Testing the ‘Fear of Floating’ Hypothesis: A Statistical Analysis for Eight African Countries

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Abstract

This paper revisits the fear of floating hypotheses for eight African countries from the collapse of the Bretton Woods fixed exchange rate system in the early 1970s up until December 2017. This long period of calendar time allows us to extend previous studies by examining the fear of floating hypotheses in two distinct ways. First, we look at a set of descriptive statistics to compare the degree of exchange rate flexibility under alternative *de jure* exchange rate regimes. We find no statistical difference between exchange volatility between declared floaters and fixers, but greater reserve volatility between the floaters, which is suggestive of fear of floating. Second, we use a non-linear, threshold VAR model, estimated for each country, to test for a relationship between exchange rate changes and reserve changes. The results suggest some evidence of a fear of floating for countries which have declared a *de jure* floating regime, with the regime-dependent impulse responses indicating that exchange rate appreciation due to positive reserve shocks is more prevalent in the high reserve regimes, indicative that level of foreign reserves available are important for their exchange rate policies. In general, although the countries with *de jure* floating regimes have a lower threshold than those with pegged regimes, reserves adjust by more than the exchange rates showing a fear of floating.

Keywords Exchange rates · International reserves · Fear of floating · Threshold VAR

JEL Classification F31 · F33 · C22

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1 Introduction

In a perfectly floating exchange rate regime there should be no change in international reserves held by the central bank, whilst in a fixed exchange rate regime there should be no change in the exchange rate. In either ‘perfect’ regime there will be no relationship between the change in the nominal exchange rate and the change in the stock of international reserves. Therefore when a country declares a floating exchange rate regime and simultaneously reserves are changing it is suggestive of some intervention in the foreign exchange market to influence the level of the exchange rate. In this case we would expect to be able to identify a negative relationship between reserve changes and exchange rate changes, with reserves being depleted to prevent or at least slow the depreciation of the exchange rate. This negative relationship between reserve changes and exchange rate changes was initially dubbed ‘fear of floating’ by Calvo and Reinhart (2002),¹ because developing countries seemed to be more tolerant of volatility in international reserves, domestic interest rates and commodity prices than they were to exchange rate volatility.

For fear of floating to be a realistic possibility then the level of maintained reserves is critical if the authorities’ are to be able to effectively intervene in the foreign exchange market. Throughout the 1990s international reserves as a share of GDP in developing countries was above that and rose faster than, the same ratio in advanced economies (Jeanne and Ranciere 2006). By 2005 the gap had closed a little, but on average developing countries ratio of international reserves to GDP was about 7% higher than that of advanced countries, most of whom had floating exchange rate regimes. Moreover, the authorities in developing countries intervene in their foreign exchange markets with large amounts of foreign currency relative to the level of market turnover, the money base, and the stock of the domestic bonds outstanding.² Not only is the level of reserves an unlikely constraint, but according to the IMF (2001) intervention by developing countries could bring about a greater impact on the path of exchange rate than in the developed economies because the authorities in these countries do not sterilize their interventions. This has been confirmed by recent literature. For example, Montes and Ferreira (2019) not only found intervention in Brazil’s exchange rate markets was significant, but also indicative of a ‘fear of floating’ in the country. The ‘fear of floating’ argument, however, contradicts Nogueira and León-Ledesma (2009) who contend that the apparent exchange rate interventions are not due to ‘fear of floating’, but are meant to achieve the inflation target objective of the central bank. In addition, Bleaney and Tian (2014), using regression analysis verified the exchange rate regimes of several countries and concluded that their results are consistent with the IMF classification.³

¹ See also Levy-Yeyati and Sturzenegger (2004) who also argue that the declared, *de jure*, exchange rate regime may not be the same as the *de facto* exchange rate regime.

² Guimarraes and Karacadag (2004) observe that foreign exchange rate interventions in developing and emerging countries are very frequent and large in size, while Neely (2007) asserts that authorities in developing countries still actively involved in foreign exchange interventions across regimes and sizes of the markets. Killeen et al. (2006) argue that it is the private sector not the public sector that absorbs the innovation in the foreign exchange order flow when the peg regime is credible.

³ Issue of fear of floating has resurfaced even in developed countries after the financial crisis. The Economist (2009) runs a special report on that in its June 13th edition where the issue was discussed in context of Western European countries.

Another important feature of foreign exchange rate interventions in developing countries is the position occupied by the central banks in developing countries (Chandavarkar 1996). Central banks in these countries buy and sell foreign exchange for a number of reasons, including support for the balance of payments and with the aim of influencing the exchange rate level or to dampen exchange rate volatility.⁴ On the whole, governments or their agencies in the developing economies are an important source of foreign exchange because of the relative large size of the government economy. It is also argued that the most important reason for governments in developing countries often participate in the foreign exchange market, is defending their exchange rate policy objectives. It was discovered that on a number of occasions, government of developing countries or their agencies borrow from abroad with the main purpose of defending their exchange rate policy and not to finance their fiscal deficits. Taylor (1981) identified this type of transaction in the foreign exchange market by the developing countries way back in the early 1980s.

In this paper we attempt to discover whether there is still evidence of a fear of floating in a number of African economies, some of which declare a *de jure* floating rate system, given their increased experience with floating regimes since the mid-1908s. In other words, we try to test the idea that the fear of floating identified in the 1990s was simply due to the central banks continuing to follow traditional policies that they used under the Bretton Woods system, possibly because they lacked confidence that floating exchange rates would be stable rates. A lack of evidence of a negative association between reserve changes and exchange rate changes may confirm a change of behaviour and increased confidence in international markets. On the other hand, further evidence of a fear of floating might suggest that our sample economies continue to value a stable currency over international reserve or commodity price stability.⁵ One reason for this may be their concerns with other macroeconomic developments such as currency crises and more recently, the growing stock of outstanding debt as 24 African countries now exceed the 55% debt to GDP ratio advised as prudent by the IMF (Financial Times (FT) 2018; Onyekwena and Ekeruche 2019; Coulibaly et al., 2019). In our sample, only Ghana exceeds this threshold (with a debt to GDP a of about 70%,) but both Kenya and South African are on the threshold. The paper uses a threshold VAR model where endogenously determined threshold is computed and the sample split into low and high regimes for each country. Consequently, the paper can determine in which of the regimes that fear of floating exists.

