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# Exchange Rate Regime Verification: An Alternative Method of Testing for Regime Changes

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## Abstract

This paper proposes a change in persistence test as an alternative method for testing de facto exchange rate regime changes. The tests are applied to 25 African countries, using monthly nominal exchange rate data for the period 1981:01-2005:12, and the results show that although this approach is broadly complementary to other approaches, it is able to identify some regime changes not picked up by existing methods.

**JEL Classification numbers:** C22, F32

**Keywords:** Persistence change tests, de facto exchange rate regime changes

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## 1. Introduction

The seminal paper of Frankel *et al* (2001) sets out a test to distinguish between announced or official exchange rate regimes and the de facto or practical regime. Alternatively, this paper tests for de facto regime changes using change in persistence tests, following Harvey *et al* (2006), where the change in an exchange rate regime between fixed and floating can in principle be detected by testing whether a change occurs in the order of integration of the time series. The idea is that a fixed exchange rate regime will be a stationary I(0) series, while on the other hand, a floating exchange rate regime might show persistence consistent with a non-stationary I(1) series, thus by detecting changes in the order of integration, changes in exchange rate regime can be identified. Our results, based on a sample of 25 African countries, show that the persistence tests can both identify regime changes not identified by other tests and reject regime change where other tests suggest such a regime change. These persistence change tests seem, in general, to be more supportive of the official IMF classification of exchange rate regimes.

The rest of the paper is set out as follows. Section 2 outlines the persistence change tests and Section 3 presents the data and examines the results.

## 2. Statistical Tests of Persistence

A time series  $y_t$ ,  $t = 1, 2, \dots, T$ , may be either I(0) or I(1) over all or part of its length. If the series is constant I(0) or constant I(1) then the presumption is that there is no change of exchange rate regime. Suppose, however, that a series is I(0) over the sub-sample  $t = 1, 2, \dots, N^*$ , but I(1) over the sub-sample  $t = N^* + 1, \dots, T$ ; this change in the behaviour of the series may reflect a change in the exchange rate regime. Harvey *et al* (2006) propose a set of ratio-based statistical tests, which are modified versions of those of Kim (2000), Kim *et al* (2002) and Buseti and Taylor (2004), and are designed to capture such changes in the persistence of a time series.

Harvey *et al* (2006) consider the following model for  $y_t$ :

$$y_t = d_t + v_t, \quad v_t = \rho_t v_{t-1} + \varepsilon_t$$

where  $d_t$  denotes a deterministic component (either a constant or constant plus linear trend), and  $\varepsilon_t$  is a zero mean process satisfying standard  $\alpha$ -mixing conditions (e.g.

stationary ARMA). Under the null hypothesis  $H_0$  of no change in persistence,  $\rho_t$  is assumed constant across the full sample period, allowing either constant I(0) ( $\rho_t = \rho \forall t$  with  $|\rho| < 1$ ) or constant I(1) ( $\rho_t = 1 \forall t$ ) behaviour. Under the alternative, the series undergoes a one-time change in persistence, either from I(0) to I(1), i.e.:

$$H_{01}: \rho_t = \begin{cases} \rho, |\rho| < 1 & t = 1, \dots, N^* \\ 1 & t = N^* + 1, \dots, T \end{cases}$$

or from I(1) to I(0), i.e.:

$$H_{10}: \rho_t = \begin{cases} 1 & t = 1, \dots, N^* \\ \rho, |\rho| < 1 & t = N^* + 1, \dots, T \end{cases}$$

The true changepoint  $N^* \in [0.2T, 0.8T]$  is assumed unknown, and Harvey *et al* propose tests based on a sequence of ratio statistics computed at all candidate changepoints:

$$K_N = \frac{(T - N)^{-2} \sum_{t=N+1}^T (\sum_{i=N+1}^t \tilde{v}_{i,N})^2}{N^{-2} \sum_{t=1}^N (\sum_{i=1}^t \hat{v}_{i,N})^2}$$

where  $\hat{v}_{i,N}$  and  $\tilde{v}_{i,N}$  denote the residuals from the OLS regression of  $y_t$  on  $d_t$  over the sub-samples  $t = 1, \dots, N$ , and  $t = N + 1, \dots, T$ , respectively.

