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Exchange Rate Crisis among Inflation Targeting Countries in Sub-Saharan Africa

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Abstract: The exchange market pressure index has proven to be a major indicator in identifying exchange rate crises in economies; however, due to the complexities surrounding developing economies, the efficacy of the index has been called to question. Specifically, the selection of an appropriate index and the problem of selecting the appropriate threshold for identifying exchange market pressure. To investigate this issue, this study identifies exchange rate crisis episodes in South Africa and Ghana using ridge regression, a discrete threshold regression, and Dynamic Ordinary Least Square (DOLS) models. The results are robust in resolving the problems with an exchange market pressure index. They also point to uneven implementation of the inflation targeting policy framework in the studied countries.

Keywords: monetary policy; FX rate regimes; Sub-Saharan Africa; exchange market pressure index

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1. Introduction

According to the literature concerning monetary economics (Obstfeld and Rogoff 1995; Kouri 1976; Bain and Howells 2003), most of the major monetary shocks have in some way been connected to a fixed exchange rate regime. Thus, countries that do not peg their currencies—as also observed by Obstfeld and Rogoff (1995)—have avoided this type of crisis that mostly affects emerging market countries (Fischer 2001).

However, monetary authorities saddled with these crises are cautioned against using other adjustable pegged exchange rate regimes, especially for countries open to international capital flows (Fischer 2001; Pentecost 1993). For instance, in emerging economies, certain structural characteristics make them more vulnerable to external shocks (Driver and Westaway 2004). This has made emerging economies more concerned about the level of appreciation or depreciation in their exchange rate. As a result, these countries will use both interest rate policy and, in some instances, foreign exchange intervention policy to respond to exchange market pressures (Fischer 2001). This has left many countries in Sub-Saharan Africa (SSA) skeptical about the adoption of a floating exchange rate regime (Calvo and Reinhart 2002), which is also the main precondition of an Inflation Targeting (IT) framework. Only Ghana and South Africa have adopted the IT framework in SSA. Uganda adopted the IT framework in 2013 (Berg et al. 2015).

Other studies (Madhou et al. 2021; Nakatani 2018) have found that the effects of these external shocks on the occurrence of an exchange rate crisis are historically larger for developing countries implementing flexible exchange rate regimes, because capital controls, in some instances, mitigate the effects of some of the exchange rate shocks in pegged regimes. Central bank interventions on the FX markets usually require a high level of exchange rate reserves, which can restrict the size and the time path of the intervention (Krušković 2017). This was first argued by Krugman (1979) and Salant and Henderson (1978), and prompted Girton and Roper (1977) to develop an exchange market pressure

(EMP) index to identify periods where there were excessive pressures on the exchange rate, in some cases accelerating an exchange rate crisis. This idea was modified by subsequent authors to capture the reaction function of monetary authorities by modifying the index of Girton and Roper (1977) to include the interest rate variable.

However, many authors (Sachs et al. 1996; Eichengreen et al. 1994; Eichengreen et al. 1996; Stavarek 2010; Kaminsky and Reinhart 1999; Hossfeld and Pramor 2018; Hegerty 2018) used extreme values of the EMP index to signal pressure on the exchange rate (i.e., an exchange rate crisis). In reaction to this, Bertoli et al. (2010) and Pontines and Siregar (2008) used an independently selected threshold value to identify exchange rate crisis periods. They cautioned about the use of the index, as there were problems with the weights of the variables used in computing the index and the choice of an appropriate threshold for identifying exchange rate crisis episodes.

In dealing with these problems revealed by the literature, this study computed different estimates of the EMP index. We employed a ridge regression and a Dynamic Ordinarily Least Square (DOLS) regression model in order to test the original index developed by Girton and Roper (1977) and the recent forms of the index.

In dealing with the 'threshold problem', a discrete threshold regression model (a non-linear time series model with the local regimes switching) is built to identify crisis episodes in both South Africa and Ghana. In our study, we aim to resolve the weighting and the threshold problem pointed out by Bertoli et al. (2010) and Pontines and Siregar (2008).

The rest of the paper is structured with a literature review—discussing the exchange rate crisis and the problems associated with the EMP index, the variables and methods used in conceptualizing the research problem, and the findings and analysis section explaining the results in the context of Ghana and South Africa. The conclusion makes recommendations on how the IT framework can be made effective in the study countries.