The rest of the paper is organised as follows. The next section discusses the data set and Section 3 uses some descriptive statistics to assess the validity of the fear of floating hypothesis in our sample of countries. Section 4 uses a threshold VAR model to examine the potential non-linear relationship between reserve changes and exchange rate changes. Section 5 concludes arguing that there is some evidence of a continuing fear of floating.

⁴ These are in addition to their traditional roles as central banks.

⁵ Refer to Deaton (1999) and Christensen (2016), among others, on importance of commodity prices to African countries.

2 The Data Set

The data is taken from International Financial Statistics (IFS) with a monthly frequency, over the long time period from January 1970 until December 2017, for eight African countries: Algeria, Botswana, Ghana, Kenya, Morocco, Nigeria, South African and Uganda. The choice of countries was made to offer a large range of de jure exchange rate regimes, see Table 1, whilst excluding some of the least developed countries of the continent.

Table 2 presents some of the descriptive statistics on these eight countries over this 40 year time period on nominal exchange rates, foreign reserves, money stocks and interest rates. All nominal exchange rates exhibit large standard deviations, often over 40% of their means, although with no evidence of skewness or kurtosis. The nominal exchange rate series are all non-stationary, but their first differences reject the null hypothesis of non-stationary as shown by the row of ADF statistics.

The money supply and reserve series show similarly large variations over the sample, but like the exchange rate series there is no evidence of either skewness or kurtosis and the first difference of the series are stationary, as shown by the ADF test statistics. The levels of reserves are consistently higher in the second part of the sample, although the fluctuations are consistently higher in the first part of the sample, before 1988, the exceptions being Botswana and Ghana whose variations are much less marked between the two sections of the sample. It seems therefore that the move towards greater exchange rate flexibility in the last 1980s is associated with a higher level of nominal reserves, perhaps due to inflation, but less reserve volatility, perhaps suggesting that interventions are smaller with a more flexible exchange rate regime.

The interest rates series show the greatest variation of all the series. The variation is most extreme in Kenya, where the rate of interest ranges from 0.8% to 84% and exhibits both skewness and extreme kurtosis. For Uganda, a more typical example, the interest rate ranges from 6% to 55%, but like all other countries exhibits no skewness or kurtosis. These large variations in interest rates, although in part a reflection of periods of high inflation is also likely to reflect monetary policy changes with a view to exchange management.

3 Descriptive Statistical Analysis

To examine the a priori case for fear of floating we initially follow Calvo and Reinhart (2002) and set out thresholds for nominal exchange rate and reserve changes to indicate the variation between de jure regimes. In the case of a fixed exchange rate, the monthly change in the log of the nominal exchange rate, Δe_t , should be close to zero and increase with the degree of flexibility. We chose two thresholds, $\pm 1\%$, which reflects the band inside the Bretton Woods exchange rate system, and $\pm 2.5\%$ range taken from the exchange rate mechanism (ERM) of the European Monetary System (EMS). We then use these relatively narrow bands to examine the frequency distribution of the change in the log of the nominal exchange rates where we expect to find that:

$$\Pr(\Delta e < \pm 1\%) < \Pr(\Delta e < \pm 2.5\%) < \Pr(\Delta e < \text{floating}) \quad (1)$$

Table 1 Descriptive statistics

Sample Monthly 1970–2017	Algeria	Botswana	Ghana	Kenya	Morocco	Nigeria	South Africa	Uganda
Exchange rate (log)								
Mean	1.423	0.811	−0.347	1.917	1.109	1.752	0.870	2.873
Std dev	0.621	0.405	1.364	0.430	0.122	0.912	0.382	1.204
Min	0.644	−0.026	−3.542	0.985	0.695	−0.178	−0.023	−1.015
Max	2.155	1.454	1.507	2.572	1.330	2.672	1.429	3.781
Skew	−0.153	−0.457	−0.869	−0.721	−1.164	−1.013	−0.851	−1.905
Kurt	−1.837	−0.857	−0.052	−0.564	2.077	−0.346	−0.338	2.453
ADF	−19.62*	−20.48*	−6.57*	−15.63*	−18.95*	−18.92*	−15.58*	−19.90*
Reserves (log)								
Mean	3.886	3.654	3.297	3.227	3.694	4.052	4.021	2.784
Std dev	0.903	0.495	0.915	0.710	0.804	0.675	0.865	0.799
Min	2.490	2.289	2.061	1.725	1.660	2.392	2.624	0.207
Max	5.491	4.243	5.187	4.472	4.506	4.917	5.416	3.650
Skew	0.494	−1.376	0.596	0.033	−1.013	−0.379	0.010	−0.701
Kurt	−1.160	0.855	−0.978	−1.162	−0.343	−1.346	−1.516	−0.892
ADF	−2.95*	−19.95	−16.62*	−12.90*	−16.98*	−12.00*	−25.78*	−15.69*
Money stocks (log)								
Mean	4.886	4.271	4.060	5.805	5.669	6.586	5.993	3.675
Std dev	0.891	0.599	0.935	0.849	0.454	0.772	0.730	0.819
Min	3.367	3.087	1.608	4.848	4.800	5.425	5.079	2.523
Max	6.430	5.228	6.076	7.549	6.465	7.935	7.403	5.359
Skew	0.011	−0.132	0.280	0.558	0.065	0.221	0.324	0.579
Kurt	−1.211	−1.177	−0.307	−1.131	−1.187	−1.351	−1.349	−0.999
ADF	−10.25*	−7.01*	−19.80*	−19.80*	−3.80*	−5.54*	−14.27*	−3.70*
Interest rates (%)								
Mean	5.586	10.868	19.969	11.922	5.291	13.023	9.924	22.049
Std dev	1.308	2.634	9.685	9.426	1.959	3.723	4.970	10.893
Min	4.000	5.750	10.500	0.830	3.000	6.000	3.750	5.990
Max	8.500	15.500	45.000	84.670	8.500	26.000	21.850	55.000
Skew	0.575	0.114	1.235	3.984	0.552	0.458	0.475	1.317
Kurt	−0.388	−1.036	0.620	24.402	−1.241	1.389	−0.994	1.655
ADF	−21.82*	−20.63*	−8.04*	−10.31*	−19.71*	−19.15*	−15.50*	−16.42*

Key: ADF test statistic is for the null hypothesis of a unit root in the first difference of the series; so the rejection of the null (denoted by *) shows the time series is stationary in first difference

We construct a similar set of thresholds for reserve changes the results from which are shown in Tables 3, 4, and 5, which is split into three sections according to the de jure exchange rate regime.

