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# Theoretical Underpinning the Nexus of Capital Flows, Exchange Rate Volatility and Monetary Policy.

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## ABSTRACT

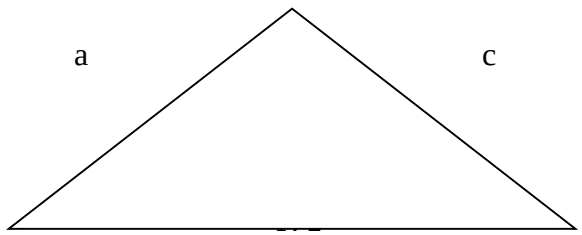
Empirically the model Mundell-Fleming Model reveals that disallowing exchange rate free movement will fraught monetary policy transmission via the exchange rate channel. It is evident that a reasonable number of emerging Asian and Latin American countries employs exchange rate control to monitor the conduct of their monetary policy so as to mitigate the impact of capital flows on the exchange rate. In line with that, monetary authority in Malaysia intervenes in the foreign exchange market to avert large exchange rates fluctuations that are not supported by fundamentals. So, the trilemma hypothesis, has extended in recent times. The Framework suggests a perpetual substitutability between the three dimensions, with the possibility that a fourth policy goal, which is financial stability, may augment it and turn it into a quadrilemma where inter-national reserves may play a role as buffers. Additionally, financial conditions can affect the movement in the developing and emerging market countries – peripheral countries. They study 1) evaluates the sensitivity of financial variables in developing and emerging markets to that of centre economies – policy interest rate, stock market prices, and the real effective exchange rates (REER) – while controlling global and domestic factors; and 2) examines the link between the projected sensitivity coefficients with the macroeconomic conditions, policies, real and financial linkages with the centre economies, and the level of institutional development. The study concludes that "trilemma policy arrangements, including exchange rate flexibility, continue to affect the sensitivity of developing countries to policy changes and shocks in the centre economies. The monetary policy of the Centre Economies (CE) influences other countries' monetary autonomy mostly through capital flows, bank leverages and credit growth. This event will render the exchange rate regime operation of countries that are not members of CE immaterial, as seen in the case of 'the Fragile Five' (Brazil, India, Indonesia, South Africa, and Turkey) during the US quantitative easing taper period.

Keywords: Capital Flows, Exchange Rate, Volatility and Monetary Policy.

## INTRODUCTION

### Mundell-Fleming Model

The direction of the analysis in this area will come from the angle of the impossible trinity – or trilemma – as postulated by [1,2,3,4,5] termed as the Mundell-Fleming model. The trilemma hypothesis is the most important policy management system in open economies. [6,7,8,9] consider the idea of the monetary trilemma to be among the leading concepts in international macroeconomics [10,11,12,13]. It is seen as a policy trade-off between the choice of monetary autonomy, exchange rate stability, and financial openness. Fundamentally, studies consider the impossible trinity as a standard feature in the discussions of the macroeconomic framework of an open economy [14,15].




a. Capital control

b. Fixed exchange rate
c. Flexible exchange rate

***Figure 1: Monetary trilemma***

This shows that a country cannot operate a fixed exchange rate, open capital account, and independent monetary policy at the same time; only two out of these objectives are mutually tenable. However, when a country freezes its capital account, it stops autonomous capital flows, which translates to having both an independent monetary policy and a fixed exchange rate regime. In this case, the substitutability of domestic and foreign assets will have an impact on monetary policy on aggregate demand due to the changes induced by policies in interest rates, which will affect the exchange rate, as well as output and inflation. Nonetheless, if a country opens its capital account, the domestic monetary policy will be determined by the exchange rate regime and the degree of substitutability between domestic and foreign financial assets [16,17,18]. In the case of a floating regime, monetary policy is expected to work either through the channel of interest rate and liquidity or that of the exchange rate. Nevertheless, if the trade-off between domestic and foreign assets is high, it equipoises the impact of monetary policy via capital flows in a fixed exchange rate regime. Therefore, in the event of a less trade up under fixed exchange rate regime, the monetary authorities will conduct domestic interest rates independent of foreign rates [19,20,21].

However, since the introduction of the original Mundell-Fleming model in 1962 several international economics authors have attempted to explain how the model works. For example, [22,23,24,25] explain the monetary trilemma with help of IS-LM model, in which they define both IS and LM equations the same but differ in the openness of the model. Feenstra and Taylor's explanation introduces the concept of foreign exchange, i.e. IS-LM-FX; while Salvatore postulates his explanation with balance of payment (BOP) equation, i.e. IS-LM-BOP. Both explanations believe that IS and LM market equilibrium are defined as functions of the income and interest rate. The foreign exchange market (FX) equilibrium in the Feenstra and Taylor model will only hold when the domestic interest rate is equal to the global interest rate. The BOP line in Salvatore's model illustrates the trade up between interest rate and income where a country has attained equilibrium in the balance of payment, i.e. neither a deficit nor surplus is recorded in the country's balance of payments [26,27,28].

Additionally, some international economic scholars explained the monetary Trilemma using different approaches, for example, [29] converse on the monetary trilemma in the context of currency unions. [30] develop a good market and asset market model to explain the phenomena i.e. the DD-AA model. The equilibrium in the two markets DD and AA is assumed to be the functions of the exchange rate and income. The approach of [3] in explaining the monetary trilemma is a bit different because he postulates his explanation without having a formal model. [9] postulates his explanation on the trilemma with the use of a model that is related to a country's current account to the country's real exchange rate. Several other International Economic authors use various ways in their books to explain the monetary trilemma without much success those studies include [7,8,9]. In contrast, [16] successfully examines the monetary trilemma as part of his analysis of open economy monetary and fiscal policies with the use of an IS-LM model with the exchange rate and income on the axes.

