 1997:04 for the case of Cambodia. They find that the Cambodian parallel and official exchange rates are cointegrated. However, our study here provides new evidence for a longer period of time by using a relatively new method of cointegration analysis, namely, the ARDL approach. We also conduct stability tests, CUSUM (Cumulative Sum) and CUSUMSQ (CUSUM of Squares) of the recursive residuals. The causality relationship between the parallel and official exchange rates, which is not investigated in Joyeux and Worner (1998), is examined as well because the information on the causality direction is useful for policy implications. We apply the Toda and Yamamoto (1995) approach to the causality test method.

The structure of this paper is organized as follows. Section 2 presents the estimation methodology. Section 3 provides the empirical analysis and Section 4 is the conclusion.

2. Estimation Methodology

Our estimation model can be expressed as logarithmic version below.

$$\ln PE_t = \alpha_0 + \alpha_1 \ln OE_t + \varepsilon_t , \tag{1}$$

[1] In many studies, the parallel market exchange rate is referred to as the black market exchange rate.
[2] See also Agénor (1992) for a detailed review.

where PE is the parallel exchange rate (Cambodian Riel per US dollar); OE represents the official exchange rate (Cambodian Riel per US dollar); and ε is the error term.

For the estimation, we use the cointegration technique. There are several cointegration approaches, such as the residual-based approach proposed by Engle and Granger (1987) and the maximum likelihood-based approach proposed by Johansen and Juselius (1990). However, we adopt the approach proposed by Pesaran *et al.* (2001), which has been shown to have advantages over the previous two approaches.[3]

The estimation Equation (1) can be written as unrestricted error correction representations of the ARDL model below.

$$\begin{aligned}\Delta \ln PE_t = constant + \sum_{i=1}^{n} \gamma_{1i} \Delta \ln PE_{t-i} + \sum_{i=1}^{n} \gamma_{2i} \Delta \ln OE_{t-i} \\ + \lambda_1 \ln PE_{t-1} + \lambda_2 \ln OE_{t-1} + \eta_t\end{aligned}, \quad (2)$$

where η is the error term.

As the analysis procedure, first, the existence of the long-run relationship between the variables in the system is tested: the null hypotheses of no cointegration, $H_0 : \lambda_1 = \lambda_2 = 0$, are tested against its alternatives, $H_1 : \lambda_1 \neq 0, \lambda_2 \neq 0$. If the computed F-statistic is higher than the appropriate upper bound of the critical value, provided in Pesaran and Pesaran (1997) and Pesaran *et al.* (2001), the null hypothesis of no cointegration is rejected. If it is lower than the lower bound, the null hypothesis cannot be rejected. Whereas, if it lies within the criteria bands, the result is inconclusive. In the second step, the lag lengths of the variables are chosen using Akaike Information Criteria (AIC). The short-run and long-run results are reported in this step. The stability tests, namely, the CUSUM (Cumulative Sum) and CUSUMSQ (CUSUM of Squares) of the recursive residuals are also conducted.

Following the Toda and Yamamoto (1995) approach, we examine the causality relationship between the two exchange rates. We adopt this approach because, as mentioned in Zapata and Rambaldi (1997) and Awokuse (2005), it reduces the potential bias caused by the unit root and cointegration pre-tests.

To conduct this approach, we have to determine the optimal lag length (k) of the VAR (Vector Autoregression) system and the maximum order of integration ($d_{\max}$) of the variables in consideration. Then, we conduct the analysis of $VAR(k + d_{\max})$ using seemingly unrelated regressions (SUR). The estimation models can be specified as the following equations.

[3] For a detailed explanation of the advantage of the ARDL approach, see Pesaran and Pesaran (1997) and Pesaran *et al.* (2001).

$$\ln PE_t = \theta_0 + \sum_{i=1}^{k+d_{\max}} \theta_{1i} \ln PE_{t-i} + \sum_{i=1}^{k+d_{\max}} \theta_{2i} \ln OE_{t-i} + u_t , \qquad (3)$$

$$\ln OE_t = \vartheta_0 + \sum_{i=1}^{k+d_{\max}} \vartheta_{1i} \ln OE_{t-i} + \sum_{i=1}^{k+d_{\max}} \vartheta_{2i} \ln PE_{t-i} + v_t , \qquad (4)$$

where u and v are error terms. The Granger causality inference, based on the Toda and Yamamoto approach, obtained by using the Wald tests for zero restrictions on θ_{2i} (for $\forall i \le k$) in Equation (3) and ϑ_{2i} (for $\forall i \le k$) in Equation (4). If $H_0 : \theta_{2i} = 0$ (ϑ_{2i}=0), for $\forall i \le k$, is rejected, we can conclude that the official exchange rate (parallel exchange rate) granger causes the parallel exchange rate (official exchange rate).