What is noticeable from Tables 3, 4, and 5 is the similarity between the fixers and the floaters. In fact statistically there is no difference between the average exchange rate change per month under floating as under fixing, with t-values of

Table 2 Alternative exchange rate regimes

Country	Sub-Period	De Jure Exchange Rate Regimes	De Facto Exchange Rate Regimes		R(logΔe, log Δr)	R(logΔe, log Δi)
			Frankel, et al's Model	HLT's Model		
Algeria	1970:01–1980:12	Pegged USD	Pegged to USD	Peg	0.125	0.019
	1981:01–1994:10	Pegged to basket	Managed/free float	Flexible	−0.079	0.019
	1994:01–2017:12	Managed floating	Managed/free float	Flexible	0.001	0.004
Botswana	1970:01–1980:12	Pegged USD	Pegged to SA Rand	Peg	0.143*	0.094
	1981:01–2017:12	Pegged to basket	Pegged to SA Rand	Peg	0.079*	0.048
Ghana	1970:01–1980:12	Pegged USD	Managed/free float	Flexible	0.066	0.278**
	1981:01–1986:08	Pegged to USD	Managed/free float	Flexible	0.134	−0.014
	1986:09–2017:12	Managed floating	Managed/free float	Flexible	0.023	0.048
Kenya	1970:01–1980:12	Pegged USD	Managed float	Peg	0.081	0.269**
	1981:01–1993:09	Pegged to basket	Managed float	Flexible	0.189**	0.357***
	1993:10–2017:12	Managed floating	Managed float	Flexible	−0.074	0.002
Morocco	1970:01–1980:12	Pegged USD	Managed float	Peg	−0.101	0.168*
	1981:01–2017:12	Pegged to basket	Managed float	Peg	−0.277**	−0.023
Nigeria	1970:01–1980:12	Pegged USD	Managed float	Peg	−0.472	0.055
	1981:01–1986:12	Pegged to basket	Free float	Flexible	−0.636	−0.004
	1987:01–1993:12	Floating	Pegged to USD	Flexible	−0.189**	0.170**
	1994:01–1998:12	Pegged to USD	Basket peg	Flexible	−0.197	−0.030
	1999:12–2017:12	Managed floating	Managed float	Flexible	0.005	−0.084
South Africa	1970:01–1974:05	Pegged USD	Floating	Flexible	0.003	0.117
	1974:06–2017:12	Floating	Floating	Flexible	−0.115**	0.056
Uganda	1970:01–1980:12	Pegged USD	Managed/free float	Crawling peg	0.474**	0.176**
	1981:01–1993:10	Peg	Managed/free float	Crawling peg	−0.156*	0.070
	1993:11–2017:12	Floating	Managed float	Crawling peg	0.025	−0.083

Key: Regimes identified from various IMF exchange rate classifications and Ahmad et al. (2011). Final column shows the correlation between changes in the log of reserves and changes in the log of the exchange rate, where * denotes significant at 10% and ** denotes significant at 5% level

Table 3 By regimes: pegged to USD

Country and Periods Pegged to USD	Probability that the monthly percent change in the nominal exchange rate falls within:		Probability that the monthly percent change in foreign exchange reserves falls within:	
	$\pm 1\%$ band	$\pm 2.5\%$ band	$\pm 1\%$ band	$\pm 2.5\%$ band
Algeria				
1970.01–1980.12	93.13	99.24	17.57	55.73
Botswana				
1970.01–1980.12	70.23	91.60	38.93	67.94
Ghana				
1970.01–1980.12	65.65	90.08	14.50	35.11
1981.01–1986.08	71.76	93.89	57.25	68.70
Kenya				
1970.01–1980.12	85.50	96.95	17.56	41.22
Morocco				
1970.01–1980.12	99.89	99.98	99.06	99.18
Nigeria				
1970.01–1980.12	62.60	89.31	16.03	30.53
1994.01–1998.12	88.14	98.31	25.42	66.10
South Africa				
1970.01–1974.05	84.31	100.00	41.18	19.61
Uganda				
1970.01–1980.12	51.15	79.39	7.63	10.79
Ave	77.24	93.88	33.50	49.49
Med	78.04	95.42	21.50	48.48
Std	15.32	6.52	27.61	26.91

0.8156 and 0.002, for each of the bands, even if Algeria is excluded from the floating rate sample. For example, when Uganda declared a pegged regime the monthly percentage change in the exchange rate fell between the 1% and 2.5% bands 51% and 79% of the time. When it declared a floating regime from 1994 onwards, the monthly percentage change in the exchange rate fell between the same 1% and 2.5% bands 56% and 88% of the time, suggesting less exchange rate variation under floating. This is a priori evidence of fear of floating.

The difference between the two broad sets of exchange rate arrangements is in the behaviour of foreign exchange reserves. We would expect reserve changes to be smaller under floating than under fixed rates and this is confirmed by the data in Tables 3, 4, and 5. Not only is the average monthly reserve change smaller under the floating and managed floating regimes, than under fixed regimes (both including and excluding Algeria), but the sample means are statistically significantly different from zero at 10% from the narrow band (t values are -1.68 and -1.89) and at 5% for the 2.5% band (t values are -3.37 and -3.65). Thus it is the behaviour of the reserves that indicates the difference between the two main regimes.