This study attempts to stick with the original layout of the Mundell-Fleming Model or IS-LN-BOP Model, below is the presentation of the theory as it is:

➢ **The Model Assumptions:**

- Identical spot and forward exchange rate with indefinite non-change in the behaviour of the exchange rate.
- The model also assumes state unemployment, resources, wages and constant return to scale. Additionally, the constant domestic

price level and elastic supply of domestic output.

- An increase in income will result to increase in the tax and savings.
- The balance of trade is the function of income and exchange rate.
- Moreover, the model assumes imperfect capital mobility and the perfect situation in the security market.
- The model also assumes a small and open economy with no capability of affecting foreign incomes or the world level of interest rates.

➢ **IS curve**

$$Y = C + I + G + NX$$

Where: $C = C\,(Y - T(Y), i - E\,(\bar{x}))$, $I = l\,(i - E(\bar{x}), Y_{t-1}$ and $NX = Nx\,(e, Y_{1,} Y^{*})$

Substituting these components from the original equation, the IS curve would be

$$Y = C\,(Y - T(Y), i - E\,(\bar{x})) + l\,(i - E(\bar{x}), Y_{t-1} + G + NX\,(e, Y_{1,} Y^{*}) \quad (1)$$

Where Y = GDP, C = Consumption, I = Physical investment plus intended inventory investment, G = Government expenditure which is term as exogenesis, $E(\bar{x})$ = expected inflation, $Yt_{-1}$ = GDP in the succeeding period, $Y^{*}$ = GDP of trade partners country, e = nominal exchange rate and NX = net export.

➢ **LM curve**

$$\frac{M}{P} = L\,(i, Y) \quad (2)$$

M = Money supply (exogenous), P = Price level (exogenous), L = Liquidity preference (i.e. real money demand), i = Nominal interest rate and Y = GDP. The assumption that, in either of the following two conditions. i.e. high interest rate or lower level of income. GPD will affect the level of income negatively.

➢ **BOP curve;**

BOP = CA + KA

Where $CA=NX$ and $KA = Z\,(i - 1^{*}) + K$

Substituting the component of BOP from the original equation, we will have:

$$BOP = NX\,(e, Y_{1,} Y^{*}) + Z\,(i - 1^{*}) + K \quad (3)$$

Where BOP = Balance of payment, CA = Current account surplus, KA = Capital Account Surplus, CA = NX note that the CA is solely imports and exports, $I^{*}$ = Foreign interest rate, K = The exogenous variables of financial capital flows and Z = The rate of interest rate sensitivity of the variables of interest rate and also the derivative of 2 refers to the degree of capital mobility i.e. differences of between domestic and foreign interest rate upon the capital flow KA. The Mundell-Fleming model is effective in the study of fiscal and monetary policy effectiveness in the presence of global capital mobility irrespective of the exchange rate. Moreover, it is capable of predicting the impact of domestic and foreign stocks, and the co-movement of macroeconomic variables, both domestic and international. In spite of these benefits, the traditional Mundell-Fleming model has been criticised for the sticky price symbol assumption as observe by [8]. And also, the model is static in nature due to the absence of the dynamic effects of capital and asset accumulations consideration. That is, it overlooked the links between flows and stocks variables. Additionally, it is lacking in studying long-run dynamic effects. Furthermore, it is single adjustments to key variables, which totally ignore restrictions and inter-temporal links. In view of these weaknesses, this study augments the Mundell-Fleming model with empirical expectations in order to achieve its objectives.

In determining the exchange rate, the traditional Mundell-Fleming model is theoretical in nature, i.e. the exchange rate is determined by the flexibility of demand and supply and shows how the staple of the equilibrium. The theoretical market determination of the exchange rate alone in the model cannot hold true for the data in the sample countries. Thus, the exchange rate data for these countries are characterized by high volatility. And it is

in convent that volatility is taking into account when modelling exchange rate. Therefore, the mean equation is highly inadequate for determining exchange rate relation in a model. It is rather the variance equation that is important. In this aspect of the study, homoskedasticity is assumed, i.e. the variance of the residuals is constant and no longer positive, (does not hold true for the data). The data that are highly volatile (such as the one for the sample countries) and are characterized by non-constant variance. Thus, with respect to the sample countries, any model to appropriately study the data has to account for heteroskedasticity. In line with this discovery, the study has to account for an ARCH effect. The study tested for all the five forms of ARCH (NAGARCH, IGARCH, EGARCH, TGARCH and MGARCH) across the data and established that there is presence of ARCH effect and the study use the model selection criteria in choosing the model that is appropriate for the data. Meanwhile, even in the Mundell-Fleming model, the exchange rate is characterized by high volatility, as found in the data. So, it is important that GARCH, ARCH effect is taken into account, which the theoretical Mundell-Fleming model does not allow, to see that ARCH effect. Moreover, capital flow volatility as against the Mundell-Fleming postulation's, the study established that the exchange rate volatility is linked to an open capital account. That is out of the three components in model two are closely related, i.e. capital flow volatility and exchange rate volatility which is a good outcome. Therefore, the study model volatility base on empirical content of the data.

**Auto-Regressive Condition Heteroskedasticity (ARCH) Model**

The traditional ARCH model developed by [9] is a model that is commonly used in modelling time series that exhibit time varying volatility and volatility clustering ($ARCH_{(}q_{)}$) model specification.

The ARCH Process

$$E_t = \theta_t Z_t$$

Where, $E_t$ is the error term (i.e. return residuals, with respect to a mean process) and strong white noise process. $Z_t$ stands as a stochastic variable and $\theta_t$ is the time dependent standard deviation.