2. Literature Review

The exchange rate is an important indicator in the monetary policy assessments of many countries (Bank of England 1999; Baqueiro et al. 2003). Usually, the exchange rate provides a link between the interest rates of two trading countries through the appreciation or depreciation of their exchange rate (Frenkel and Levich 1975; Dornbusch 1976). Its effects are wide and varying—it affects the flow of exports and imports, as well as the passing through of the price of foreign goods to domestic prices (Taylor 2001). These effects can erode the purchasing power of domestic citizens, and affect the allocation of resources by the government, leading to political and economic problems, as well (Fischer 2001).

Excess liquidity, traditionally, is known to be the main cause of increases in domestic prices and depreciation of the exchange rate, partly because of their inter-connectedness (see, for example, the phenomenon of imported inflation). Indeed, the relationship between the exchange rate and inflation is of utmost importance in a monetary environment in which shocks affect both inflation and the exchange rate (López-Villavicencio and Mignon 2017).

2.1. Exchange Rate Crisis

The financial crises of the past (the late 1960s and early 1970s, the 1980s, 1992 and 1993, and 1994 and 2000) all implied that an exchange rate crisis is intense for countries that are exposed to international capital flows (Fischer 2001). Most of the major exchange rate crises linked to the international capital market have either involved countries with a fixed or a non-flexible exchange rate regime (Cavdar and Aydin 2015). At the same time, as argued by Obstfeld and Rogoff (1995), countries that had flexible exchange rates—including South Africa—avoided this type of crisis that affected emerging countries (Fischer 2001). The currency crisis theories of Salant and Henderson (1978) and Krugman (1979) employ models that have countries anchoring their currencies with gold sales and foreign exchange reserves, respectively, to mitigate the risk of currency devaluation.

Friedman (1953) led the argument for flexible exchange rates, pointing to the fact that supply or demand shocks in the exchange rate will require the adjustment of inflation between countries that are connected through trade. To this end, a flexible exchange rate, according to Friedman (1953), allows prices to adjust instantaneously. This argument will mean that authorities in open developing economies should adopt flexible exchange rate regimes. The above-mentioned course of policy also relies on the notion that exchange rate movements immediately affect domestic prices. Recent studies (Bank of England 1999; Devereux and Engel 2003; Baqueiro et al. 2003; Gali and Monacelli 2005); however, find that this effect may be negligible in the short run. López-Villavicencio and Mignon (2017), in estimating the link between the exchange rate and inflation, found that the adoption of an inflation-targeting framework reduces the effect of depreciation pressures on consumer prices.

2.2. Dealing with Exchange Rate Crisis

As a result, policymakers recommend that countries choose to either peg their currencies or adopt a flexible exchange rate regime, since intermediate exchange rate regimes are not sustainable (Fischer 2001). This indicates that scholars are divided in terms of what the optimum policy option should be (Latter 1996).

Certain structural characteristics make emerging economies more vulnerable to external shocks (Devereux et al. 2006). This will leave emerging economies more concerned about the appreciation or depreciation of their exchange rate. Thus, they will often have what Calvo and Reinhart (2002) refer to as a "fear of floating," because they are not willing to tolerate sharp movements in their exchange rate—a situation that can occur under a flexible exchange rate regime.

The effect of monetary policy shocks on the exchange rates has also been a debatable issue among scholars over the years. Most studies have found that the maximum response of the exchange rate to shocks could only be observed with substantial delays (Kim and Lim 2018). Eichenbaum et al. (2017) studied this phenomenon and found that the exchange rate could not predict inflation effectively. When they extended their analysis by introducing an open-economy model, they discovered a significant role of dollar-denominated bonds in this regard. Fratzscher (2009) found that countries with low foreign exchange reserves and high dollar-denominated bonds witnessed larger exchange rate depreciations during the 2009 financial crisis in general (Fratzscher 2009).

2.3. Inflation Targeting (IT) Framework as a Cure to Exchange Rate Crisis

Nakatani (2018) analyzed FX rate shocks, FX regimes, and capital controls in relation to the occurrence of an exchange rate crisis. He found that exchange rate crises are more probable in countries that adopt flexible exchange rate regimes. In pegged exchange rate regimes, Nakatani (2018) discovered that productivity shocks are reduced in the presence of capital controls. Soe and Kakinaka (2018) discovered the opposite by finding that countries committed to an IT regime would not be required to intervene in reducing pressure on their currencies. Goldfajn and Gupta (2003) confirmed the findings of Soe and Kakinaka (2018) in their study.

Few studies, such as Fiador and Biekpe (2015), have considered Sub-Saharan African (SSA) countries by applying the EMP index to these countries. They studied the impact of the EMP index proposed by Girton and Roper (1977) on the monetary policy of 20 SSA countries. They found this impact to be negative and significant—the discount rate was used as a proxy for non-IT framework countries. The problem with this application of the index is that it assumed indirectly that all the 20 SSA countries use the monetary policy rate as the main variable for policy action, as would have been the case under an IT framework.

