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Full Length Research Paper

Exchange rate regimes and inflation in Sub-Saharan Africa

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The main argument in favor of a fixed exchange rate regime (ERR) is its ability to maintain lower inflation in the long run compared to a flexible ERR (Mundell, 1963; Fleming, 1962). This paper empirically tests whether the fixed ERR of the CFA franc currency union provides lower inflation to its members relative to inflation in the non-CFA Sub-Saharan African (SSA) countries. SSA countries are grouped by their exchange rate regimes using the International Monetary Fund (IMFs) de facto classification to analyze the dynamics of inflation within the groups of fixed ERR in comparison to the non-fixed ERR groups. The empirical results support the inflation-growth trade-off in the CFA zones. While the CFA countries experience a relatively lower inflation in the short and long run, they suffer from a pronounced output loss relative to all other non-CFA countries in general and relative to the non-CFA countries with pegged ERR in particular. As individuals' welfare depends on the change in their consumption of goods and services rather than the growth level of inflation (Aiyagari, 1990), the finding of this paper suggests that the CFA countries' fixed ERR compounded with an alignment to a common currency undermines their economic performances.

Key words: Inflation, exchange rate regimes, CFA franc currency union, Sub-Saharan Africa.

INTRODUCTION

The impact of exchange rate regime (ERR) on economic performance is one of the hotly debated issues in the field of international finance. This correlation gained more importance in the face of financial crises as international capital flows become increasingly unstable. The critical role of ERR in economic performance in our globalizing world has induced many countries in recent years to switch from one regime to another. If, following the demise of the Bretton Woods system, the choice of an ERR was important for stabilization outcomes, then, nowadays the choice of ERR may have important policy implications - particularly, for policy aimed at tackling external shocks and speculative attacks (Eichengreen, 2008).

Across the globe, different types of ERR ranging from hard peg to free floating regimes exist. There is no consensus on which type of regime better enhances economic performance. Alternative ERRs have some

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strengths and weaknesses regarding economic outcomes in the country when they are at work. There are some arguments in favor of and against each type of the ERR. For instance, Mundell (1963) and Fleming (1962) argue that under a fixed ERR, trade and investment are more certain. The trade and investment advantages of the fixed ERR stem from the reduction of transaction costs and lower inflation expectations. These advantages are what led the European Economic Community (EEC) to adopt the fixed ERR to achieve their single market program. The lower inflation associated with the fixed ERR has been an important incentive that enticed Great Britain to return to the gold standard in 1925 after abandoning it in the wake of world war I in 1914 (Capie et al., 1986a). By fixing a currency to a foreign anchor, the domestic country imports the monetary policy of the anchor country. Such import is associated with political commitment and disciplinary monetary policy (that is, alignment to the anchor country's monetary policies) for anti-inflationary outcomes. However, the fixed ERR is criticized for poorly insulating the economy against external shocks (Obstfeld and Rogoff, 1995).

Supporters of the flexible ERR argue that it confers more independence of monetary policy through the flexibility of the nominal exchange rate. By changing the nominal exchange rate, the country gains control over the impact of disruptive economic shocks. Friedman (1953) pointed out that the speed at which a country adjusts relative prices when hit by a real shock depends on the ERR at work in that country.

Friedman (1953) argues that in a world of sticky prices, the flexible ERR absorbs the effects of external shocks more effectively than the fixed ERR. Indeed, under a flexible regime, in the presence of shocks, the nominal exchange rate adjusts immediately, allowing relative prices to change. This mechanism reduces the effects of shocks on macro variables, especially on output. Previous empirical work has found support for Friedman's hypothesis. For example, Broda (2004) tests Friedman's hypothesis on the terms of trade shocks and finds that the response of real GDP to a terms of trade shock is much smaller under a flexible regime than under a fixed regime. Broda notes that in response to a 10 percent negative shock to the terms of trade, the real exchange rate depreciated faster under the floating system while the depreciation was slower in the pegged regime. As a result, real GDP fell by 1.9 percent under fixed regime and only by 0.2 percent in the flexible exchange rate regime.

The advantage of the floating ERR is that it insulates the economy from external shocks and eventual speculative attacks. However, floating regimes are expected to exhibit high volatility in exchange rates and high inflation. Mussa (1986) underlined that real exchange rates fluctuate a lot more in the short run in countries with flexible ERR than in countries with fixed ERR. This is so because nominal exchange rates are very volatile under flexible regimes. Similarly, Shambaugh (2004), Klein (2005), and Klein and Shambaugh (2008) show that exchange rates are more volatile under a floating ERR than under a fixed ERR. Specifically, Klein and Shambaugh (2008) find that in magnitude, pegged (fixed) ERRs have about 16 percent less volatility in the nominal exchange rate than a floating ERR. After classifying counties by the de facto behavior of the country's monetary authorities, Levy et al. (2001) show that a flexible ERR exhibits higher exchange rate volatility with lower volatility in international reserves while the opposite holds under a pegged ERR.