Therefore, $\theta^2$ is model by the following equation;

$$\theta_t = q_o + q_1 E_{t-1} \ldots . q_q E^2{}_{t-q} = q_0 + \sum_{t=1}^{a} ai\, E^2{}_{t-i} \quad (4)$$

Where $q_0 > 0 \; and \; ai \geq 0, i > 0$

In this the Procedure of Estimation is as follows;

Best fitting estimates autoregressive model AR(q)

$$Y_t = a_o + a_1 Y_{t-1} + \cdots aqY_{t-q} + E_t = q_o + \sum_{t=1}^{a} aiY_{t-i} + E_t \quad (5)$$

Therefore, the squares of the error $\hat{E}^2$ was obtained and regress then on a constant and q lagged value:

$$\hat{E}^2{}_t = \hat{\alpha}_0 + \sum_{t=1}^{a} \hat{\alpha}_i \hat{E}^2{}_{t-1}$$

Where q = Length of ARCH lays

The Model Hypothesis

1. The Null Hypothesis of the model state that, $\alpha_i = 0 \; for \; all \; i = 1 \ldots q$ in case of non-existence ARCH in the model.
2. The alternative hypothesis state that, $\alpha_i$ coefficients must be significant in the presence of ARCH components and also in the sample of T residuals under the null hypothesis of ARCH errors, the test statistics $T^1R^2$ follows $X^2$ distribution with $q$ degrees of freedom.

Where $T^1$ is the number of equations in the model which fits the residuals as the lags (i.e. $T^1 = T - q$). If $T^1R^2$ is greater than the chi-square table value, we reject the null hypothesis and conclude

there is an ARCH effect in the ARMA model. If $T^1R^2$ is smaller than the chi-square able value, we do not reject the null hypothesis.

**GARCH (p, q) Model Specification**

1. Best fitting AR(q) model:

$$Y_t = a_o + a_1 Y_{t-1} + \cdots a_q Y_{t-q} + E_t = a_o + \sum_{t=1}^{a} a_i Y_{t-1} + E_t$$

2. Computation and rotary of auto corrections

$$P = \frac{E_{t-i+1}\left(\hat{E}_t{}^2 - \hat{O}_t{}^2\right)\left(\hat{t}^2{}_{t-1} \quad -\hat{O}^2{}_{t-1} \quad\right)}{\Sigma_{t-1}\left(\hat{t}_t{}^2 - \widehat{\theta_t}^2\right)^2}$$

3. $p\ (i) = \frac{1}{\sqrt{T}} which\ is\ asymptotic$

**EGARCH**

The exponential GARCH model of [12] is employed by the study to account for the volatility of capital field, exchange rate volatility and the capital volatility spillover to exchange rate due to its advantages over pure GARCH specification. The advantages are:

1. Due to the log $\theta^2{}_t$automatically turn positive.
2. Asymmetric are allowed for under the E GARCH formulation, since if the relationship between volatility and return is negative, Y will be negative.

The specification of the model is as:

$$Log\ \theta^2{}_t = w + \sum_{k=1}^{q} \beta kg\ (2_{t-k}) + \sum_{k=1}^{q} \alpha k\ log\ \theta^2_{t-k}$$

Where $g = (Z_t) = \theta 2_t + \lambda\left(1Z_t\ 1 - E\ (1Z_t 1)\right)\theta_t^2$

Presented as the conditional variance.

$w, \beta, \theta\ and\ \lambda = Coefficients$

$Z_t = Standard\ normal\ variable\ O\ generalised\ error\ distribution.$

However, leverage effect and it is spilling over to exchange rate, the study establishes how capital flows are volatile and the nature of their volatility follows the behaviour of EGARCH and to a large extent, it will explain how the exchange rate is volatile. Thus, since the capital volatility follows the behaviour of EGARCH substantially, the study does not expect the exchange rate volatility behaviour to deviate from that. Such is in line with the study's prior expectation that the behaviour of the exchange rate will be in line with the capital flow volatility.

**New Keynesian Monetary Policy Rule**

At this juncture, the study incorporates an ad-hoc model to the New Keynesian monetary policy due to the inadequacy of the Mundell-Fleming LM equation in explaining the monetary policy across the sample countries. The reasons for its inadequacy are as follows;

1. The fact that the model in based on the monetary authority to change the money supply in conducting monetary policy i.e. real money stock equal liquidity preference M/P. But this assumption contradicts the current practice of the central banks in small open economies, the practice of the monetary authorities mostly is targeting inflation with aim of keeping it low, for example, the South African Reserve Bank. Thus, the LM equation in the Mundell-Fleming model does not have a component of expected inflation. The only framework that allows for expected inflation to be accounted for is the New Keynesian because it has a micro foundation. And therefore, this study employs the New Keynesian to augment for the deficiency of the Mundell-Fleming equation.
2. The Mundell-Fleming model is susceptible to Lucas critique, i.e. policy invariance. This is when the data that are used to estimate the parameter of a model is invariant to policy, i.e. no change when policy changes are found to be defective.

In other words, it is not responsive to policy.

3. The Mundell-Fleming does not incorporate expectations.

However, in view of the above problems in the Mundell-Fleming model the study employs a more superior framework that has the ability to account for the practice of the central banks in the sample country. This is due to the fact that central banks are in line with managing expectations and the New Keynesian model has both macro and micro foundations and its parameters are policy variance. Moreover, all the sample countries are open economy and they are all trading with the rest of the world base on the value of their currency in relation to the US dollar. Therefore, the baseline equation is extended with the ad-hoc model of openness to account for this reality and also underline characteristics of these economies.