2.4. Measuring Pressure on the Exchange Rate, Possibly Leading to an Exchange Rate Crisis

According to Krušković (2017), intervention by the central bank to reduce depreciation pressures is dependent on the level of a country's foreign exchange reserves, which intro-

duces a limit to the level of intervention. Krušković (2017) argues that if the depreciation was arising from weak fundamentals (i.e., large accumulated fiscal deficit), then foreign exchange intervention will not be enough to reduce depreciation pressures unless the main interest rate is increased. This argument influenced Girton and Roper (1977) to develop an exchange market pressure (EMP) index to identify periods where there was excess pressure on a country's exchange rate. This idea was modified by subsequent authors to capture the reaction function of monetary authorities by adding the interest rate variable to the index developed by Girton and Roper (1977). Since then, a substantially large number of studies, for example, Sachs et al. (1996), Hegerty (2018), Kaminsky and Reinhart (1999), Hossfeld and Pramor (2018), Eichengreen et al. (1994, 1996), and Stavarek (2010), have used the EMP index to identify crisis episodes in different economies. Eichengreen et al. (1994) employed extreme values to the formula of the EMP index to identify a contagious currency crisis. Accordingly, a crisis is detected when the index exceeds 1.5 of the standard deviation and the sample mean of the index. Similarly, some other studies used various unconventional methods to determine periods of exchange market pressure.

2.5. Research Gap

Bertoli et al. (2010) proved that the recent form of the index has some flaws, especially in a developing country setting. Bertoli et al. (2010) cautioned against the use of an arbitrary variable to identify exchange market pressure. For instance, in dealing with the threshold problem, Pontines and Siregar (2008) focused on the normality assumption of the EMP index but still used an arbitrary number of standard deviations to identify crisis episodes. Pontines and Siregar (2008) also discovered weighting problems with the component of the EMP index and the threshold problem described earlier.

These findings from the literature present a gap that this study is seeking to fill. Previous studies have still not addressed the threshold problem identified by Pontines and Siregar (2008). In addition, most studies did not dwell significantly on IT framework countries in SSA, even though a significant addition to the index by Girton and Roper (1977) had been the interest rate variable, which is key in an IT framework. In order to fill this gap, this study used different estimate versions of the EMP index based on the reviewed literature and applied them to two countries in SSA (i.e., South Africa and Ghana) that have adopted the IT framework. Addressing these problems will help to resolve the problems with the EMP index in countries applying the IT framework.

3. Materials and Methods

3.1. Materials

Data from the IMF's International Financial Statistics (IFS) were used for this study (Table 1). The data are a monthly data set spanning from February 2002 to December 2017. The choice of the data period was influenced by data availability, especially on the broad money, interest rate, and reserve variables. Using the IMF's annual report on exchange arrangements and exchange restrictions 2019, three countries—Ghana, South Africa, and Uganda—in SSA were found to be using the IT framework for monetary policy and were thereby expected to adopt a floating exchange rate regime. This classification by the IMF is the de facto classification of exchange rate arrangements, as of 19 October 2021, and monetary policy frameworks (IMF 2021). It reports the country's actual exchange rate and monetary policy arrangement as observed by the IMF staff. This classification may differ from what the countries officially announce as their exchange rate and monetary policy arrangement; thus, market determination prevails against official action. The study focuses on only South Africa and Ghana because Uganda only adopted the IT framework in 2013, making their data series very short.

Table 1. Variables and data source.

Variables	Data Source	Data Time Period
Exchange Rates	IFS	2002–2017
Financial, Interest Rates, Monetary Policy-Related Interest Rate	IFS	2002–2017
International Reserves, Official Reserve Assets	IFS	2002–2017
Monetary, Broad Money	IFS	2002–2017
Monetary, Reserve Money	IFS	2002–2017
Total Reserves, US Dollars (Gold at Market Price)	IFS	2002–2017

Source: Authors' Construction.