Specifically, three alternative tests are proposed to test  $H_0$  against  $H_{01}$ , based on the mean score, mean exponential and maximum principles:

$$\begin{aligned} MS_{m\min} &= \exp(-bJ_{\min})(0.6T + 1)^{-1} \sum_{t=0.2T}^{0.8T} K_t \\ ME_{m\min} &= \exp(-bJ_{\min}) \ln \left[ (0.6T + 1)^{-1} \sum_{t=0.2T}^{0.8T} \exp(0.5K_t) \right] \\ MX_{m\min} &= \exp(-bJ_{\min}) \max_{t \in [0.2T, 0.8T]} K_t \end{aligned}$$

where  $\exp(-bJ_{\min})$  is a Vogelsang (1998)-type correction to ensure that, for a given significance level, the asymptotic null critical values are the same for both constant I(0) and constant I(1) data; see Harvey *et al* for full details on the computation of  $J_{\min}$  and the values of  $b$  to be used in each case. Three further tests, denoted by  $MS_{m\min}^R$ ,  $ME_{m\min}^R$  and  $MX_{m\min}^R$ , are proposed for testing  $H_0$  against  $H_{10}$ , and these are constructed in the same way as  $MS_{m\min}$ ,  $ME_{m\min}$  and  $MX_{m\min}$ , respectively, but on replacing  $K_t$  with  $K_t^{-1}$  and  $J_{\min}$  with an alternative correction statistic  $J_{\min}^R$ . Finally, three tests are also proposed for testing  $H_0$  against either  $H_{01}$  or  $H_{10}$ ; these are

denoted by  $MS_{m\min}^M$ ,  $ME_{m\min}^M$  and  $MX_{m\min}^M$ , and are constructed using a combination of information employed in the above tests (see Harvey *et al* for details). Critical values for all tests are provided by Harvey *et al*.

A switch from fixed to floating exchange rates should hence be captured by the  $MS_{m\min}$ ,  $ME_{m\min}$  and  $MX_{m\min}$  tests; a switch from floating to fixed by a rejection of the null according to the  $MS_{m\min}^R$ ,  $ME_{m\min}^R$  and  $MX_{m\min}^R$  tests; and a switch in either direction by  $MS_{m\min}^M$ ,  $ME_{m\min}^M$  and  $MX_{m\min}^M$ .

### 3. Data and results

We use monthly data on 25 African countries' nominal exchange rates against the SDR for the period 1981 to 2005 giving a sample of 288 observations. Some 14 of these countries were in monetary union arrangements and so there are only 11 nominal exchange rates to consider. Over this time period, 7 of the 13 exchange rates officially changed from a pegged regime to a more flexible regime while the other 6 exchange rates maintained a constant de jure regime, pegged to a basket (Botswana, Morocco), the French franc/Euro (WAEMU, CAEMC)<sup>4</sup>, a crawling peg (Tunisia) or a floating regime (South Africa). Table 1 shows the full list of countries, the de jure exchange rate arrangements over the sample period and in the final column the regime identified by applying the Frankel *et al* model, which is used for comparison.

Table 2 shows the results of the Harvey *et al* (2006) modified persistence tests. It confirms a constant level of persistence, i.e. no de facto exchange rate regime change over the sample period, for Botswana, Egypt, Ghana, Morocco, South Africa, Tanzania, Tunisia, Uganda and the CFA Franc zones. There are four countries in this group of ten – Egypt, Ghana, Tanzania and Uganda – where the Harvey *et al* tests have failed to pick up a de jure regime change, indicating no evidence of a practical regime change for these countries. This is also confirmed by the Frankel *et al* test, where the pegs in the early part of the period are probably de facto managed floats rather than fixed rate regimes.