The traditional Baseline equation indicates that the dynamic behaviour of a country is ruled by the following set models;

**The Baseline New Keynesian Model**

This shows that the dynamic behavior of the country is governed by the following set of traditional equations:

$$Y_l^n = \frac{(1-\alpha)(1n\,(1-\alpha)-u)}{w} + \frac{1+\varphi}{w} q_t + \frac{\sigma\,(1-\alpha)}{w} q_t \quad (6)$$

$$\hat{Y}_t = \hat{Y}_t + Y_t^n - Y_1$$

$$\hat{Y}_t = \hat{C}_t + g_t$$

$$\hat{Y}_t = q_t + (1-\propto)\hat{n}_{t1}$$

$$\varphi\hat{n}_t + \sigma C_t - \frac{w_l}{p_t} = 0$$

$$r_t^n = p - \sigma\,\frac{1+4}{w}(1 - p_a)q_t + \sigma\,\frac{\varphi+\alpha}{w}\,(1 - p_g(g_r) \quad (7)$$

$$\hat{\mu}_t = \hat{Y}_t - \hat{n}_t - \left(\frac{w_t}{p_t}\right)_1$$

Dynamic equations:

$$\hat{Y}_t = E_t\hat{Y}_{t-1} - \frac{1}{\sigma}(i_t - E_t\pi_{t+1} - r_t^n) \quad (8)$$

$$\pi_t = \beta E_t\pi_{t+1} + \lambda\left(\sigma + \frac{\alpha+\varphi}{1-\alpha}\right)\hat{Y}_t$$

Monetary Policy

$$i_t = p + \emptyset\pi - \pi_t + \emptyset_{\,y}\hat{Y}_t - v_t \quad (9)$$

Exogenous process:

$$a_t = p_a a_{t-1} + E_{a_1} t_1 \quad (10)$$

$$v_t = p_v v_{t-1} + E_{v_1} t$$

$$g_t = p_v q g_{t-1} + E_{g_1} t_1$$

Where: $\lambda = \frac{(1-\theta)(1-\beta\theta)(1-\alpha)}{\theta\,(1-\alpha+\alpha_t)}$ *and* $w = \alpha + \varphi + \sigma\,(1-\alpha)$

Overall, this study attempts to establish whether the monetary policy responses of AEE countries are guided by rule(s) that help curb capital flow volatility and exchange rate volatility. Using monetary policy rule in converting capital flows and exchange rate volatility, [9] asserts that,

*"If central banks want to avoid excessive exchange rate volatility, they are likely to take into account other central banks' actions when determining their own policy rates. It is possible that the policy rule (i.e. the Taylor Rule) will include a term with other central banks' policy rate.*

Additionally, [9] claims that many central banks' rules contain the policy rate of other central banks. The question now is: what is monetary policy rule? For [9], monetary policy rule is the application of a systematic decision process that uses information in a consistent and predictable way in the implementation of monetary policies by central banks. However, a potential good policy rule should have the ability to exert changes in the price level or in real income [11]. The main goal of using the rule in monetary policy is to achieve a certain level of price stability in the economy. In order to recognise the policy rule in a country, it is essential for that country to detail the instruments its central bank is able to use, as well as how these tools encroach on price development.

$$i - t = r + \varphi(\pi - t - \bar{\pi}) + r_t^s + \bar{r} \quad (11)$$

This shows that the monetary policy rule of a central bank of a country raises interest rate if the inflation rate exceeds 2% or if real GDP is higher than potential GDP. The Taylor rule is a well-thought-out idea that is considered as the most popular monetary policy econometric model for policy evaluation. The model demonstrates the application of rules in monetary practical policymaking situation. The model categorically affirms that the quality of a policy rule determines the changes in the central bank's policy response to changes in inflation rate or real income. [5] asserts that policy rule is important to central banks because studies have confirmed that monetary policy rule produces yield better macroeconomic performance. [9] states that the advantages of using monetary policy rule are that "it is precise in its usefulness and goal, i.e. it prescribes responses to fluctuations in inflations or the output gap tends to stabilize those variables". Additionally, using simple rules in the conduct of monetary policy, irrespective of the usage method by central banks, can be analysed with simulation and optimization techniques [7]. In recent times, models characterise monetary policy, all thanks to the introduction of new econometric and statistical packages [11]. Similarly, many types of research in monetary policy rules have been conducted to solve monetary challenges, and more recently the challenges caused by the recent global financial crisis and movement towards more independent central banks. For example, using forward-looking monetary policy rule, [9] estimates the pre and post October 1979 United States conduct of monetary policy. This coincided with the beginning of Paul Volcker's Chairmanship at Federal Reserve. The study discovers that the US monetary policy was not in line with the Taylor rule prior to 1979. Additionally, the study revealed that the Taylor rule interest rate coefficients adhered to the Taylor principle through the Volcker and

It should be noted that literature on monetary policy rule, particularly in the industrial and emerging countries, have grown significantly during the last two decades[1]. Most of the studies report evidence of the relevance of using interest rate rule as a tool for the analysis of the conduct of monetary policy. These findings confirm the adherence of the industrial countries to the usage of Taylor-type rules, which is similar in principles to the one described in [8].

Taylor formalises the idea that the monetary authority sets the real interest rate as a function of how inflation differs from its target level, and also as a function of the output gap ($y_t^d$).

The idea is as follows:

[1] See Clarida *et al*. (1998); Minella *et al*. (2003); Bell & Slaridan (2005); Cukiemen & Muscetella (2008)

Greenspan tenures as Feds chairs. In an attempt to describe central bank behaviour using US quarterly real-time data, [4] compare both the in-sample and out-of-sample properties of five Taylor rate varied and two simple unvaried models of federal fund rates. The study report that the forward-looking rule and nonlinear rule that allow stronger interest reaction when the interest rate is high than when it is low best fit in simple specification giving Akaike and Bayesian information criteria. They are also the best models in out-of-sample forecasting performance. They disagree with the findings of [14], in which they argue that the fed followed the Taylor principal before 1979during the Volcker-Greenspan era. Despite the research proliferation in this area, researchers often overlook the less developed countries in their samples. This may be because the economies are shallow, or possibly due to data issues.[2]

It is established that monetary policy rule plays an important role in determining the dynamics of macroeconomic processes and its outcomes in countries.[3] This confirms [15] position that significant progress has been achieved in understanding how to adjust the simple rule to deal with measurement error and expectations. Modelling the reaction of the monetary policy rule to changes in economic conditions has long been an important task for model builders. For instance, the short-term interest rate can be utilised to stabilise inflation and output fluctuations in response to demand or supply shocks. Several types of monetary policy rules have been developed to respond to changes in macroeconomic activities. These monetary rules include Wicksell reactive monetary rule of 1898, Simson's price level targeting of 1936, and Milton Friedman's K-percentage rule.