3.2. Methodology

From the literature reviewed, there have been different variations of the exchange market pressure index originally developed by Girton and Roper (1977). As a first step of the analysis, we estimate the different variations of the index based on the works of previous authors such as Sachs et al. (1996), Hegerty (2018), Kaminsky and Reinhart (1999), Hossfeld and Pramor (2018), Eichengreen et al. (1994, 1996), and Stavarek (2010). This is expected to help deal with the sensitivity issues associated with the estimation of the EMP index. Starting with the most recent version of the index—as developed by Hegerty (2018)—followed by the original index by Girton and Roper (1977), the various variations of the index are expressed algebraically as the follows:

$$EMP\_1_t = \frac{1}{\sigma_{\Delta e}}(e_t - e_{t-1}) - \frac{1}{\sigma_{\Delta res}}\frac{\Delta RES_t}{Money_{t-1}} + \frac{1}{\sigma_{\Delta r}}\Delta(r_t - r_t^{us}) \quad (1)$$

$$EMP\_2_t = \frac{e_t - e_{t-1}}{e_{et-1}} - \frac{RES_1 - RES_{t-1}}{Mon_{t-1}} \quad (2)$$

$$EMP\_3_t = \frac{e_t - e_{t-1}}{e_{et-1}} - \frac{RES_1 - RES_{t-1}}{RES_{t-1}} \quad (3)$$

$$EMP\_4_t = \frac{e_t - e_{t-1}}{e_{et-1}} - \frac{RES_1 - RES_{t-1}}{Mon_{t-1}} + \frac{r_t - r_{t-1}}{r_{t-1}} \quad (4)$$

$$EMP\_5_t = \frac{1}{\sigma_{\Delta e}}(e_t - e_{t-1}) - \frac{1}{\sigma_{\Delta res}}(RES_t - RES_{t-1}) \quad (5)$$

where $e_t - e_{t-1}$ is the change in the nominal exchange rate expressed in domestic currency per US \$. $\frac{\Delta RES_t}{Money_{t-1}}$ is the changes in reserves, scaled by a measure of money supply), and $\Delta(r_t - r_t^{us})$ is the interest-rate differential against that of the United States. The component in Equations (1) and (5) are normalized by their own standard deviation so that the most volatile part does not dominate the index ($\frac{1}{\sigma_{\Delta e}}$, $\frac{1}{\sigma_{\Delta res}}$ and $\frac{1}{\sigma_{\Delta r}}$).

The index captures the severity of pressure on a currency—as would happen in the presence of depreciation and appreciation expectations—which is often not shown in the nominal exchange rate dynamics.

These equations (*EMP*_1 to *EMP*_5)—the explanatory variables (X_t)—will be regressed on changes in the exchange rate variable—dependent variable (Y_t)—to identify the index with the most explanatory power (see Equation (6)). The components of the index will suggest we guard against multicollinearity.

The correlation analysis showed a strong association between *EMP*_1 and *EMP*_2 for the log changes in the exchange rate variable in Ghana and South Africa, respectively (see Tables A1 and A2). A unit root test conducted on the computed indexes (*EMP*_1 to *EMP*_5) rejected the null hypothesis of unit root (for both common and individual unit root processes) at the level for the group of indexes and the log changes of the exchange rate variable. This indicates that the variables are cointegrated. This result is not surprising

given that the variables used for computing the indexes were differenced and adjusted by a reserve indicator.

$$Y_t = \alpha_0 + \beta_1 X_t + \varepsilon_{it} \tag{6}$$

As a result, a ridge regression model and a Dynamic Ordinary Least Square (DOLS) model were applied to Equation (6) above and used to test the explanatory effect of these indexes on the exchange rate variable. These models, and especially the ridge regression, were chosen to help deal with multicollinearity and the cointegration among the variables—the DOLS model is efficient in estimating equations with cointegrating relationships. The DOLS model used in this study assumes the existence of a single cointegrating vector, which is a variant of the models proposed by Saikkonen (1991) and Stock and Watson (1993).

After selecting the appropriate EMP index to use for the rest of the analysis, we employed a discrete threshold regression model to help identify crisis episodes in both South Africa and Ghana. This is different from the model used by Cavdar and Aydin (2015) in predicting the financial crisis in Turkey since they used forecast error measures. This is going to help deal with the threshold problem pointed out by Pontines and Siregar (2008). The threshold regression model is a non-linear time series model (in this case, a univariate model) with the local regimes switching. In this case, the coefficients are constant in each regime but could change between regimes. The switching from one regime to the other is triggered by specific observed data series. Thus, the main goal is to find a value among the values of the data series that triggered the regime change or the exchange rate crisis. The assumptions underlining this model are similar to those of Hansen (2000) and Bai and Perron (2003).