Table 4 Pegged to basket

Country and Periods Basket pegs	Probability that the monthly percent change in the nominal exchange rate falls within:		Probability that the monthly percent change in foreign exchange reserves falls within:	
	± 1% band	± 2.5% band	± 1% band	± 2.5% band
Algeria				
1981.01–1994.10	83.73	95.18	20.48	47.59
Botswana				
1981.01–2017.12	65.32	94.14	61.26	94.37
Ghana				
1986.09–2017.12	68.62	95.74	23.14	53.46
Kenya				
1981.01–1993.09	68.63	90.85	30.72	54.90
Morocco				
1981.01–2017.12	99.90	100.00	99.52	99.87
Nigeria				
1981.01–1986.12	67.61	85.92	7.04	21.13
Uganda				
1981.01–1993.10	62.75	92.81	35.95	67.32
Average	73.79	93.52	39.73	62.66
Median	68.62	94.14	30.72	54.90
Std Deviation	13.33	4.39	31.22	27.41

Table 5 Managed floating and floating

Country and Periods of Floating	Probability that the monthly percent change in the nominal exchange rate falls within:		Probability that the monthly percent change in foreign exchange reserves falls within:	
	± 1% band	± 2.5% band	± 1% band	± 2.5% band
Algeria				
1994.11–2017.12	88.49	98.92	51.44	87.77
Kenya				
1993.10–2017.12	59.45	89.50	48.45	83.16
Nigeria				
1987.01–1993.12	79.52	96.39	32.53	65.06
1999.01–2017.12	81.88	97.81	53.95	94.74
South Africa				
1974.06–2017.12	61.80	92.71	55.28	75.43
Uganda				
1993.11–2017.12	56.06	87.89	53.98	82.70
Average	71.20	93.87	49.27	81.48
Median	70.66	94.55	52.70	82.93
Std dev	13.70	4.55	8.55	10.26

Table 6 Interest rate change by regimes: Pegged to USD

Country and Periods Pegged to USD	Probability that the monthly percent change in the nominal interest rate falls within:		Probability that the monthly percent change in the nominal interest rate falls outside:	
	$\pm 0.25\%$ band	$\pm 0.5\%$ band	$\pm 4\%$ band	$\pm 5\%$ band
Algeria				
1970.01–1980.12	96.95	97.71	0.00	0.00
Botswana				
1970.01–1980.12	93.13	94.66	0.00	0.00
Ghana				
1970.01–1980.12	92.37	93.13	4.41	2.29
1981.01–1986.08	82.35	82.35	8.82	4.41
Kenya				
1970.01–1980.12	56.49	71.76	0.00	0.00
Morocco				
1970.01–1980.12	99.98	99.98	0.00	0.00
Nigeria				
1970.01–1980.12	93.13	93.89	0.76	0.76
1994.01–1998.12	86.44	91.52	0.00	0.00
South Africa				
1970.01–1974.05	45.10	60.78	0.00	0.00
Uganda				
1970.01–1980.12	90.84	90.84	4.58	3.05
Average	83.68	87.66	1.86	1.05
Median	91.61	92.33	0.00	0.00
Std dev	18.21	12.47	3.06	1.62

Tables 6, 7, and 8 shows that interest rate variability was low under floating or managed floating regimes – with only Uganda and Kenya showing any signs of large interest rate changes. Interest rate volatility was highest under basket pegs, largely due to Kenya and Nigeria whose pegs probably lacked credibility and who both moved to declared floating rate regimes.

For fear of floating to be credible hypothesis we would expect exchange rate variability to be relatively low although a floating regime is announced. This low exchange rate variability may stem from policy actions, in which case the reserve volatility or interest rate volatility is likely to be high compared to true floaters. In pure float and pure pegged regimes the correlation between the change in reserves and the change in the exchange rate should be insignificantly different from zero. On the other hand, a negative sign denotes some intervention in the market and may indicate a “fear of floating” if the exchange rate is depreciation (rising) whilst reserves are falling. Similarly a positive correlation between exchange rate changes and interest rate changes may suggest that central banks are “leaning-into-the-wind” to slow the rate of depreciation or appreciation in a floating rate regime.

Table 7 Pegged to basket

Country and Periods Basket pegs	Probability that the monthly percent change in the nominal interest rate falls within:		Probability that the monthly percent change in the nominal interest rate falls outside:	
	± 0.25 band	± 0.5%band	± 4% band	± 5% band
Algeria				
1981.01–1994.10	99.40	99.40	0.00	0.00
Botswana				
1981.01–2017.12	91.44	97.44	0.00	0.00
Ghana				
1986.09–2017.12	80.59	87.23	1.86	0.00
Kenya				
1981.01–1993.09	16.34	35.95	10.46	9.15
Morocco				
1981.01–2017.12	99.95	99.99	0.00	0.00
Nigeria				
1981.01–1986.12	93.06	93.06	2.78	1.52
Uganda				
1981.01–1993.10	38.56	46.41	7.19	4.58
Average	91.44	93.06	1.86	0.00
Median				
Std Deviation	33.19	26.99	4.11	3.51

Table 8 Managed floating and floating

Country and Periods of Floating	Probability that the monthly percent change in the nominal interest rate falls within:		Probability that the monthly percent change in the nominal interest rate falls outside:	
	± 0.25 band	± 0.5%band	± 4% band	± 5% band
Algeria				
1994.11–2017.12	98.92	98.92	0.00	0.00
Kenya				
1993.10–2017.12	50.86	65.29	1.03	0.00
Nigeria				
1987.01–1993.12	80.72	80.72	0.00	0.00
1999.01–2017.12	94.74	96.49	0.00	0.00
South Africa				
1974.06–2017.12	84.13	88.72	0.00	0.00
Uganda				
1993.11–2017.12	75.43	84.08	0.69	0.35
Average	80.80	85.70	0.29	0.06
Median	82.43	86.40	0.00	0.00
Std dev	17.08	12.20	0.46	0.14

The final two columns of Table 2 shows the correlation coefficients between exchange rate changes, and reserve and interest rate changes for all countries in the sample and across the various exchange rate regimes. "Leaning-into-the-wind" is significant in Ghana, Kenya, Morocco, Nigeria and Uganda over specific sub periods and market negatively signed and significant for Morocco, Nigeria, South Africa and Uganda and over certain sub-periods. There are six instances of booth features occurring together (Algeria, January 1980 to October 1994; Kenya, October 1993 to December 2017; Morocco, January 1970 to December 1980; Nigeria, January 1970 to December 1980 and January 1987 to December 1993; South Africa, June 1974 to December 2017; and Uganda, January 1981 to October 1993), although only in the case of Nigeria from January 1987 to December 1993 are both correlation statistically significant at the 5 % level, but in four of the six instances one of the coefficients are statistically significant.