The [6] monetary rule is particularly important because it has widely experimented within macroeconomic models, and has been used and analysed in recent studies. The rule stipulates that the instrument of the monetary authority reacts to two key basic variables: 1) deviations of synchronous inflation from a pre-set target rate and 2) deviations of synchronous real output from its potential level. The structure of this rule is simple and tractable but also captures the essence of the behaviour of the monetary authority. There have been numerous modifications to the Taylor rule over time in order to take into account other elements of the workings of monetary policy. There is a huge body of literature on the properties of the Taylor rule and other Taylor-type rules. This study presents a survey of this literature, with a view to estimating and formulating Taylor-type rules, and how such rules affect the dynamics of macroeconomic of African emerging economies.

**Interest Rate Parity: Foreign Interest Rate vs Domestic Interest Rate and Monetary Autonomy**

This study also concerned with the relationship between foreign and domestic interest rates, and an evaluation of the strength of monetary autonomy.[4] Such in this study we consider the following equation by [9]:

$$i_t - i_t^* = R_t\{\Delta a_{t+1}\} \qquad (12)$$

In the above equation, $i_t$ is a domestic interest rate, while $i_t^*$ is foreign interest rate belonging to the security of the same maturity. This, therefore, stands for the expected rate of depreciation of the domestic currency. The expected rate of depreciation of the domestic currency in a country with a flexible exchange rate

[2] See Basilio (2013); Galimberti & Moura (2013); Molodtsova & Papell (2012).

[3] See Fraga *et al*. (2003); Minella *et al*. (2003); Bell & Sleridan (2005); Baitinei *et al*. (2005).

[4] See Frankel *et al*. (2004), Obstfeld *et al*. (2005); Klein and Shambaugh (2013); Obstfeld (2015); Edward (2015); Disyatat & Rungcharoenkitkul (2015); Aizenman & Binici (2016)

regime is equalled to zero - $R_t\{\Delta a_{t+1}\}$ =0 and domestic interest rate will be equal to foreign interest rate - $i_t = i_t^*$. In other words, the interest rate on the domestic currency will not deviate from its foreign counterpart; that is, they will move in equal rate and in the same direction. This framework shows that the central banks of countries under a fixed exchange rate regime cannot operate independent monetary policies since they cannot choose their own rate. Suppose $i > i_t^*$ under this regime due to the contractionary monetary policy in the foreign country, the foreign interest rate will increase the domestic interest rate. The situation under flexible exchange rate outlines that: in the case of foreign interest appreciation, the domestic exchange rate is expected to also appreciate in order to protect domestic interest rate i.e. $R_t\{\Delta a_{t+1}\}$ <0, consequently leading to the high volatility of the domestic currency.

[7] offers an alternative explanation that explains the link between domestic and foreign interest rate under these scenarios. Firstly, in the event of the absence of capital mobility, regardless of the exchange rate regime, a country would have an independent monetary policy. In this case, there is no relationship between domestic interest rates and foreign interest rates. Second, free capital mobility provides two scenarios under fixed exchange rate regime:1) a positive relationship between domestic interest rate and foreign interest rate, 2) high foreign interest rates would prompt capital outflow, which would lead to a depreciation of the domestic currency. To avert this situation, therefore, domestic interest rates must rise. Third, the link between foreign and domestic interest rate is not too clear under the floating exchange rate and free mobile capital regime. This is because operating a particular regime does not often stop central banks from intervening in the foreign exchange market to curve volatility or accumulate foreign reserves. Fourth, domestic interest largely affects foreign interest rate whenever there is intervention from a central bank irrespective of the regime in operation. Empirically, co-movement of interest rate is associated with a general pattern of greater harmonization of nominal variables across countries than fluctuations in real activity, irrespective of the degree of business-cycle frequencies [8]. Similarly, [4] discovers that the international long-term interest rate tends to influence the domestic long-term interest rate more than the domestic policy rate. Additionally, the study shows that central banks will gain from keeping inflation low and maintaining a stable macroeconomic environment in helping to stabilise long rates. [14] demonstrate that short and long-term interest rates – irrespective of the interest rate regime a country is operating –can influence foreign interest rate in the long run. [14] buttresses that the interest rate of the countries with pegged exchange rate tends to behave in a similar manner in response to the interest rate of their base country.

## Exchange Rate Regime Classifications

Prior to 1997, IMF is the only publisher of information about the exchange rate regime of their member's country, which is occasionally imprecise. The institution later introduced official exchange rate regime categorisation. This categorisation is being undertaken by the IMF through its Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) for its member countries.[5] This is classified as de jure, a system that is based on the openly stated exchange rate commitment of the monetary authorities in the countries in question [12]. For the purpose of this study, the latest IMF classification within reach has been used (AREAER 2014), which

[5] For alternative historical classification see Levy-Yeyati & Sturzenegger 2005; (Reinhart & Rogoff 2004).

broadly categorised the exchange rate regime into floaters, intermediate, hard pegs, and currency zones. These are discussed below:

a) **Floaters** are divided into independently floating and manage to float:

1. **Independently floating**: This type of exchange rate regime is categorised by [16] as "market determined, with any official foreign exchange market intervention aimed at moderating the rate of change and preventing undue fluctuations in the exchange rate, rather than establishing a level for it". In other words, it is considered as independent, and as such entirely determined by the market forces.
2. **Manage to float**: The IMF defines it as a regime with no program track for the exchange rate. It also has more authoritative intervention than the independently floating regime. However, the monetary authority tends to influence the exchange rate in order to ensure a precise exchange rate track or target. The intervention of the authorities is guided by macroeconomic indicators such as inflation, the balance of payment, foreign reserves, and capital market development.

b) **Intermediate/Soft Pegs** are divided into crawling pegs, exchange rate pegged within horizontal bands, and conventional fixed peg arrangement.