For Algeria, Kenya and Nigeria the modified persistence tests show a change in persistence from I(0) to I(1), suggesting a switch from a fixed to a more flexible regime over the sample period. This confirms the switch in the de jure regime, but the

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<sup>4</sup> West and Central African CFA monetary zones, which use CFA franc as their currency.

regimes changes for Algeria and Kenya are not picked up by the test of Frankel *et al*. In these two cases the change in persistence tests concur with the de jure regimes. Furthermore, in the case the CAEMC area, the Frankel *et al* test identifies a switch from a fixed type of regime to a floating regime, where officially no such switch occurred, while our persistence tests are able to confirm that the exchange rate series for the CAEMC area did not undergo a change in the order of integration suggesting, in line with the IMF's official classification, no change from the announced fixed regime throughout the sample period.

#### **4. Conclusions**

This paper uses the Harvey *et al* (2006) modified ratio tests for a change in persistence as an alternative method of testing for changes in de facto exchange rate regimes. Results from our sample of African countries indicate that the tests can give different results from other traditional tests of regime changes of which the model of Frankel *et al* (2001) is used as the benchmark. Given the difficulty of distinguishing between alternative exchange rate policy regimes, however, it seems most appropriate to regard these tests of persistence change as complementary to other procedures.

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<b>Table 1</b> <b>De Jure Exchange Rate Arrangements</b>			
<b>Country</b>	<b>Sub-Period</b>	<b>Officially Announced Regimes (De Jure)</b>	<b>Frankel <i>et al</i>'s Model</b>
Algeria	1981:01-1994:10 1994:01-1998:12 1999:01-2005:12	Pegged to the basket Managed floating Managed floating	Managed/free float Managed/free float Managed floating
Botswana	1981:01-1993:12 1994:01-1998:12 1999:01-2005:12	Pegged to a basket Pegged to a basket Pegged to a basket	Pegged to S. A. Rand Pegged to S.A. Rand Pegged to S.A. Rand
Egypt	1981:01-1998:12 1999:01-2002:12 2003:01-2005:12	Pegged to \$≠ Managed floating Managed floating	Inconclusive Managed floating Managed floating
Ghana	1981:01-1986:08 1986:09-1998:12 1998:01-2005:12	Pegged to \$≠ Managed floating Managed floating	Managed/free float Managed/free float Managed/free float
Kenya	1981:01-1993:09 1993:10-1998:01 1999:01-2005:12	Pegged to basket Managed floating Managed floating	Managed/float Managed float Managed float
Morocco	1981:01-1998:12 1999:01-2005:12	Pegged to a basket Pegged to a basket	Managed float Managed float
Nigeria	1981:01-1986:12 1987:01-1993:12 1994:01-1998:12 1999:12-2005:12	Pegged to a basket Floating Pegged to \$≠ Managed floating	Managed float Free float Pegged to \$≠ Basket peg
South Africa	1981:01-1993:12 1994:01-1998:12 1999:01-2005:12	Floating Floating Floating	Floating Floating Floating
Tanzania	1981:01-1985:12 1986:01-1998:12 1999:01-2005:12	Peg Floating Floating	Managed float Float Float
Tunisia	1981:01-1998:12 1999:01-2005:12	Crawling peg Crawling peg	Crawling peg Crawling peg
Uganda	1981:01-1993:10 1993:11-1998:12 1999:01-2005:12	Peg Floating Floating	Managed/free float Managed/free float Managed float
W/Africa CFA (WAEMU)	1981:01-1998:12 1999:01-2005:12	Pegged to FF# Pegged to Euro	Pegged to FF# Basket peg to \$≠
C/Africa CFA (CAEMC)	1981:01-1998:12 1999:01-2005:12	Pegged to FF# Pegged to Euro	Pegged to FF# Managed float
≠United States Dollar #French Franc.			