Botswana and Kenya (January 1981 to September 1993) have positive and significant correlations between exchange rate changes and reserve changes, despite declaring a pegged regime, suggesting that reserves were rising to prevent the exchange rate from appreciating too rapidly.

4 Econometric Threshold Analysis and Results

The descriptive analysis suggests that there may be a 'fear of floating' for some of our sample countries over specific periods of time. Specifically: Algeria (January 1980 to October 1994); Kenya (October 1993 to December 2017); Morocco (January 1970 to December 1980); Nigeria (January 1970 to December 1980 and January 1987 to December 1993); South Africa (June 1974 to December 2017); and Uganda, (January 1981 to October 1993). As identifying a relationship between exchange rate changes and reserves changes is problematic due to the simultaneity problem and therefore we choose to use a VAR model, which treats all variables as endogenous to addresses this issue. Therefore in this section we attempt to test the fear of floating hypothesis using a bi-variate threshold VAR model, following Tsay (1998) and Balke and Fomby (1997).⁶ The advantage of this non-linear approach is that not only can the threshold level for reserves, γ , vary between countries, but so can the delay parameter, d , which indicates how long it takes the effect of crossing the estimated reserves threshold to be felt by the rest of the system.

Defining the vector X as $X = [\Delta e, \Delta r]$, the bivariate VAR can be written as

$$\begin{bmatrix} \Delta e_t \\ \Delta r_t \end{bmatrix} = \begin{bmatrix} \beta_{11i}(s) & \beta_{12i}(s) \\ \beta_{21i}(s) & \beta_{22i}(s) \end{bmatrix} \begin{bmatrix} \Delta e_{t-i} \\ \Delta r_{t-i} \end{bmatrix} + \begin{bmatrix} u_{et} \\ u_{rt} \end{bmatrix} \quad (2)$$

where u_{et} and u_{rt} are random error terms, the $\beta(s)$'s are the system parameters to be estimated with i period lags, where s defines the estimated threshold of the two reserve

⁶ We attempted estimating a four-variable model that included reserves, exchange rates, money supply and interest rate, to capture the effect of monetary policy. However, both money supply and interest rate turned out to be insignificant. This may not be unconnected to the underdeveloped financial systems in the sample countries, except perhaps South Africa.

regimes such that $s_t = \{h, l\}$ where h and l refer to the high- and low-reserve regimes, respectively. The regimes depend on the country's reserves, such that:

$$\begin{cases} S_t = h & \text{if } r_{t-d} > \bar{\gamma} \\ S_t = l & \text{if } r_{t-d} \leq \bar{\gamma} \end{cases} \quad (3)$$

where r_t denotes the reserves, $\bar{\gamma}$ denotes the threshold between high and low reserves regimes and d denotes the delay parameter.

We follow the conventional procedure in estimating the TVAR model⁷ in (2). We first determine the number of lags (p) on the endogenous variables using the Information Criteria and test for the existence of multiple regimes using the C(d) threshold test statistic.⁸ The testing procedure re-orders the data according to ascending values of the threshold variable and estimates (2) using sub-samples of the data which partition the VAR into high and low regimes based on the reserve threshold.

Tables 9 and 10 reports the estimated multivariate threshold, C(d), along with the delay parameters, d , and the threshold values, γ . The delay parameters are reported for up to 24 months for each of the countries whose p -values indicate that they are all significant. The estimated threshold values range from 12.50 for Botswana to 7.16 for Uganda. The results indicate that the threshold for countries with de jure pegged regimes, Botswana and Morocco are the largest at 12.50 and 10.57, respectively. Since the threshold variable is the reserves this suggests that countries with pegged exchange rate regimes seem to tolerate higher reserve volatility than those with more flexible regimes. This is as expected and not evidence of fear of floating, although what is important to note is that countries with more flexible exchange rate regimes also have a relatively high reserve thresholds, in excess of 7.00; for example, South Africa at 7.75 and Nigeria at 8.45, which are indicative of substantial intervention in the foreign exchange market.

The impulse response functions (irf). are computed from these estimated regime-dependent VARs where generalized impulse responses (Pesaran and Shin 1998) that do not require orthogonalization of shocks and are also invariant to the ordering of the variables in the VAR.⁹ Impulse response functions allow the possibility of investigating the dynamic response of the variables to different shocks within the system. The impulse response functions (irfs) derived from the estimated threshold VAR model show the responses of exchange rate changes and reserve changes to one another in both high (h) and low (l) reserve regimes over time and are shown in Fig. 1. These irfs are regime-dependent and therefore we report the responses of the variables to the shocks in both high (h) and low (l) regimes. The variance decompositions in Tables 11,

⁷ See for example Çatik and Martin (2012) and Ahmad et al. (2014).

⁸ The C(d) Test Statistics, asymptotically follow a Chi-square distribution and test for the existence of a threshold VAR against a linear VAR and also calculates the threshold value, γ , and the delay parameter, d . The C(d) test is used to re-arrange the variables in the VAR in ascending values of the threshold variable and the model is then estimated recursively. Tsay (1998) shows that a choosing an appropriate starting value for m_0 is very important, so as not to introduce bias in the empirical distributions of C(d), so we have used different values of m_0 in order to determine the optimum starting value.

⁹ We have also computed the orthogonalized impulse response functions for robustness check and the results are largely consistent.

