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Determinants of Angola's Parallel Market Real Exchange Rate

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Abstract

The paper estimates Angola's equilibrium parallel market real exchange rate during the 1992–98 period. Using standard integration/co-integration techniques, the results fail to support the purchasing power parity hypothesis and indicate that two exogenous variables—the price of oil and the foreign interest rate—are able to explain most of the variation in the real exchange rate during the last seven years. These results contrast with the tenet that the parallel market exchange rate in Angola is solely influenced by monetary developments.

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I. INTRODUCTION

The purchasing power parity (PPP) hypothesis is often used in assessing a particular level of exchange rate or the adequacy of an exchange rate policy. However, in countries where the real exchange rate is likely to be affected by real factors, PPP becomes a less useful tool, whereas obtaining an estimate of the equilibrium real exchange rate could be beneficial. This paper conducts an empirical examination of Angola's parallel market real exchange rate during the 1992–98 period. We test the PPP hypothesis and then assess the influence of two key variables on the parallel market real exchange rate: the price of oil and the world interest rate.

We study the parallel market rate because Angola's official market exchange rate has been traditionally distorted by unsustainable fixed exchange rates and a highly regulated environment.[2] There has been no direct central bank intervention in the parallel market, while the official market has been mainly used for channelling oil export revenues toward essential imports. High inflation and a number of balance of payments crises have prompted several devaluations of the official exchange rate.[3] As a result, there has been a large and volatile discrepancy between the parallel and the official exchange rates.

The paper is divided into five sections. Section II describes the theoretical framework, and Section III examines the time-series properties of the data and reports on the testing of the PPP hypothesis. Section IV discusses the time-series properties of the real exchange rate equation and examines the speed of convergence to the steady state. Section V contains concluding remarks.

II. THEORETICAL BACKGROUND

For decades, the PPP hypothesis has remained a focal point of policy discussions, models, and empirical work. The hypothesis posits an underlying tendency for changes in the nominal exchange rate to be fully offset by changes in the ratio of foreign to domestic price levels, thus implying that the real exchange rate should be mean-reverting. Empirical studies have produced some evidence in favour of the hypothesis, but the speed of convergence of the

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[2]Until May 24, 1999, the central bank set the official exchange rate but was not able to deliver the amount of foreign exchange demanded at that rate, leading to rationing of official reserves. In addition, most trade and invisible transactions were subject to surrender requirements and prior approval by the central bank. On May 24, 1999, the central bank stopped setting the official exchange rate, leading to the virtual unification of the foreign exchange market. During the 1992–98 period, the parallel market exchange rate was, on average, 2.9 times higher than the official rate.

[3] High correlations among changes in the money supply, domestic prices, and the nominal parallel market rate have been observed in a sample with a small number of observations (Ferrari, 1998).

actual exchange rate to its PPP level has been found to be very slow, with half-lives of four years or more.[4] Such a slow convergence has been attributed to nominal price rigidities, either related to price-wage stickiness or to market segmentation and pricing-to-market policies. A well-known blend of PPP with the monetary model posits that, since nominal rigidities prevent a quick adjustment of prices and wages in goods markets, monetary innovations are the cause of the temporary deviations from PPP (Dornbusch, 1976). In studies of high-inflation episodes, there is evidence that PPP holds in shorter time horizons, as movements in prices appear to dominate other factors that could lead to deviations from PPP (Zhou, 1997).

Another group of researchers views the deviation of actual rates from PPP as a more permanent phenomenon, suggesting the importance of understanding that real exchange rate movements might be caused by changes on the real side of the economy (e.g., Stockman, 1988; and Neary, 1988). These types of models vary depending on the main factors that are considered as affecting the real exchange rate. Models based on productivity differentials have been highlighted by Balassa (1964) and Samuelson (1964), while Marston (1987) and Chinn and Johnson (1996) have looked at the effect of real interest rate differentials and demand shocks, respectively. Exogenous changes in the terms of trade are also seen as an important determinant of real exchange rate behaviour (Edwards, 1994; Ostry, 1988).