3. Empirical Analysis

3.1. Data

Monthly data are used in our analysis. The sample period is from January 1993 to December 2008. The data of the period average of the official exchange rate, measured as the Cambodian Riel per US dollar, are obtained from International Financial Statistics (IFS) published by the International Monetary Fund (IMF). The data for the period average of the parallel market exchange rate are obtained from Economic and Statistic Research Department of the National Bank of Cambodia (NBC).

3.2. Estimation Results

F-statistics results are presented in Table 1 with various lag lengths on the first difference variables in Equation (2). The table indicates that, except for a few cases of lag length, there is evidence supporting the long-run or cointegration relationship between the parallel and official exchange rates, since the computed F-statistics are higher than the upper bounds of the critical values, in most lag length cases.

Given the evidence of cointegration existence, in the next step, we estimated Equation (2) based on the ARDL approach. By setting the maximum lag length to 6, the AIC-based ARDL recommends the results of ARDL(2,4).[4]

[4] This maximum lag setting helps saving the degree of freedom for econometric analysis as our sample size is quite small.

Table 1: F-statistics of the Bound Tests, 10% CV [3.182, 4.126], 5% CV [3.793, 4.855], 1%CV [5.288, 6.309]

Lag orders	**1**	**2**	**3**	**4**	**5**	**6**
F-statistics	3.143	6.485***	4.503*	13.502***	3.469[a]	1.165
Lag orders	**7**	**8**	**9**	**10**	**11**	**12**
F-statistics	5.813**	2.269	2.191	3.749[a]	6.069**	6.271**

Notes: 1. The asterisks *** and ** are 1% and 5% of the significant levels, respectively.
2. "[a]" denotes that the value lies between the CV bands.

Table 2: The Error Correction Representation for the Selected ARDL Model (Dependent variable: $\ln PE$).

Variables	**AIC-based ARDL(2,4)**
$\Delta \ln PE_{t-1}$	-0.227 (0.049)***
$\Delta \ln OE_{t}$	1.119 (0.025)***
$\Delta \ln OE_{t-1}$	0.189 (0.056)***
$\Delta \ln OE_{t-2}$	0.058 (0.019)***
$\Delta \ln OE_{t-3}$	-0.044 (0.016)***
$Constant$	0.105 (0.023)***
EC_{t-1}	-0.619 (0.072)***
$\bar{R}^2$	0.933
DW-statistic	2.007
SE of Regression	0.006
$EC_{t-1} = \ln PE_{t-1} - 0.980 \ln OE_{t-1} - 0.169C$	
Serial Correlation: F(12, 166)= 0.684[0.765]	
Functional Form: F(1, 177)= 0.221[0.638]	

Notes: 1. *, ** and *** are respectively the 10%, 5% and 1% of the significant level.
2. The numbers in parentheses are the standard errors.
3. The numbers in the brackets are the p-values of the test.

The results of the short-run estimation, or error correction representations, are illustrated in Table 2. They indicate that the error correction term (EC_{t-1}) is statistically significant with the correct sign, providing the evidence of cointegration relationship between the parallel and official exchange rates. The absolute values of the coefficient of the EC_{t-1} is high, indicating the high speed of adjustment to the long-run equilibrium, following short-run shocks. Table 2 also presents the diagnostic tests. The tests indicate that the estimation passes the functional form test, rejecting the misspecification problem.

Table 3: Long-Run Estimation Results
(Dependent variable: $\ln PE$)

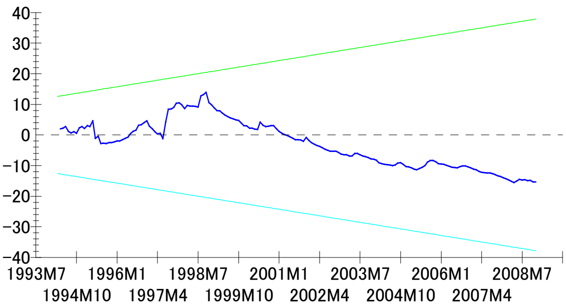
Variables	AIC-based ARDL(2,4)
$\ln OE$	0.980 (0.003)***
Constant	0.169 (0.030)***

Notes: 1. The asterisks *** and ** are the 1% and 5% of significant levels, respectively.
2. The numbers in parentheses are the standard errors.