1. **Crawling pegs regime**: Under this type of exchange rate, the expectation is for the exchange rate to adjust gradually over time at a fixed rate, or in response to economic indicators. This will reduce the pressure of sudden and large amount devaluation by allowing the currency to intermittently depreciate.
2. **Exchange rate pegged within horizontal bands regime**: This type of exchange rate is kept within certain limits, usually around a fixed central rate. The sustainability of this system depends solely on the width of the band.
3. **Conventional fixed-peg regime**: Under this exchange rate, a central bank will peg its currency to foreign currency or a currency basket of its choice. In most cases, the currency is allowed to fluctuate within plus or minus 1%. The monetary authority under this arrangement tries to maintain the fixed parity through direct intervention (sale or purchase of foreign exchange) in the event of market surplus or deficit. On the other hand, the monetary authority can make indirect interventions through interest rate policy, the imposition of foreign exchange regulations, the exercise of moral suasion that constrains foreign exchange activity, or through intervention by other public institutions [11].

**c) Hard Pegs:** this can be divided into currency board and dollarize

1. **Currency board**: In this case, *"the basic idea is that the currency board issues currency with a pledge (which could be backed by a law) to do two things: (1) hold a sufficient quantity of another country's currency (the reserve currency) so as to be able to retire the entire domestic currency supply in the hands of the general public and (2) exchange domestic currency for the reserve currency at the fixed exchange rate upon demand (which is the reason that currency boards are sometimes called 'currency vending machines'). The currency board, it is hoped, is a bullet-proof fixed exchange rate foreign exchange regime, qualifying it as a hard peg"* (de Rosa 2009, p 79).
2. **Dollarize**: This refers to a situation in which a country adopts another country's currency, for example, a dollar. For IMF (2014), there are currently about nine countries that are under this category, out of which seven are using US dollar – Ecuador, El Salvador, Marshall

Islands, Micronesia, Palau, Panama, and Timor-Leste – while San Marino and Kiribati use Eastern Caribbean Currency Union (ECCU) and Australian dollar respectively.

**d) Currency zones:** This refers to a conglomeration of countries using the same currency, for example, the euro zone, central African franc zones and (ECCU).

**Concept Monetary Policy**

Monetary policy can be seen as an economic strategy by a government in deciding expansion or contraction in the country's money-supply. The main objective of monetary policy is to ensure price and monetary stability, which are essential for sustainable economic growth in addition to full employment; and also, to establish a healthy distribution of income and wealth in the economy. This is mainly achieved through a well design policy to encourage savers to save, and investors to take risk by using appropriate interest rate structure, such as control of exchange rate fluctuation, ensuring financial sectors dependability through proper supervision and control, maintaining efficient payment system, expanding the scope of financial system to include informal sector particularly in developing countries. The policy often applied through the central bank through three major tools [20]. There are instruments available for a nation's central banks for managing interest in the economy, and therefore influencing the level of aggregate demand through the money market operation. The money market represents the total supply of liquid money in the economy. This refers to cash, cheque cable deposit and savings accounts. The money demand curve represents the demand for money as an asset or a medium of exchange with which to buy outputs or goods produced in the nation's economy. However, there are three popular tools available for a central bank to use for monetary policy. These tools are:

- **Reserve Requirement (Required Reserve Ratio)**: This is the percentage of the bank's total deposit from households and firms that must be kept at a central bank. For example, if a bank has a total deposit of $100m and the reserve ratio in the country is 0.2, this indicates that the bank must keep 20% of the $100m in the central bank. The coefficient of the reserve ratio fluctuates pending the economic situation and government policy. However, if a central bank is pursuing expansionary policy the coefficient of its reserve ratio will be decreased. This will lead to an increase in the supply of money and a fall in the equilibrium interest rate in the economy. The commercial banks will have more money at their disposal to lend to households and firms at a relatively cheaper rate. This will affect the general level of price and aggregate demand in the economy in a positive way. On the other hand, a central bank can embark on contractionary monetary policy if it perceives the inflation rate is high. The contractionary policy, in this case, is by increasing the reserve ratio. This will decrease the amount of money in circulation in the economy; since the commercial banks will be compelled to keep more of their deposit with the central bank. However, the equilibrium interest will increase, and decrease the level of lending by the commercial. Subsequently, the general level of price and aggregate demand will be affected negatively.
- **Open Market Operation (OMO)**: This is the most regularly use of a tool of monetary policy according to literature. This simply is buying bonds or selling bonds from commercial banks and households in order to increase or decrease the supply of money in the economy. Bonds are the liquid assets investments held by households and commercials banks that can earn interest, but they cannot be spent on goods and services. Typically, the decision to embark on OMO is the responsibility of countries' central

banks. This apex financial institution will meet on periodically to review the economic condition of the country in order to determine the next line of action in respect of buying, selling or maintaining the current level of its bond holding. Their decision will be guided by the current economic situation in the country. In a country like the United States, the Federal Reserve meets every two months to take decisions on the level of bonds it should hold. The implication of buying bonds is an expansionary monetary policy, while, the implication of selling bonds is a contractionary monetary policy. The expansionary monetary policy means buying bonds from commercial banks and households to increase the level of money supply in the economy. A central bank will give liquid cash to commercial banks and households in exchange for illiquid bonds. The increase in the money supply will exert downward pressure on the equilibrium interest rate in the economy. This condition will motivate commercial banks to lend out money to households and firms, and this will affect the output level and aggregate demand positively. Nonetheless, contractionary monetary policy refers to buying bonds from commercial banks and households. If a central bank decides to reduce the money supply will sell bonds to the households and commercial banks. This condition will drain the liquid money from the economy in exchange for bond certificates. Therefore, the level of equilibrium interest rate will increase and the price and output level will decrease. Subsequently, the level of aggregate demand in the economy will fall.