Developing or rapidly transforming countries are regarded as those where real exchange rates are subject to changes over time, although the extent to which different shocks affect their behavior depends on country-specific factors. Based on the fundamental equilibrium exchange rate (FEER) approach originally proposed by Williamson (1983), the model presented below posits a time-varying real exchange rate as the equilibrating variable counteracting shocks to the basic balance.[5] The concept of external balance is defined here as a zero level in the basic balance (i.e. the balance on the current account balance plus long-term capital inflows):

$$\overline{BB} = g(r, \bar{q}, oil) = 0 \tag{1}$$

where a bar over a variable signals its level consistent with external balance, BB is the basic balance, oil is the world price of oil, q is the real exchange rate, and r is the real foreign

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[4]See, for instance, Phylaktis and Kassimatis (1994) and MacDonald (1995).

[5] The FEER essentially embodies a medium-run current account theory of exchange rate determination. The use of the basic balance in the definition of external balance is essentially the same as using a medium-term equilibrium concept of the current account where the latter becomes equal to the desired or target rate of accumulation of net long-term foreign assets (see, for instance, Faruquee, 1994). The model used here does not address the issue of internal balance.

interest rate.[6] The real exchange rate is defined as the nominal exchange rate (units of domestic currency per unit of foreign currency) times the foreign price level divided by the domestic price level. The world price of oil is a key determinant of export revenue in Angola. The volume of imports is assumed to be negatively related to the real exchange rate. It is further assumed that foreign prices and interest rates are exogenous, and that oil output is not consumed at home. These assumptions are well suited to Angola: the country is a price taker in world markets, 95 percent of the oil produced is exported, and the domestic consumption basket consists of imported and nontradable domestic goods. The foreign real interest rate enters the equation on account of its impact on the service balance and, possibly, on cross-border direct foreign investment.[7] Equation (1) implies that terms of trade shocks and changes in the foreign interest rate will require an adjustment in the real exchange rate (q) to restore the basic balance to zero.[8]

Following the basic balance condition in equation (1) (i.e., $\overline{BB} = 0$), the equilibrium real exchange rates can then be derived as:

$$\overline{q} = z(r, \ oil) \tag{2}$$

Equation (2), therefore, asserts that Angola's equilibrium real exchange rate is a function of the price of its major export, oil, and the foreign interest rate. An increase in the price of oil improves the current account, and a real exchange rate appreciation would be required to restore external balance via an increase in imports. Similarly, an increase in foreign interest rates leads to a rise in debt-service payments and a worsening of the current account, thus requiring a real exchange rate depreciation to restore external balance.

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[6]Lack of data on other potential determinants of the real exchange rate including output developments in the oil sector and the destruction of productive capacity in the non-oil sector preclude the inclusion of these variables in the analysis.

[7]A large part of Angola's external debt is guaranteed with oil at market interest rates plus a premium, implying that changes in foreign interest rates have a direct impact on the balance of payments. Similarly, changes in the foreign interest rate could affect direct foreign investment flows through their effect on investment projects' internal rates of return. However, foreign exchange restrictions isolate Angola's financial system from the rest of the world, which suggests that the traditional role ascribed to trade in financial assets is not relevant here.

[8] In other words, stock equilibrium is not required, and the current account need not necessarily equal zero. This approach is essentially consistent with a given rate of accumulation of net foreign debt d that reflects, for instance, the country's long-term investment opportunities. For given values of the price and output of oil, the foreign interest rate, and the stock of net foreign assets, the equilibrium level of the real exchange rate is the one that makes the current account equal to $-d$.

A testable linear specification of the exchange rate equation, therefore, can be expressed as:

$$\bar{q} = \beta_1 r + \beta_2 oil + \beta_3 + \epsilon \qquad (3)$$

where βs are parameters and β_3 represents a constant term. As an equilibrium concept, Equation (3) can be statistically valid if the data support the existence of co-integration in the specification. This implies that each variable ($\bar{q}$, r, and oil) follows a non-stationary process and that ϵ, the residual, follows a stationary process.