In our analysis, we use a regression model with T observations and m potential thresholds producing $m+1$ regimes. Specification for the observations in regime $j = 0, 1, \ldots, m$ is given by Equation (7) below.

$$y_t = X_t'\beta + Z_t'\delta_j + \epsilon_t \tag{7}$$

The X variables do not vary across regimes, while the coefficients of the Z variables are regime-specific. Assuming that q_t is a set of strictly increasing threshold values, then in regime j, the threshold variable is greater or equal to the j-th threshold value but less than the $(j+1)$-th threshold. Consider, for example, Equation (8) below:

$$y_t = X_t'\beta + \sum_{j=0}^{m} 1_j(q_t, \gamma) * Z_t'\delta_j + \epsilon_t \tag{8}$$

where y_t is a single threshold, the two regime models are using an indicator function $1(.)$, which takes the value 1, if the expression $-\infty < q_t < \gamma_1$ and $\gamma_1 \leq q_t < \infty$ is true for the two regimes and 0 otherwise. The two models are combined into a single equation, as shown in the expression above. q_t, X_t, and Z_t determines the type of threshold regression specification.

The resulting non-linear least-squares equation as defined by the sum-of-squares objective function is shown below:

$$S(\delta, \beta, \gamma) = \sum_{t=1}^{T} \left(y_t - X_t'\beta - \sum_{j=0}^{m} 1_j(q_t, \gamma) * Z_t'\delta_j \right)^2 \tag{9}$$

Threshold regression estimates can be obtained by minimizing $S(\delta, \beta, \gamma)$ with respect to the parameters. Threshold regressions can be thought of as breakpoint regressions with time as the threshold variable.

The diagnostic tests for the threshold regression model did not reject the null hypothesis of normality, serial correlation, and heteroskedasticity in the case of South Africa; thus, the population was normally distributed, there was no serial correlation, and the error variance was all equal. The normality assumption for Ghana was not met as the null hypothesis of normality was rejected in this case (see Appendix A Table A1).

The Eviews software was used for the estimations based on the methodologies of Bai and Perron (2003).

4. Results and Discussion

Before arriving at the result, we test different estimates of the EMP index—based on the reviewed literature—against the dependent variable (log changes of the exchange rate variable) to identify which elements of the index would be effective for explaining it. The focus here is on the EMP index that will have a positive and significant relationship with the log changes of the exchange rate variable. The results of the DOLS regression and the ridge regression model shown in Table 2 demonstrate that the *EMP*_2 had more explanatory power on the exchange rate in both South Africa and Ghana. The recent form of the index defined in Equation (1)—*EMP*_1—had some explanatory power but was not significant. Some of the other variations of the EMP index considered were also significant (*EMP*_3 and *EMP*_4) for Ghana and all countries pooled as one. These other indexes, though significant, will not be considered as they had a negative relationship with the exchange rate. Generally, these results were consistent with the result from the estimated ridge regression and the correlation result explained earlier. Even if a single explanatory variable estimation technique is employed, the resulting Akaike information criterion, Schwarz criterion, and the Hannan–Quinn criterion favor the use of *EMP*_1 and *EMP*_2 for Ghana and South Africa, respectively (See Table A3).

Table 2. The best EMP index for South Africa and Ghana.

	DOLS Regression			**Ridge Regression**		
	S. Africa	**Ghana**	**All**	**S. Africa**	**Ghana**	**All**
*EMP*_1	0.004	0.012	−0.001	0.005	0.008	0.006
	(0.168)	(1.059)	(−0.318)	(3.899)	(2.287)	(2.559)
*EMP*_2	1.003	1.750	1.254	0.754	0.480	0.874
	(5.703) *	(2.454) **	(16.646) *	(3.281)	(4.137)	(3.817)
*EMP*_3	−0.018	−0.551	−0.470	0.157	−0.085	−0.209
	(−0.060)	(−1.339)	(−8.641) *	(3.759)	(3.492)	(3.426)
*EMP*_4	−0.085	−0.398	0.014	−0.037	−0.155	−0.037
	(−0.254)	(−1.955) ***	(0.439)	(2.971)	(2.800)	(2.518)
*EMP*_5	−0.001	−0.006	0.002	−0.003	0.000	−0.001
	(−0.128)	(−0.678)	(1.138)	(2.717)	(3.652)	(3.317)
C	−0.001	−0.007				
	(−0.278)	(−1.988) ***				
R-squared	0.9999	0.9937	0.9518	0.9916	0.8530	0.8755
Adjusted R-squared	0.9991	0.9556	0.9482			

NB: For DOLS, t-statistics is in parenthesis (). Symbols *, **, *** indicates statistical significance at 1%, 5% and 10%. For ridge regression VIF is in parenthesis ().