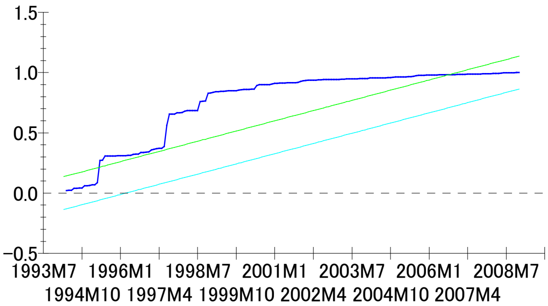
In Table 3, the long-run estimation results are reported. The estimated coefficient of $\ln OE$ is statistically significant, supporting the evidence of a long-run relationship between the parallel and official exchange rates.

The stability tests, CUSUM and CUSUMSQ, in Figure 1, illustrate that based on the CUSUM test, the estimated model is stable, where there are some signs of instability based on the CUSUMSQ test. However, the plot of the CUSUMSQ statistics completely returns back to inside the criteria bands, indicating that the estimated model is roughly stable.

Figure 1: CUSUM and CUSUMSQ Stability Tests



The straight lines represent critical bounds at 5% significance level



The straight lines represent critical bounds at 5% significance level

To certify the direction of causality, we conduct a causality test using the Toda and Yamamoto (1995) approach. As mentioned previously, the optimal lag length (k) and the order of the integration ($d_{\max}$) of the variables in the system have to be determined.

Table 4 provides the results of optimal lag selection based on various criteria. Although they indicate mixed results of optimal lag selection, two criteria, the AIC and the Final Prediction Error (FPE), select 6 as the optimal lag. Therefore, we obtain $k = 6$. To determine the order of integration of the variables, we employ the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test proposed by Kwiatkowski *et al.* (1992), whose null hypothesis is that the variable is stationary. The results of the KPSS unit root tests are provided in Table 5. The table points out that, for level case, the null hypotheses of being stationary are rejected for both the parallel and official exchange rates; however, for first difference case, they are not rejected. These results imply that the parallel and official exchange rates are stationary at first difference or they are I(1); thus, we obtain $d_{\max}=1$.

Table 4: Vector Autoregression (VAR) Lag order Selection Criteria

Endogenous Variables: $\ln PE$, $\ln OE$

Lag Orders	LogL	LR	FPE	AIC	SC	HQ
0	728.6166	NA	1.07E-06	-8.073518	-8.03804	-8.059133
1	1229.965	985.9859	4.25E-09	-13.59961	**-13.49318***	-13.55646
2	1237.338	14.3362	4.10E-09	-13.63709	-13.4597	**-13.56517***
3	1241.247	7.512936	4.10E-09	-13.63607	-13.38773	-13.53538
4	1249.023	14.77545	3.93E-09	-13.67804	-13.35874	-13.54858
5	1251.133	3.961071	4.02E-09	-13.65703	-13.26678	-13.4988
6	1257.556	11.91795	**3.91e-09***	**-13.68395***	-13.22275	-13.49695
7	1260.262	4.962283	3.97E-09	-13.66958	-13.13742	-13.45381
8	1263.737	6.293547	3.99E-09	-13.66375	-13.06063	-13.41921
9	1266.392	4.749294	4.06E-09	-13.6488	-12.97473	-13.3755
10	1268.551	3.813309	4.14E-09	-13.62834	-12.88332	-13.32626
11	1273.845	9.236249	4.09E-09	-13.64272	-12.82675	-13.31188
12	1279.734	**10.14209***	4.00E-09	-13.66371	-12.77678	-13.3041

Notes: 1. * indicates lag order selected by the criterion.
2. LR: sequential modified LR test statistic (each test at 5% level).
3. FPE: Final prediction error
4. AIC: Akaike information criterion
5. SC: Schwarz information criterion
6. HQ: Hannan-Quinn information criterion

Table 5: KPSS Unit Root Test

	Level		First Difference	
	Intercept	Trend and Intercept	Intercept	Intercept and Trend
$\ln PE$	1.301***	0.281***	0.159	0.051
$\ln OE$	1.357***	0.322***	0.225	0.039

Notes: 1. KPSS unit root test has the nulll hypothesis of stationary.
2. *** denotes the rejection of the null hypothesis at 1% level.