III. DATA ANALYSIS

The data, obtained from the National Bank of Angola and the World Economic Outlook database, cover the January 1992–December 1998 period. No data is available for an earlier period. The real exchange rate (q) is calculated as the bilateral parallel market exchange rate of the readjusted kwanza[9] vis-à-vis the U.S. dollar times the U.S. consumer price index and divided by the domestic consumer price index. Only U.S. data is used since more than 50 percent of Angola's trade is with the United States and the U.S. is the main source of foreign investment in the country. Thus, an increase in q represents a real depreciation of the domestic currency. The world price of oil is a composite of Brent, Dubai, and Texas intermediate oil prices. The real interest rate (r) is constructed by deflating the ten-year U.S. bond rate by a 12-month moving average of U.S. inflation rates.[10]

The time-series properties of each variable are examined using a standard augmented Dickey-Fuller (ADF) test, and results and details of the test are summarized in Table 1. Statistics to examine the null hypothesis that the variables are integrated of order one, I(1), against the alternative of stationarity, are provided besides the respective variables in levels; and statistics examining the null of I(2) against I(1) are displayed next to the differenced variables. Our study considers two cases involving different combinations of the deterministics—the time trend and/or the constant. The results lead to the conclusion that all the time-series are I(1), which therefore allows us to analyze the equilibrium properties of the real exchange rate equation. Since the long-run or equilibrium concept of PPP requires that the real exchange rate be stationary, our finding that the real exchange rate has a unit root over the 1992-98 period implies that PPP is not a useful benchmark to assess the level of the real exchange rate in Angola.[11]

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[9] Official denomination of Angola's currency as of May 1999.

[10] MacDonald and Nagayasu (1999), for instance, find that longer-term interest rates are more relevant in a long-run or equilibrium study.

[11] These results are consistent with findings from other individual African countries (Nagayasu, 1998). The non-rejection of the unit root for the real exchange rate in this study may be partly due to a short sample period.

IV. TIME-SERIES PROPERTIES OF THE REAL EXCHANGE RATE EQUATION

This section tests empirically whether a statistically significant relationship exists in equation (3) using the multivariate co-integration method of Johansen (1988). The method is based upon the maximum likelihood algorithm. Consider a standard unrestricted vector autoregression (VAR) with k lags, in which the $(p \times 1)$ vector of endogenous variables, x, is assumed to follow an I(1) process:

$$x_t = \sum_{i=1}^{k} \Pi_i x_{t-i} + \epsilon_t \tag{4}$$

where $E(\epsilon_t)=0$, $E(\epsilon_t \epsilon'_{t-1})=0$, $E(\epsilon_t \epsilon'_t)=\Omega$ ($\Omega=\omega_{ij}$) and $t = 1, ..., T$. Johansen (1988) developed an analytical model in which the existence of co-integration can be examined by re-parametizing the above equation as:

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \epsilon_t \tag{5}$$

where $\Pi = \sum_{i=1}^{k} \Pi_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{k} \Pi_j$. The null hypothesis of non co-integration against the alternative of existence of co-integration can be analyzed by examining the rank (m) of Π. A value of m greater than unity ($1 \leq m < p$) suggests that there is at least one co-integrating vector. This, in turn, suggests the existence of an error-correction model. However, if m equals zero, the existence of an equilibrium relationship cannot be proved. The null hypothesis of this test can, by decomposing Π into two matrices (α and β) of dimension ($p \times m$), be summarized, as

$$H(r): \quad \Pi = \alpha \beta'. \tag{6}$$

The term α is an adjustment coefficient that measures the speed of adjustment to the equilibrium path, and β is the cointegrating vector. A linear combination of βx, which represents a disequilibrium condition, must be stationary. In order to evaluate hypothesis (6), we use two types of likelihood ratio test statistics, namely, the maximum eigenvalue (λ) and the trace statistics. Finally, in order to find a solution for I(1) variables, the condition that $\alpha'_\perp \Gamma \beta_\perp$ has a full rank must hold.[12]

Our unrestricted VAR consists of three endogenous variables, with 12-period lags: q_t, r_t, and oil_t, and the constant term. The appropriateness of the specification is examined using conventional autocorrelation and normality tests applied to the VAR (Table 2). The results suggest that our VAR specification captures well the data-generating process of the time series. The Johansen test results show that our analysis, based on the above VAR specification, provides support for the existence of more than one statistically significant co-integration. Both maximum eigenvalue and trace statistics reject the null hypothesis of non

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[12] If this condition is not met, there is some possibility that the time series may well be co-integrated of an order higher than one (see Johansen 1995, for example).

co-integration (Table 2), implying that the exchange rate specification is valid as an equilibrium condition. In fact, our statistics strongly suggest that there are two significant relationships.