Table 9 Multivariate threshold test

Country	Delay Parameter, d	$C(d)$			p-values	Threshold Value, γ
		$m_0 = 150$	$m_0 = 180$	$m_0 = 250$		
Algeria	$d = 1$	418.62	460.68	439.12	0.00	9.73
	$d = 2$	421.21	437.21	422.10	0.00	
	$d = 3$	422.10	465.66	456.77	0.00	
	$d = 4$	435.40	456.97	448.03	0.00	
	$d = 8$	439.47	435.32	443.34	0.00	
	$d = 12$	600.81	532.75	457.18	0.00	
	$d = 18$	546.95	599.17	519.07	0.00	
	$d = 24$	669.45	730.15	589.76	0.00	
Botswana	$d = 1$	457.41	541.42	509.72	0.00	12.50
	$d = 2$	452.38	520.12	483.57	0.00	
	$d = 3$	448.22	529.15	544.82	0.00	
	$d = 4$	456.94	515.67	439.84	0.00	
	$d = 8$	353.71	434.53	407.71	0.00	
	$d = 12$	372.23	468.60	409.34	0.00	
	$d = 18$	383.80	538.54	389.33	0.00	
	$d = 24$	448.52	508.54	359.49	0.00	
Ghana	$d = 1$	556.26	654.06	608.92	0.00	7.35
	$d = 2$	587.16	649.16	554.02	0.00	
	$d = 3$	588.93	618.83	630.41	0.00	
	$d = 4$	653.50	664.31	591.40	0.00	
	$d = 8$	718.72	733.52	578.31	0.00	
	$d = 12$	708.38	684.07	531.07	0.00	
	$d = 18$	551.57	811.86	594.86	0.00	
	$d = 24$	653.20	725.42	298.12	0.00	
Kenya	$d = 1$	546.17	357.21	466.86	0.00	7.96
	$d = 2$	511.62	391.12	461.24	0.00	
	$d = 3$	504.28	399.09	473.02	0.00	
	$d = 4$	502.65	413.38	451.74	0.00	
	$d = 8$	460.57	448.53	376.88	0.00	
	$d = 12$	420.37	424.90	414.86	0.00	
	$d = 18$	350.23	440.87	338.70	0.00	
	$d = 24$	341.65	418.18	331.57	0.00	

12, and 13 show the effect of a unit shocks to u_e and u_r on the variance to exchange rate and reserve equations.

Table 2 shows both de jure and de facto exchange rate regimes of the countries covered. The de facto regimes were obtained by using models of Frankel et al. (2001) and Harvey et al. (2006) as in Ahmad et al. (2011). The table indicates that Algeria, Ghana, Kenya, Nigeria, South Africa have declared that their regimes for most of the

Table 10 Multivariate Threshold Test

Country	Delay Parameter, d	$C(d)$			p-Values	Threshold Value, γ
		$m_0 = 150$	$m_0 = 180$	$m_0 = 250$		
Morocco	$d = 1$	304.01	441.86	338.74	0.00	10.57
	$d = 2$	336.22	456.93	356.88	0.00	
	$d = 3$	206.81	484.61	337.82	0.00	
	$d = 4$	321.52	481.35	341.98	0.00	
	$d = 8$	109.33	499.92	328.63	0.00	
	$d = 12$	323.03	508.33	324.22	0.00	
	$d = 18$	323.87	446.23	300.13	0.00	
Nigeria	$d = 24$	344.66	506.01	389.98	0.00	8.45
	$d = 1$	457.41	541.42	509.72	0.00	
	$d = 2$	452.38	520.12	483.57	0.00	
	$d = 3$	448.22	529.15	454.82	0.00	
	$d = 4$	456.94	515.67	439.84	0.00	
	$d = 8$	353.71	434.53	407.71	0.00	
	$d = 12$	372.23	468.60	409.34	0.00	
South Africa	$d = 18$	383.80	538.54	389.33	0.00	7.75
	$d = 24$	448.52	508.54	359.49	0.00	
	$d = 1$	444.68	328.05	373.18	0.00	
	$d = 2$	479.47	319.20	382.25	0.00	
	$d = 3$	494.07	311.09	467.30	0.00	
	$d = 4$	489.83	323.27	396.63	0.00	
	$d = 8$	382.20	305.68	366.79	0.00	
Uganda	$d = 12$	406.80	341.20	429.89	0.00	7.16
	$d = 18$	348.64	259.61	415.72	0.00	
	$d = 24$	311.36	253.83	340.07	0.00	
	$d = 1$	510.81	422.46	338.75	0.00	
	$d = 2$	492.75	435.63	363.29	0.00	
	$d = 3$	467.65	428.41	361.31	0.00	
	$d = 4$	456.74	395.04	342.84	0.00	
	$d = 8$	588.42	396.97	393.89	0.00	
	$d = 12$	227.30	351.52	386.23	0.00	
	$d = 18$	424.65	250.95	332.04	0.00	
	$d = 24$	463.86	285.10	362.66	0.00	

sample period is floating. Botswana and Morocco are two countries which have had a pegged regime as their de jure regime for the whole period.

The results for Algeria indicate that the exchange rates have responded insignificantly to positive changes in reserves in the high reserve regime, but appreciated in the low regime. The reserves, on the other hand, responded positively in the high reserve regime, but negatively in the low regime. The results for Uganda also show that, although the exchange rates have reacted insignificantly to positive reserve shocks, the

Fig. 1 The impulse response functions

reserves responded negatively to exchange rate depreciation in both low and high regimes. For both countries this suggests the existence of fear of floating in the low regime as the country's *de jure* exchange rate was a floating one for the period as indicated in Table 2.

Figure Impulse Response Functions

Ghana: Response to Reserve

Response to Exchange Rates

Kenya: Response to Reserve

Fig. 1 (continued)

The results for Kenya indicate the presence of fear of floating as its exchange rates responded to positive reserves shocks by appreciating in both low and high regimes. In the same vein, reserves responded by decreasing in response to exchange rate

Fig. 1 (continued)

depreciation. Similarly the results for Nigeria indicate that exchange rates have responded to positive reserve shocks in the low regime by marginally appreciating

Fig. 1 (continued)

while its reserves to exchange rate depreciation by decreasing in both low and high regimes. Reduction of reserves in response to exchange rate appreciation in this context, is an indication of fear of floating as the country's *de jure* regime is a floating.