Having obtained the information on the optimal lag length and the integration order of the variables in consideration, we can conduct the Toda and Yamamoto (1995)-based Granger causality tests. The results are reported in Table 6. From the table, we can see that the null hypotheses in both equations are rejected, indicating the bi-directional causality link between the parallel and official exchange rates.[5]

Table 6: Granger Causality Test based on the Toda and Yamamoto (1995) Approach

Null Hypothesis (H_0)	$\chi^2(6)$	p-value	Result
$\ln OE$ does not Granger cause $\ln PE$	28.812	0.000	Reject H_0
$\ln PE$ does not Granger cause $\ln OE$	62.109	0.000	Reject H_0

4. Conclusions

This paper contributes to the literature on exchange rate economics by conducting an empirical study on short-run and long-run relationships between the parallel and official exchange rates using the Autoregressive Distributed Lag (ARDL) approach to cointegration on the case of Cambodia. Furthermore, unlike previous studies, the stability and causality tests are also conducted.

From the results of the ARDL approach to cointegration and the stability tests, we find the existence of the stable cointegration or long-run relationship between the parallel and official exchange rates in Cambodia. In addition, unlike many other developing countries, causality tests indicate a mutual causality relationship between the two exchange rates for the case of Cambodia.

[5] In many other developing countries, only the unidirectional causality links between the two rates are confirmed (Agénor and Taylor, 1993 and Bahmani-Oskooee and Goswami, 2004).

References

[1] Agénor, P. (1992) “Parallel currency markets in developing countries: theory, evidence, and policy implication” IMF working paper WP/90/114.

[2] Agénor, P., and M. P. Taylor (1993) “The causality between official and parallel exchange rates in developing countries” *Applied Financial Economics* **3**, 255-266.

[3] Awokuse, T. O. (2005) “Exports, economic growth and causality in Korea” *Applied Economics Letters* **12**, 693-696.

[4] Bahmani-Oskooee, M., and G. Goswami (2004) “Long-run nature of the relationship between the black market and the official exchange rates” *Economic System* **28**, 319-327.

[5] Baghestani, H., and J. Noer (1993) “Cointegration analysis of the black market and official exchange rates in India” *Journal of Macroeconomics* **15**, 709-721.

[6] Booth, G. G., and C. Mustafa (1991) “Long-run dynamics of black and official exchange rates” *Journal of International Money and Finance* **10**, 392-405.

[7] Caporale, G. M., and M. Cerrato (2008) “Black market and official exchange rates: long-run equilibrium and short-run dynamics” *Review of International Economics* **16**, 401-412.

[8] Diamandis, P. F., and A. A. Drakos (2005) “Long-run dynamics of official and black-exchange rates in Latin America” *Global Finance Journal* **15**, 219-237.

[9] Engle, R. F., and C. W. J. Granger (1987) “Co-integration and error correction: representation, estimation, and testing” *Econometrica* **55**, 251-276.

[10] Johansen, S., and K. Juselius (1990) “Maximum likelihood estimation and inference on cointegration--with applications to the demand for money” *Oxford Bulletin of Economics and Statistics* **52**, 169-210.

[11] Joyeux, R., and W. E. Worner (1998) “Price and exchange rate determination between the Mekong river economies of Cambodia and Thailand” *Journal of Asia Pacific Economy* **3**, 424-445.

[12] Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., and Y. Shin (1992) “Testing the null hypothesis of stationary against the alternative of a unit root: How sure are we that economic time series have a unit root?” *Journal of Econometrics* **54**, 159-178.

[13] Love, J., and R. Chandra, (2007) “The relationship between the black market and official exchange rates: an examination of long-run dynamics in India” *Scottish Journal of Political Economy* **54**, 283-294.

[14] Moore, M., and K. Phylaktis (2000) “Black and official exchange rates in the Pacific Basin: Some tests of dynamic behaviour” *Applied Financial Economics* **10**, 361-369.

[15] Pesaran, M. H., and B. Pesaran (1997) *Microfit 4.0 (Window Version).* New York: Oxford

University Press.
[16] Pesaran, M. H., Shin, Y., and R. J. Smith (2001) "Bounds testing approaches to the analysis of level relationships" *Journal of Applied Econometrics* **16**, 289-326.
[17] Toda, Hiro Y., and T. Yamamoto (1995) "Statistical inference in vector autoregressions with possibly integrated process" *Journal of Econometrics* **66**, 225-250.
[18] Zapata, H. O., and A. N. Rambaldi (1997) "Monte Carlo evidence on cointegration and causation" *Oxford Bulletin of Economics and Statistics* **52,** 285-298.