Further supportive evidence for our specification is reported in Table 3. The most significant co-integrating vector can be normalized as the real exchange rate equation:
q = 1.664 + 0.626 r - 2.267 oil. The rationale for the choice of this vector as the exchange rate equation is based on the fact that our theoretical model suggests that this specification of the exchange rate is appropriate. The estimates imply that Angola's real parallel exchange rate is a negative function of the price of oil and a positive function of foreign interest rates. At the same time, the parameters of these de-terminants are found to be significantly different from zero when using the likelihood ratio test. These results are consistent with the predominance of oil in Angola's exports and its external position as a net debtor vis-à-vis the rest of the world. Furthermore, the first column of the adjustment coefficients (α) is found to be $\alpha_1 = [-0.193, 0.791, 0.053]'$. The negative sign of the first coefficient provides some evidence that the most significant co-integrating vector is the one that corresponds to the exchange rate.

The actual and estimated equilibrium real parallel exchange rates can be seen in Figure 1. The actual parallel market rate revolves quite closely around the estimated equilibrium path during the sample period, and any difference between these two rates tends to narrow very quickly. One simple way to calculate the speed of convergence is to use the estimated adjustment coefficient ($\alpha = -0.193$). The time profile (j) required for a shock to reduce to the half level can be calculated as $j = \ln(0.5)/\ln(1 + \alpha)$. Our estimated adjustment coefficient implies that half of the effects of a shock are reversed in 3.2 months. Compared with the speed of convergence in other PPP studies which examine the mean reverting property of the real exchange rate, the much faster speed of convergence found here reflects the richer specification of our model and the fact that the real parallel market rate is indeed being well explained by the two variables considered.[13]

V. CONCLUDING COMMENTS

Using the parallel market exchange rate, we found that the real exchange rate follows a unit root process, thus leading to a rejection of the PPP hypothesis for Angola. In other words, we failed to reject the hypothesis that Angola's real exchange rate is a random walk, which implies that shocks to the real exchange rate can have a permanent impact on its level and that the real exchange rate is not mean reverting (i.e., it does not revert toward PPP). This result also suggests that monetary innovations affecting the price level would not be sufficient to explain the behavior of the parallel market exchange rate in Angola.

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[13] Our specification is richer than PPP in the sense that equation (3) can be regarded as a variant of PPP that allows for time-varying real exchange rates.

We found a strong relationship between the real exchange rate, on the one hand, and the world price of oil and foreign interest rates, on the other. The latter two variables displayed plausible signs and were statistically significant. At the same time, any deviation from the equilibrium path consistent with economic fundamentals tended to disappear within a short period of time.

By shedding light on the dependence of Angola's foreign exchange market on the world price of oil, our study may have implications for the choice of exchange rate regime. Given the time series properties of the real exchange rate, the country's vulnerability to changes in oil prices and foreign interest rates, and its low level of foreign exchange reserves, a fixed nominal exchange rate regime—even if accompanied by prudent financial policies—may prove very difficult to maintain. Thus, the authorities' recent move toward a flexible exchange rate system may be the most appropriate policy to pursue.

Table 1. Unit Root Tests 1/

	Constant	Constant and Trend
q	-1.502	-0.803
r	-0.854	1.363
oil	-0.569	-0.521
Δq	-6.730	-8.127
Δr	-3.099	-3.671
Δoil	-1.941	-4.903
95 percent CV	-2.913	-3.486

1/ The critical values are obtained from MacKinnon (1990), and those with the constant and trend are -3.470. The ADF tests for variables in levels are based on the following specifications:

$$\Delta y_t = \alpha + (\rho\text{-}1)y_{t\text{-}1} + \sum_{i=1}^{k}\theta_i\Delta y_{t\text{-}i} + \epsilon_t \tag{a}$$

$$\Delta y_t = \alpha + \beta t + (\rho\text{-}1)y_{t\text{-}1} + \sum_{i=1}^{k}\theta_i\Delta y_{t\text{-}i} + \epsilon_t \tag{b}$$

where ϵ_t is a white noise error. Specification (a) allows for the drift and (b) for the drift and the time trend. The null hypothesis of the unit root is examined using the null hypothesis: $(\rho\text{-}1) = 0$.