Results for Ghana are generally insignificant responses, except the exchange rates in the high regime that responded to positive reserve shocks by appreciating for about five months after a lag of a couple of months. This suggests that the country suffers from fear of floating only in that regime. South Africa's results show that neither exchange rate nor reserves responded to positive shock in reserves and exchange rates,

Fig. 1 (continued)

respectively, for both the low and high reserve regimes. This is consistent with the declared *de jure* flexible exchange rate regime of the country for the sample period. However, the reserves seem to respond to exchange rates depreciation by a slight

Fig. 1 (continued)

Table 11 Variance Decomposition

High Regime							Low regime					
Variance EXC due:				Variance of RES due to:			Variance EXC due:			Variance of RES due to:		
Step	Std Error	EXC	Res	Std Error	Exc	Res	Std Error	EXC	Res	Std Error	Exc	Res
Variance Decomposition: Algeria												
1	0.02	100.00	0.00	0.03	0.02	99.98	0.03	100.00	0.00	0.11	0.61	99.39
2	0.02	100.00	0.00	0.05	0.07	99.93	0.04	99.99	0.01	0.16	0.59	99.41
3	0.03	100.00	0.00	0.06	0.26	99.74	0.05	99.95	0.05	0.19	0.57	99.43
4	0.03	100.00	0.00	0.07	0.60	99.40	0.06	99.90	0.10	0.22	0.55	99.45
12	0.05	99.98	0.02	0.11	7.23	92.77	0.11	99.00	1.00	0.35	0.41	99.59
16	0.05	99.96	0.04	0.13	12.11	87.89	0.14	98.29	1.71	0.39	0.36	99.64
24	0.06	99.91	0.09	0.17	22.49	77.51	0.17	96.58	3.42	0.44	0.28	99.72
Variance Decomposition: Botswana												
2	0.01	100.00	0.00	0.02	5.80	94.20	0.02	100.00	0.00	0.02	5.82	94.18
3	0.01	73.09	26.91	0.03	3.03	96.97	0.02	99.76	0.24	0.03	2.89	97.11
4	0.01	56.86	43.14	0.03	2.00	98.00	0.03	99.66	0.34	0.03	1.90	98.10
12	0.01	46.46	53.54	0.04	1.53	98.47	0.03	99.62	0.38	0.04	1.50	98.50
16	0.01	31.38	68.62	0.07	3.69	96.31	0.04	99.63	0.37	0.07	2.60	97.40
24	0.01	30.91	69.09	0.09	5.68	94.32	0.04	99.64	0.36	0.08	3.63	96.37
Variance Decomposition: Ghana												
1	0.04	100.00	0.00	0.10	5.15	94.85	0.04	100.00	0.00	0.05	0.01	99.99
2	0.06	99.75	0.25	0.13	3.87	96.13	0.06	99.75	0.25	0.06	0.29	99.71
3	0.07	99.81	0.19	0.16	2.54	97.46	0.07	99.81	0.19	0.06	0.63	99.37
4	0.07	99.85	0.15	0.18	2.08	97.92	0.07	99.85	0.15	0.06	0.71	99.29
12	0.11	99.28	0.72	0.28	3.76	96.24	0.11	99.28	0.72	0.09	2.84	97.16
16	0.12	98.58	1.42	0.31	4.23	95.77	0.12	98.58	1.42	0.10	5.76	94.24
24	0.14	96.76	3.24	0.34	5.05	94.95	0.14	96.76	3.24	0.11	14.19	85.81

decrease, perhaps reflecting difficulties the currency experience during the latter period of the sample.

The reported irfs of Botswana show that the exchange rates responded insignificantly to positive changes in reserves, but the reserves responded negatively to exchange rates depreciation in both the low and high regimes. This seems to be consistent with the *de jure* regime declared by the country as a pegged one. Similarly, Morocco's results show that the country's exchange rates responded to positive reserves shock by appreciating in both the low and high regimes. Similarly, its reserves decrease in responding to exchange rate depreciation, both of which are consonant with a declared fixed exchange rate regime.

Overall there is evidence that the fear of floating does exist among the floaters in the sample except perhaps for South Africa. This is, of course, consistent with South African being a more developed economy with deeper financial markets. The results for countries that report a peg as their *de jure* regimes seem to suggest that their *de facto* regimes are same as the declared ones.

Table 12 Variance Decomposition

High Regime							Low Regime					
Variance EXC due:			Variance of RES due to:				Variance EXC due:			Variance of RES due to:		
Step	Std Error	EXC	Res	Std Error	Exc	Res	Std Error	EXC	Res	Std Error	Exc	Res
Variance Decomposition: Morocco												
2	0.13	100.00	0.00	0.19	0.25	99.75	0.13	100.00	0.00	0.19	0.25	99.75
3	0.18	99.99	0.01	0.26	0.14	99.86	0.18	99.99	0.01	0.26	0.14	99.86
4	0.22	99.98	0.02	0.32	0.10	99.90	0.22	99.98	0.02	0.32	0.10	99.90
12	0.26	99.97	0.03	0.36	0.08	99.92	0.26	99.97	0.03	0.36	0.08	99.92
16	0.43	99.72	0.28	0.56	0.09	99.91	0.43	99.72	0.28	0.56	0.09	99.91
24	0.49	99.54	0.46	0.62	0.13	99.87	0.49	99.54	0.46	0.62	0.13	99.87
Variance Decomposition: Kenya												
1	0.05	100.00	0.00	0.19	0.17	99.83	0.05	100.00	0.00	0.19	0.17	99.83
2	0.07	99.97	0.03	0.26	0.31	99.69	0.07	99.97	0.03	0.26	0.31	99.69
3	0.08	99.91	0.09	0.31	0.37	99.63	0.08	99.91	0.09	0.31	0.37	99.63
4	0.10	99.82	0.18	0.36	0.39	99.61	0.10	99.82	0.18	0.36	0.39	99.61
12	0.17	98.23	1.77	0.54	0.38	99.62	0.17	98.23	1.77	0.54	0.38	99.62
16	0.19	97.08	2.92	0.58	0.36	99.64	0.19	97.08	2.92	0.58	0.36	99.64
24	0.24	94.52	5.48	0.64	0.31	99.69	0.24	94.52	5.48	0.64	0.31	99.69
Variance Decomposition: Nigeria												
2	0.13	100.00	0.00	0.19	0.25	99.75	0.13	100.00	0.00	0.19	0.25	99.75
3	0.18	99.99	0.01	0.26	0.14	99.86	0.18	99.99	0.01	0.26	0.14	99.86
4	0.22	99.98	0.02	0.32	0.10	99.90	0.22	99.98	0.02	0.32	0.10	99.90
12	0.26	99.97	0.03	0.36	0.08	99.92	0.26	99.97	0.03	0.36	0.08	99.92
16	0.43	99.72	0.28	0.56	0.09	99.91	0.43	99.72	0.28	0.56	0.09	99.91
24	0.49	99.54	0.46	0.62	0.13	99.87	0.49	99.54	0.46	0.62	0.13	99.87