These results generally suggest that the IT framework has not been effectively implemented in both Ghana and South Africa. This is because the variation of the index that considers the reaction of the monetary authority through the monetary policy rate (*EMP*_1) was not significant in explaining the exchange rate variable. As mentioned earlier, Ghana and South Africa de jure declared that they use Inflation Targeting (IT) alongside a freely floating exchange rate regime, but *de facto*, both countries heavily manage or target the exchange rate (Knedlik 2006; Mminele 2013; Győri and Benedek 2021). These 'two targets, two instruments' situation—adopting a flexible exchange rate regime and at the

same time managing the exchange rate—could be complicating the identification of the policy framework and analysis of monetary policies of these countries.

As indicated in the literature review, the interest rate and the exchange rate are important instruments for monetary policy in small-open developing economies. In the case of developing economies that allow full capital mobility, the exchange rate targeting will incapacitate the monetary authority's use of interest rate or monetary aggregates to operate as an intermediate policy target; thus, changes in the exchange rate and the interest rate differential determine monetary conditions in general. Consequently, the 'two targets, two instruments' policy will only be effective if there is imperfect capital mobility in these countries. Since Ghana and South Africa have capital controls on most capital transactions, the analysis shows that they have been successful in dealing with exchange rate pressures, despite the improper implementation of the IT framework. This somewhat confirms the works of Soe and Kakinaka (2018) and Goldfajn and Gupta (2003); however, unlike Soe and Kakinaka (2018), the case for exchange rate stability was not established.

In identifying the crisis periods in both Ghana and South Africa, the discrete threshold regression was estimated for the countries individually. As a result, the sample period was adjusted based on the instrument variables—2003M01 to 2017M12 for EMP 1 and 2002M11 2017M12 for *EMP*_2. The threshold value used is the highest positive threshold among the five (5) estimated ones. Even though *EMP*_2 had the most explanatory effect on the exchange rate, for the threshold analysis, we also considered the variation of the index, which is intended to capture the use of the interest rate as a policy tool for preventing pressure on the exchange rate (*EMP*_1). The results are shown in Appendix A Table A4.

In total, twenty-eight (28) crisis episodes were identified for Ghana, irrespective of whether *EMP*_1 or *EMP*_2 were used as the dependent variable. This suggests that the use of the interest rate as a reaction function by the central bank was not effective in reducing exchange rate pressure. The crisis periods were more pronounced from 2008 to mid-2009, the first half of 2012, and late 2013 to 2015. The maximum threshold variables for the two indexes used were significantly different, confirming the diversity of the two indexes (as seen before in Figure 1). For South Africa, there were thirty-one (31) and twenty-seven (27) crisis episodes when the *EMP*_1 and the *EMP*_2 were used as dependent variables. The crisis periods were more pronounced in 2008, from late 2011 to the first half of 2012, and from 2013 to 2015 (Figure 1). This confirms the use of the interest rate to dampen pressure on the exchange rate in South Africa since more crisis periods were detected if we applied the interest rate-adjusted index. This observation is not as pronounced as one will expect under an IT regime.

These periods of crisis episodes correspond fairly with reported episodes of exchange rate pressure in South Africa and Ghana. In this regard, the IMF, in its Annual Report on Exchange Arrangements and Exchange Restrictions, reports that volatility in major exchange rates has increased more than during any similar period since the global financial crisis in 2015. This, in turn, led to most central banks intervening to counter the rapid depreciation of their local currencies. This affected most of the exchange rate arrangement reclassifications over the period. South Africa, for instance, eased some restrictions on certain advance payments for imports. Over the same period, Ghana firmly prohibited offshore foreign exchange deals in order to reduce foreign exchange market pressure by enhancing the repatriation of foreign exchange earnings and the use of the domestic currency—most of these measures were later reversed when the pressure still persisted (IMF 2015, 2018).