Table 2. Johansen Test 1/

H_0:	λ	Trace	95 percent CV (λ)	95 percent CV (Trace)	Diagnostic Tests
$m == 0$	43.469	74.303	22.040	34.870	AR $F(36, 21) = 1.254$
$m <= 1$	24.692	30.573	15.870	20.180	Normality Chi^2 (6) = 12.456
$m <= 2$	5.8806	5.8806	9.1600	9.1600	

1/ Critical values (CV) are obtained from Ostward-Lenun (1992). The autocorrelation test (AR) is based on the Lagrange multiplier, and the normality test (Normality) on Doornik and Hansen (1994).

Table 3. Normalized Co-integrating Vectors 1/

	β_0 (q)	β_1 (r)	β_2 (*oil*)	β_3 (constant)
Co-integrating vectors (β')	1.000	-0.626	2.267	-1.664
	3.024	1.000	2.905	-8.250
	-1.999	-3.275	1.000	7.267
Log-likelihood test		β_1=0	β_2= 0	
		18.396 2/	18.534 2/	

1/ The cointegrating vectors are normalized in such a way that the cointegrating vectors can be regarded as that of exchange rates. The log-likelihood test is based on χ^2 with degree of freedom equal to one.
2/ Significant at the 1 percent level.

Figure 1. Actual and Estimated Equilibrium Real Parallel Exchange Rates 1/
March 1994-December 1998
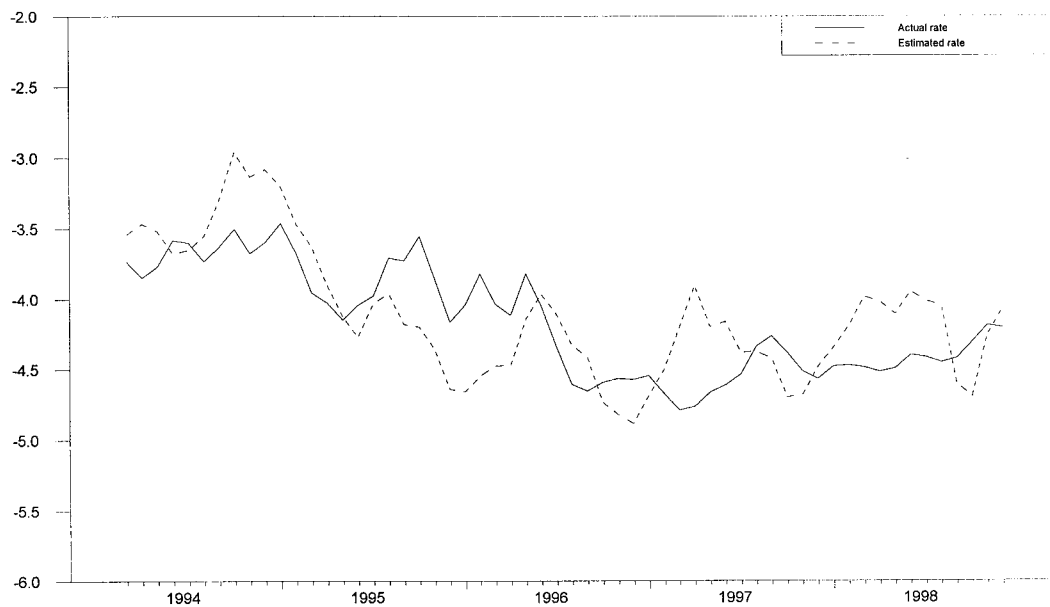
1/ In logarithms. Increase = depreciation.

REFERENCES

Balassa, Bela, 1964, "The Purchasing-Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, Vol. 72 (December), pp. 584-96.

Chinn, Menzie and L. Johnston, 1996, Real Exchange Rates, Productivity and Demand Shocks: Evidence from a panel of 14 countries, NBER Working Paper 5709.