Table 13 Variance Decomposition

High Regime							Low regime					
Variance EXC due:				Variance of RES due to:			Variance EXC due:			Variance of RES due to:		
Step	Std Error	EXC	Res	Std Error	Exc	Res	Std Error	EXC	Res	Std Error	Exc	Res
Variance Decomposition: South Africa												
1	0.02	100.00	0.00	0.09	1.03	98.97	0.02	100.00	0.00	0.09	1.03	98.97
2	0.02	99.70	0.30	0.12	1.16	98.84	0.02	99.70	0.30	0.12	1.16	98.84
3	0.03	98.26	1.74	0.15	1.23	98.77	0.03	98.26	1.74	0.15	1.23	98.77
4	0.04	95.81	4.19	0.17	1.29	98.71	0.04	95.81	4.19	0.17	1.29	98.71
12	0.07	65.16	34.84	0.25	1.60	98.40	0.07	65.16	34.84	0.25	1.60	98.40
16	0.09	53.17	46.83	0.28	1.74	98.26	0.09	53.17	46.83	0.28	1.74	98.26
24	0.13	38.28	61.72	0.30	1.99	98.01	0.13	38.28	61.72	0.30	1.99	98.01
Variance Decomposition: Uganda												
2	0.05	100.00	0.00	0.10	0.74	99.26	0.05	100.00	0.00	0.10	0.74	99.26
3	0.07	99.99	0.01	0.14	0.42	99.58	0.07	99.99	0.01	0.14	0.42	99.58
4	0.09	99.99	0.01	0.16	0.32	99.68	0.09	99.99	0.01	0.16	0.32	99.68
12	0.10	99.99	0.01	0.18	0.27	99.73	0.10	99.99	0.01	0.18	0.27	99.73
16	0.17	99.99	0.01	0.27	0.30	99.70	0.17	99.99	0.01	0.27	0.30	99.70
24	0.19	99.99	0.01	0.30	0.40	99.60	0.19	99.99	0.01	0.33	0.69	99.31

The variance decomposition profiles are reported in Tables 11, 12, and 13. Results for Algeria show that variations in exchange rates are explained by exchange rates itself but fluctuations in reserves are contributed by exchange rate volatility where about 24% of reserve changes are explained by the changes in exchange rates by the 24th month in the high regime. Changes of exchange rates were marginally contributed by in reserves, about 3% in the low regime. But reserve volatility is generally explained by fluctuations in itself.

Results for Botswana indicate that exchange rate variations are due to changes in reserves in the high regime where almost 70% of that volatility was due to changes in reserves. However, changes in reserves were generally due to fluctuations in the reserve itself. Similarly, variations of the series in the low regime are explained by fluctuations in the series themselves. Variance decomposition for Ghana show that exchange rate variations are marginally explained by reserve volatility, about 3% by the end of the second year in the high regime. Reserve changes played a higher role in exchange rate variations in the low regime, about 14% of such changes are due to reserve variations. Morocco's results indicate that percentage of each of the series contribution to the variation of each other is very minimal in both regimes.

Kenya's variance decomposition indicate that reserve fluctuations are responsible for about 5% exchange rate changes in the high regime by 24th month whereas exchange rates played a less important role in reserve fluctuations. Results for the low regime are similar. Both exchange rate and reserve fluctuations played very little role in each other's volatility in Nigeria for both low and high regimes. South Africa recorded contrast results where reserves have contributed hugely, over 60%, to exchange rate

variation in the high regime. However, exchange rates' contribution to reserve changes has been very little. Results for the low regime is consistent with those of the high regime. Uganda's reserve accounted for only about 1% of fluctuations in exchange rates in both high and low regimes. Similar pattern is recorded for exchange rates' role in reserve fluctuations in both regimes.

5 Conclusions

In this paper we have re-visited the fear of floating hypothesis for eight African countries, using both descriptive statistical techniques and more formal non-linear VAR methods. We find evidence of some continued fear of floating, but since 2000 there seems to have been less volatile movements in the US dollar which has perhaps been reflected in smaller exchange rates in some of our African countries. For example, Calvo and Reinhart (2002) report that for the US dollar there was a 59% probability that the monthly change falls within the plus/minus 2.5% band, but in this sample, it is nearer a 95% probability. That said we have found evidence of a negative relationship between exchange rate changes and reserve changes at both the descriptive level and from the threshold VAR analysis. This suggests that there is some evidence of the fear of floating, but as countries have become more used to floating exchange rates they have perhaps also less fear of floating and do not undertake drastic action on either interest rate policy or reserve policy to protect their exchange rates.

The results also show that most of the fear of floating are found in the high regimes, an indication that availability of reserve is critical for fear of floating. Therefore, as the sample countries covered in the study depend on a few commodities for their foreign exchange earnings, the analysis highlights the importance of diversifying sources of the foreign reserves. This will reduce the level of foreign interventions in the markets and promote credibility of the monetary authorities.

Further research could usefully focus on the role of a more internationally stable US dollar as well as commodity prices on developing countries 'fear of floating' type behaviour.

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