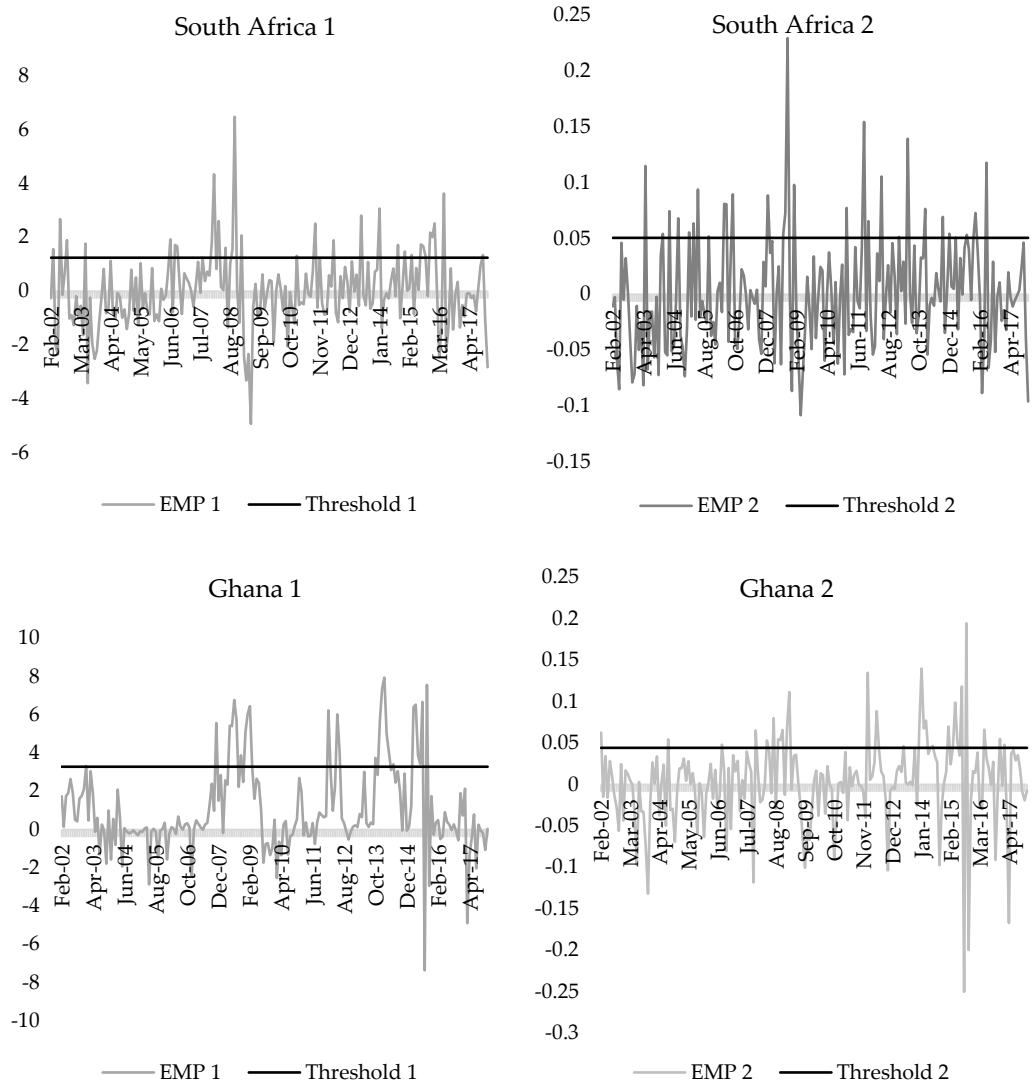

Figure 1. Exchange rate crises episodes in South Africa and Ghana (2002–2017). Source: Authors' Construction.

5. Conclusions

This study has highlighted the importance of the exchange rate variable from a developing country perspective (via the case of some SSA countries). The reviewed literature discussed the historical antecedents that led to emerging economies moving to the adoption of a flexible exchange rate system. This policy prescription, as discussed, is quite challenging for developing economies such as Ghana and South Africa. Thus, certain structural characteristics make emerging economies more vulnerable to external shocks, leaving them more concerned about the level of appreciation or depreciation of their exchange rate. This may indicate that developing countries that adopt the IT framework will not be in the position to allow their domestic currencies to float freely.

In addition, recent models that have been used to measure exchange market pressure—specifically, variations of the EMP index—have indirectly assumed that most countries adopt the IT framework by including the interest rate in the reaction function of countries who experience exchange market pressure. Bertoli et al. (2010) and Pontines and Siregar (2008) identified weighting and threshold problems with the EMP index and cautioned its use in a developing country. We found it important to cite the problems associated with the index as a basis for the research framework of this study and highlight a gap in the literature.

To bridge these gaps, this study relied on the IMF's annual report on exchange arrangements and exchange restrictions 2019 to select Ghana and South Africa as the study countries. In other to deal with the sensitivity issues raised by Bertoli et al. (2010) and Pontines and Siregar (2008), different variations of the EMP index were thus estimated and tested against changes in the exchange rate variable—an attempt at dealing with the weighting problems associated with the EMP index. Results from the Dynamic Ordinary Least Square (DOLS) and a ridge regression model showed that the original index developed by Girton and Roper (1977), *EMP*_2, had more explanatory power on the log changes of the exchange rate variable in both South Africa and Ghana. The recent form of the index defined in Equation (1)—*EMP*_1—had some explanatory power but was not significant. These results generally suggest that the IT framework has not been effectively implemented in both Ghana and South Africa. This is because South Africa and Ghana practice a 'two targets two instruments' monetary policy system, which complicates the identification of the policy framework and the analysis of monetary policy.