Doornik, Jurgen A. and Henrik Hansen, 1994, "A Practical Test of Multivariate Normality," (unpublished, Oxford: Nuffield College, Oxford University).

Dornbusch, Rudiger, 1976, "Expectations and Exchange Rate Dynamics," *Journal of Political Economy*, Vol. 84 (December), pp.1161-76.

Dornbusch, Rudiger, 1987, "Purchasing Power Parity", *New Palgrave Dictionary of Economics*, pp.1075-85.

Edwards, Sebastian, 1994, "Real and Monetary Determinants of Real Exchange Rate Behaviour: Theory and Evidence from Developing Countries," in *Estimating Equilibrium Exchange Rates*, ed. by John Williamson Washington: Institute for International Economics, pp.61-91.

Faruquee, Hamid, 1994, "Long-run Determinants of the Real Exchange Rate: A stock-flow Equilibrium Approach", *IMF Staff Papers*, Vol. 42, pp. 80-107.

Ferrari, Cesar, 1998, "Stabilization and Growth in Angola: A Financial Program for 1998" (unpublished, National Bank of Angola, Luanda).

Johansen, Soren, 1988, "Statistical Analysis of Cointegration Vectors," *Journal of Economic Dynamics and Control,* Vol. 12 (June-September), pp. 231-54.

_____, 1995, "A Statistical Analysis of Cointegration for I(2) Variables," *Econometric Theory*, Vol. 11 (March), pp. 25-59.

MacDonald, Ronald, 1995, "Long-Run Exchange Rate Modelling: a survey of the recent evidence," *Staff Papers*, International Monetary Fund, Vol. 42 (September), pp. 437-89.

MacDonald, Ronald and Jun Nagayasu, 1999, "The Long-Run Relationship Between Real Exchange Rates and Real Interest Rate Differentials: A Panel Study", IMF Working Paper 99/37 (Washington: International Monetary Fund).

MacKinnon, James G., 1991, "Critical Values for Co-Integration Tests," in *Long-run Economic Relationships: Readings in Co-Integration*, ed. by Robert F. Engle and Clive W. J. Granger (Oxford: Oxford University Press),

Marston, Richard 1987, "Real Exchange and Productivity Growth in the United States and Japan", in R. F. Engle *et al*, *Real-Financial Linkages Among Open Economies*, Cambridge: MIT Press, pp. 71-96.

Meese, Richard and Kenneth, Rogoff, 1988, "Was it Real? The Exchange Rate-Interest Differential Relation over the Modern Floating-Rate Period," *Journal of Finance*, Vol. 43 (September), pp. 433-480.

Nagayasu, Jun, 1998, "Does the Long-Run PPP Hypothesis Hold for Africa: Evidence from Panel Co-Integration Study," IMF Working Paper 98/123 (Washington: International Monetary Fund).

Neary, Peter, 1988, "Determinants of the Equilibrium Real Exchange Rate," *American Economic Review*, Vol. 78 (March), pp. 210-15.

Osterward-Lenum, Michael, 1992, "A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Co-Integration Rank Test Statistics", *Oxford Bulletin of Economics and Statistics*, Vol. 54 (August), pp. 461-71.

Ostry, J. 1988, "The Balance of Trade, Terms of Trade, and the Real Exchange Rate, *IMF Staff Papers* (December), pp. 541-73.

Phylaktis, Kate, and Yiannis Kassimatis, 1994, "Does the Real Exchange Rate Follow a Random Walk? The Pacific Basin Perspective," *Journal of International Money and Finance*, Vol.13, No.4 (August), pp. 476-95.

Samuelson, Paul A., 1964, "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, Vol. 46 (May), pp. 145-54.

Stockman, Alan C., 1988, "Real Exchange-Rate Variability Under Pegged and Floating Nominal Exchange Rate Systems: An Equilibrium Theory," *Carnegie Rochester Conference Series on Public Policy*, Vol. 29 (Autumn), pp. 259-94.

Williamson, John, 1983, *The Exchange Rate System*, Washington: Institute for International Economics).

Zhou, Su, 1997, "Purchasing Power Parity in High-Inflation Countries: A Cointegration Analysis of Integrated Variables with Trend Breaks," *Southern Economic Journal*, Vol. 64, No. 2 (October), pp. 450-67.