- **Discount Rate:** This simply means the rate of interest on short term loans from the central banks to commercial banks. In this case, the central banks manipulate the discount rate in order to speed up or slow down the economic movement by either decreasing or increasing the rate of interest. The increase in the discount rate will result in an upward movement of equilibrium interest in the economy and decrease the rate of commercial banks lending to households and firms. In other words, by increasing central bank discount will make it more expensive for commercial banks to borrow from the central bank, which means more expensive to lend to the household and firms. By default, a reduction in the ability of commercial banks to give out loans will affect the aggregate demand and cut down prices in the economy. If on the other hand, the central bank decides to lower the interest rate. Commercial banks will be motivated to borrow money from a central bank because of the low cost of borrowing. The excess liquidity at their disposal will make them reduce their rate of lending. This will motivate the household and firm to borrow. Therefore, an increase in the level of household and firms spending means an increase in the level of aggregate demand.

## Concept of Monetary Policy Rule

Every aspect of human life is governed and organized by various rules and monetary policy is not an exception. [8] states that monetary policy rule is the application of systematic decision process that uses information in a consistent and predictable way in the implementation of monetary policy by a central bank. [18] state that potential good policy rule should have the ability to exert changes in price level or in real income. The main goal of using rule in monetary policy is to achieve a certain level of price stability in the economy. In order to recognise a policy rule in a country, it is essential for that country to detail the instruments its central bank is able to use, as well as how these tools encroach on price development. It should be noted that literature on monetary policy rule of industrial countries have grown significantly during the last two decades.

Most of the studies report evidence of the relevance of using interest rate rule as a tool for the analysis of the conduct of monetary policy. These findings express the adherence of the industrial countries to the usage of Taylor type rules similar in principles to the one described in [9]. [17] formalises the idea that a monetary authority sets the real interest rate as a function of how inflation differs from its target level and also as a function of the output gap ($y_t^d$). The idea is as follows:

$$r_t + i = \varphi(\pi_t - \pi^*) + r_t^s + r^* \quad (13)$$

The Taylor rule is considered as the most popular monetary policy econometric model for policy evaluation. The model demonstrates the application of rules in monetary practical policymaking situation. The model categorically affirms that the quality of policy rule normally to confer changes in the central bank policy responsive to changes in the inflation rate or real income. [11] asserts the important of using policy rule by central banks due to the fact that studies produce macroeconomic performance under rule guided monetary policy. [15] state that the advantages of using monetary policy rule is that "it is precise in its usefulness and goal, i.e. it prescribes responses to fluctuations in inflations or the output gap tends to stabilize those variables". Additionally, using simple rules in the conduct of monetary policy in respective of the usage manner by central bank "can be evaluated using simulation and optimization techniques" [19]. In recent times, models characterise monetary policy thanks to the introduction of new econometric and statistical packages (Basilio 2013). And also, much research in monetary policy rules have been conducted due to a set of monetary challenges particularly posed by the recent global financial crisis and the movement towards more independent central banks. Despite the research proliferation in this area, researchers often overlook the less developed countries in their samples. This may be because these economies are shallow or due to data issues [19,22]. It is an established fact that monetary policy rule plays an important role in determining the dynamics of macroeconomic processes and outcomes of a country. This can be confirmed by [7] statement that "important progress has also been made in understanding how to adjust simple rule to deal with measurement error and expectations". Modelling the reaction of the monetary policy rule to changes in economic conditions has long been an important task to model builders. For instance, the short-term interest rate can be utilized to stabilize inflation and output fluctuations in response to demand or supply shocks. Several types of monetary policy rules have been discussed in the economic literature like that of Wicksell reactive monetary rule of 1898, Simson's price level targeting of 1936 and Milton Friedman's K-percentage rule. [8] monetary policy rule has however been widely experimented within macroeconomic models and analysed in the literature in recent years. The rule stipulates that the instrument of the monetary authority reacts to two key basic variables, 1) deviations of synchronous inflation from a pre-set target rate and 2) deviations of synchronous real output from its potential level. The structure of this rule is simple and tractable but at the same time captures the essence of the behaviour of the monetary authority. There have been numerous modifications to the Taylor rule over time in order to take into account other elements of the working of monetary policy. There exists a huge body of literature on the properties of the Taylor rule and other Taylor-type rules. This study presents a survey of this literature with a view to estimating and formulating Taylor-type rules and how such rules affect the dynamics of macroeconomic of emerging African economies.

## Taylor Rule Specification and Estimation

[18] establishes that monetary policy rules are useful in practical decision-making environment. Countries can use these rules to characterize and evaluate the past behaviour of their monetary policy actions, and this provides information on

how to generate optimal responses to changes in macroeconomic conditions. Additionally, good policy rules typically call for changes in the federal funds rate in response to changes in the price level or changes in real income (Taylor 1993).

That is:

$$i_t = \pi_t + X + a^*(\pi_t - n) + b^*(k) \quad (14)$$

Where $t$ = time $t$, $i_t$ = federal fund rate, $\pi_t$ = inflation rate, and X = real interest rate, $a^*$ = inflation gap multiplier, $n$ = target inflation rate, $b^*$ = output gap multiplier, $k$ = percentage of GDP below potential.