In dealing with the threshold problem pointed out by Pontines and Siregar (2008), the threshold regression model was used to identify the crisis episodes in South Africa and Ghana. This resolves a recommendation for future studies by Cavdar and Aydin (2015)—that a time–series analysis should be considered in determining crisis episodes. For this study, the crisis periods were more pronounced from 2008 to mid-2009, for the first half of 2012, and from late 2013 to 2015 in the case of Ghana. The maximum threshold variables for the two indexes used were significantly different, confirming the diversity of the two indexes. For South Africa, there were thirty-one (31) and twenty-seven (27) crisis episodes when the *EMP*_1 and the *EMP*_2 are, respectively, used as dependent variables. The crisis periods were more pronounced in 2008, from late 2011 to the first half of 2012, and from 2013 to 2015. This shows that South Africa has been more effective in implementing the IT framework than Ghana. More crisis episodes were discovered with the *EMP*_1 than with the *EMP*_2 in South Africa. To confirm these findings, the methods used in dealing with the weighting and threshold problems of the EMP index in this study will have to be tested in a developed country setting as well. This can be an avenue for future studies.

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Appendix A

Table A1. Correlation results for South Africa.

	DLNFX	***EMP*_1**	***EMP*_2**	***EMP*_3**	***EMP*_4**	***EMP*_5**
DLNFX	1	0.8501	0.9971	0.9102	0.7268	0.7458
*EMP*_1	0.8501	1	0.8522	0.7903	0.9264	0.6784
*EMP*_2	0.9971	0.8522	1	0.9333	0.7346	0.7854
*EMP*_3	0.9102	0.7903	0.9333	1	0.7133	0.9224
*EMP*_4	0.7268	0.9264	0.7346	0.7133	1	0.6029
*EMP*_5	0.7458	0.6784	0.7854	0.9224	0.6029	1

Table A2. Correlation results for Ghana.

	DLNFX	***EMP_1***	***EMP_2***	***EMP_3***	***EMP_4***	***EMP_5***
DLNFX	1	0.7942	0.7233	0.5010	0.5677	0.7821
EMP_1	0.7942	1	0.6139	0.4383	0.7623	0.7970
EMP_2	0.7233	0.6139	1	0.9401	0.8042	0.9326
EMP_3	0.5010	0.4383	0.9401	1	0.7625	0.8328
EMP_4	0.5677	0.7623	0.8042	0.7625	1	0.7974
EMP_5	0.7821	0.7970	0.9326	0.8328	0.7974	1

Table A3. Information criterion for selecting the best index for South Africa and Ghana.

	South Africa			**Ghana**		
	AIC	**SIC**	**HQIC**	**AIC**	**SIC**	**HQIC**
EMP_1	−4.4862	−4.4521	−4.4724	−5.3152	−5.2811	−5.3014
EMP_2	−8.3527	−8.3187	−8.3389	−5.0596	−5.0255	−5.0458
EMP_3	−4.9669	−4.9328	−4.9531	−4.6080	−4.5740	−4.5942
EMP_4	−3.9551	−3.9210	−3.9413	−4.7080	−4.6739	−4.6942
EMP_5	−4.0164	−3.9823	−4.0026	−5.2651	−5.2310	−5.2513

Note: The table shows a single explanatory model with the log changes of the exchange rate variable as the dependent variable. The shaded area shows the best index based on the information criterion.

Table A4. Threshold regression results for South Africa and Ghana.

	South Africa		**Ghana**	
	EMP_1	***EMP_2***	***EMP_1***	***EMP_2***
Variable chosen	*EMP_1*(-11)	*EMP_2*(-7)	*EMP_1*(-5)	*EMP_2*(-5)
Estimated number of thresholds	5	5	5	5
Threshold value used	1.245	0.051	3.292	0.044
R-squared	0.571	0.400	0.639	0.476
Adjusted R-squared	0.320	0.145	0.428	0.253
Jarque–Bera Normality Test	1.455	0.875	154.932	173.943
Probability	0.483	0.646	0.000	0.000
Breusch–Godfrey Serial Correlation LM Test				
F-statistic (Prob.)	0.880	0.926	0.673	0.511
Obs*R-squared (Prob)	0.813	0.894	0.527	0.379
Heteroskedasticity Test: Breusch–Pagan–Godfrey				
F-statistic (Prob.)	0.102	0.068	0.969	0.855
Obs*R-squared (Prob)	0.146	0.101	0.931	0.801

Source: Author's Construction.

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