**Table 2**  
**Harvey-Leybourne-Taylor Tests for Changes in Persistence**

Country		$MS_{m \min}^{10\%}$ $MS_{m \min}^{5\%}$	$ME_{m \min}^{10\%}$ $ME_{m \min}^{5\%}$	$MX_{m \min}^{10\%}$ $MX_{m \min}^{5\%}$	$MS_{m \min}^R$ $MS_{m \min}^{5\%}$	$ME_{m \min}^R$ $ME_{m \min}^{5\%}$	$MX_{m \min}^R$ $MX_{m \min}^{5\%}$	$MS_{m \min}^M$ $MS_{m \min}^{5\%}$	$ME_{m \min}^M$ $ME_{m \min}^{5\%}$	$MX_{m \min}^M$ $MX_{m \min}^{5\%}$
Algeria	Mean Case	225.35* 30.73*	161.66* 10.84*	145.66 94.70	0.00 0.00	0.00 0.00	0.00 0.00	26.84* 2.05	9.10* 0.35	82.21* 3.70
	Trend Case	1.97 0.15	0.04 0.00	1.04 0.04	0.10 0.01	0.00 0.00	0.06 0.00	0.18 0.01	0.00 0.00	0.05 0.00
Botswana	Mean Case	0.00 0.00	0.00 0.00	0.00 0.00	0.05 0.00	0.01 0.00	0.09 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Trend Case	0.43 0.10	0.02 0.00	0.20 0.03	0.00 0.00	0.00 0.00	0.00 0.00	0.09 0.02	0.00 0.00	0.03 0.00
Egypt	Mean Case	1.05 0.03	0.08 0.00	1.32 0.02	0.00 0.00	0.00 0.00	0.00 0.00	0.02 0.00	0.00 0.00	0.01 0.00
	Trend Case	0.05 0.00	0.00 0.00	0.04 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Ghana	Mean Case	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Trend Case	0.13 0.00	0.00 0.00	0.02 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Kenya	Mean Case	0.00 0.00	0.00 0.00	0.00 0.00	0.01 0.00	0.00 0.00	0.01 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Trend Case	15.23* 4.56*	6.57* 0.97	43.45* 8.86*	1.26 0.45	0.20 0.04	1.32 0.36	7.81* 2.31	2.51* 0.35	19.13* 3.50
Morocco	Mean Case	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Trend Case	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Nigeria	Mean Case	7.66 0.09	0.88 0.00	24.82 0.11	0.00 0.00	0.00 0.00	0.00 0.00	0.06 0.00	0.00 0.00	0.08 0.00
	Trend Case	370.69* 189.53*	925.58* 601.47*	957.09* 688.59*	0.00 0.00	0.00 0.00	0.00 0.00	819.29* 299.98*	195.37* 171.55*	152.96* 108.90*
South Africa	Mean Case	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Trend Case	2.85 0.76	0.24 0.03	1.86 0.33	0.00 0.00	0.00 0.00	0.00 0.00	0.70 0.15	0.03 0.00	0.30 0.03
Tanzania	Mean Case	1.82 0.21	0.34 0.01	5.73 0.33	0.01 0.00	0.00 0.00	0.00 0.00	0.18 0.01	0.01 0.00	0.28 0.01
	Trend Case	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
Tunisia	Mean Case	0.00 0.00	0.00 0.00	0.05 0.00	0.01 0.00	0.11 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Trend Case	0.17 0.05	0.04 0.01	0.45 0.10	0.02 0.00	0.00 0.00	0.02 0.00	0.05 0.01	0.01 0.00	0.09 0.01
Uganda	Mean Case	0.66 0.01	0.04 0.00	1.47 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00	0.00 0.00
	Trend Case	0.22 0.00	0.00 0.00	0.14 0.00	0.02 0.00	0.00 0.00	0.00 0.00	0.24 0.01	0.00 0.00	0.22 0.00
C/Africa CFA (CAEMC)	Mean Case	1.29 0.25	0.24 0.03	1.33 0.18	0.00 0.00	0.00 0.00	0.00 0.00	0.22 0.03	0.02 0.00	0.16 0.01
	Trend Case	1.29 0.25	0.24 0.03	1.33 0.18	0.00 0.00	0.00 0.00	0.00 0.00	0.22 0.03	0.02 0.00	0.16 0.01
W/African CFA (WAEMU)	Mean Case	1.30 0.25	0.24 0.03	1.33 0.18	0.00 0.00	0.00 0.00	0.00 0.00	0.22 0.03	0.02 0.00	0.16 0.01
	Trend Case	0.01 0.00	0.00 0.00	0.01 0.00	0.02 0.00	0.00 0.00	0.02 0.00	0.00 0.00	0.00 0.00	0.00 0.00

\*Signifies rejection