To affirm this assertion, [8] shows that macroeconomic performance tends to be better when central bank decisions are described by such rules. He also explains general rule-based model which has been successful in explaining monetary policy in the US in [9] as:

$$i_t = \pi_t + X_t + h_t(\pi_t - \pi^*) + i_{t-1} \quad (15)$$

Where $\pi^*$= inflation target and $h_t$ = rate of policy response to inflation's deviation from target.

[15] affirms that using a simple rule offers a great benefit of prescribing responses to fluctuations in inflation. In contrast to discretion, rules-based policy is optimal because "simple rules for monetary policy which central banks have used in various ways to guide their interest rate decisions can be evaluated using simulation and optimization techniques" [23,26]. The debut of new econometric techniques expanded the way models characterize monetary rules and substantiate the ability of monetary policy rule models in explaining and predicting several phenomena in macroeconomics and finance. Additionally, a number of recent studies [27] report on how to adjust simple monetary rules to resolve measurement error and expectations. But despite the numerous studies on monetary rules, a number of issues remain vague, and key among them are 1) whether any observed Taylor rules in the past continue to apply even with the advent of current monetary challenges, and 2) whether the same policy rules apply to different countries.

### *Monetary Policy Regime Classification*

Monetary policy regime is "a set of monetary arrangements and institutions accompanied by a set of expectations – expectations by the public with respect to policy maker's reactions and expectations by policy makers about the public's reaction to their actions" [7]. Monetary policy regime can be classified into five categories based on the IMF's (2014) Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) publication, under de-factor classification:

- **Exchange rate anchor**: This framework comprises of currency boards, fixed exchange rate arrangement and currency zone. Currency boards and fixed exchange rate arrangements are circumstances that allow monetary authorities to keep exchange rate fluctuation within a predetermined level. The authorities tend to intervene by buying or selling foreign currency at a particular quoted rate so as to maintain the exchange rate within range. Currency zones are situations where two or more countries use a common currency. In some instances, the group of countries may only peg their exchange rates to keep the value of their currency at a certain level.
- **Monetary aggregate target**: The main aim of the monetary aggregate target is to reduce the average rate of inflation and improve the stability of real output. Central banks utilise it to achieve a targeted growth rate such as reserve deposits, M1, or M2.
- **Inflation targeting:** [14] stated that " *"Inflation targeting is a framework for monetary policy characterized by the public announcement of official quantitative targets (or target ranges) for the inflation rate over one or more-time horizons, and by the explicit acknowledgement that low, stable inflation is monetary policy's primary long-run goal. Among other*

*important features of inflation targeting are vigorous efforts to communicate with the public about the plans and objectives of the monetary authorities, and, in many cases, mechanisms that strengthen the central bank's accountability for attaining those objectives."*

- **The monetary program supported by IMF**: Monetary authorities under this programme embark on carrying out monetary and exchange rate policies within the boundaries and basis that establish floors for international reserves and a ceiling for net domestic assets of the central bank.
- **Others**: Countries sometimes have no openly stated nominal anchor, but nonetheless monitor their various indicators in conducting monetary policy. IMF uses "others" to categorise countries without relevant information about their monetary policy activities.

**Monetary Policy in African Economies**

Capital flows to African countries increased tremendously in the last two decades, only to be interrupted by the global financial crisis of 2007. The flows, however, resumed after the crisis. This explains why the conduct(s) and the performance of the countries' central banks have come under scrutiny in recent times. The dimension of the studies in this area is multifaceted and includes assessing the ability of African countries to conduct autonomous monetary policies. A number of studies were conducted to assess the effectiveness of monetary policies in managing inflation, while others tried to determine countries' choice of exchange rate regime. Some researches were directed towards examining the evolution, conduct, and performance of monetary policies in developing countries as a whole, but very few were conducted in respect of individual countries. [15] classified the evolution of monetary policies in Africa into five regimes, which are: currency board, printing press, rationing regime, credit ceiling regime, and clearing regime. This categorisation is no longer stable considering that many things have changed since [18] study. In their study on the conduct of the monetary policies of sub-Saharan Africa countries after the 2007 financial crisis, [4] discover that monetary policy framework, which uses a domestic anchor for momentary policy in the region, adhered to quantitative money targets, thus reducing inflation in the region. The paper, however, argues that the policy framework in the region will not suit the discretionary fine tuning of monetary policy that is required in response to the global economic crisis. In this regard, the paper argues the need for monetary policy reform, especially in the 'frontier market' of the sub-Saharan African region. The paper also speaks of the need to adopt a broader set of policy objectives to manage inflation, replacing broad money as an intermediate target with a more sophisticated set of indicators and forecasts and reform of the operating target. In addition, the region needs to strengthen the transmission mechanism of its monetary policies. In a similar study, [7] examines the design and effectiveness of monetary policies in sub-Saharan Africa. The research discovers that there were a number of major changes in the conduct and design of monetary policies in the region. It notes that a number of developing countries adopted flexible exchange rate regimes, which gave their monetary policies greater scope to converge with economics performances of their trade partners. Some researchers devoted attention to studying the evolution of monetary policies in the region. For example, the study of [14] examines the evolution and stages of monetary policies in Africa in the last forty years. He identifies the financial system as an important factor for effective monetary policy. He also identifies the impact(s) of financial sector reforms in the region, which includes reduction of financial sector repression through liberalisation of interest rate, the institutional transition from direct to indirect monetary policy,

banks' balance sheet restructuring and solvency restoration, and development of the financial market. [18] examines the episode of excess liquidity and its consequences on monetary policy in sub-Saharan Africa using nonlinear structural VAR model. The paper argues that to understand liquidity issues, there is the need to quantify commercial banks' holdings of liquidity. This allows for a determination of the extent to which commercial banks exceed the level of precautionary required liquidity. Further, he discovers that keeping excess liquidity weakens the monetary policy transmission mechanisms, which inevitably affect the monetary policies' ability to influence economic demand condition.

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