Whether in the aftermath one type of ERR outperforms the others in terms of the economic outcome; ERRs are crucial determinants of economic performance. Rose (2011) states, "exchange rate is an important asset price, perhaps the most important asset price". This implies that the regime monitoring the exchange rates is important to assets' prices and therefore economic outcomes. An ERR can impact the economy through different macroeconomic channels. For instance, flexible ERR can expose the economy through the inflationary channel; the fixed regime by retarding the adjustment of prices in the face of external shocks allows large fluctuations in output. Inflation expectations can lead to higher or lower interest rates in the country and thereby affect trade and investment incentives. In short, an ERR is a crucial determinant of economic outcomes.

Despite the prominent connection between ERR and economic performance, the literature is limited in addressing how the type of ERR implemented is retarding the economic take-off of some developing countries. This paper attempts to fill this gap for some Sub-Saharan African (SSA) countries which are still lagging behind economically. Specifically, this paper focuses on the inflation dynamics between three groups of countries with distinct types of ERR in SSA: the CFA[1] franc currency unions with a pegged ERR, the Non-CFA[2] SSA countries with floating ERRs, and the Non-CFA countries with pegged ERR. Two important facts explain the choice of the country sample. First, the countries of the CFA currency unions[3] started using the common currency - the CFA

[1]At the creation of the CFA franc currency, CFA was standing for French Colonies of Africa. Nowadays, the "CFA" of the West African Economic and Monetary Union stands for Communaute Financiere Africaine (African Financial Community) and the "CFA" of the Central African Monetary and Economic Union stands for Cooperation Financiere Africaine (Financial Cooperation in Central Africa).

[2]Different types of ERR exist within the non-CFA sample, ranging from a managed ERR to a floating ERR.

[3]The West African Economic and Monetary Union (WAEMU) - The countries of WAEMU are: Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau Mali, Niger, Senegal and Togo. But Guinea- Bissau is not included in the analysis as it joined the union only in 1998, and the Central African Monetary and Economic Community (CAMEC) - The countries of CAMEC are: Cameroon, Central African Republic, Chad, Congo Republic, Equatorial Guinea and Gabon.

franc with a conventional peg before their indepen-dence from France and they are still using it up to date. The CFA franc was pegged to the French Franc from December 26, 1945 – the date of its creation- to January, 1999. Since January, 1999 up to date the CFA franc is pegged to the Euro. From this fact, it is hard to assess how these countries would have performed economically under an alternative ERR and/or without belonging to a currency union (owning their personal central banks).

Secondly, SSA countries exhibit many commonalities in terms of their history and economic characteristics (market access issues, dependence on the export of few primary commodities, financial markets develop-ment, geography, level of industrialization, government efficiency, etc.). Therefore, it is appropriate to compare the economic performances of the CFA countries to that of the non-CFA SSA countries with alternative ERR. Discussing the correlation between economic outcomes and ERR for the CFA countries and distinguishing between the CFA and non-CFA countries of SSA can provide important policy prescriptions - for both exchange rate regime and monetary policy reforms - to aid in solving the countries' delay in economic take-off. This paper focuses essentially on inflation dynamics and compares SSA's CFA franc currency union to its Non-CFA-currency-union countries, because a key purpose of participating in a currency union is to benefit from lower inflation.

The goal carried out in this paper is so far an uncovered topic, especially distinguishing between the CFA and Non-CFA countries of SSA on inflation dynamics. The remainder of this paper is organized as follows: Section 2 states the stylized facts about the fixed and flexible ERR. Section 3 describes exchange rate regimes in general and provides the classification of SSA countries by exchange rate regime and by monetary policy framework. Section 4 explains the methodology, presents the models and the data, and frames the hypothesis and the discussion points. The results tables and their interpretations are in section 5. Section 6 concludes the paper. The figures are stored in the appendix I.

The stylized facts about fixed and flexible exchange rate regimes

Across the literature there are three key stylized facts about the ERR. The first is the inconsistency between the de facto and the de jure ERR (i.e., countries that officially claim to float heavily intervene in the exchange market to regulate the rate of exchange of their currencies). The second is that many countries have shifted to a flexible ERR since the demise of the Bretton Wood System. The third fact is what Eichengreen (1994) named the "hollowing-out hypothesis" and Fischer (2001) refers to as a "bipolar view". The "hollowing-out hypothesis" or the "bipolar view" stipulates that intermediate regimes including conventional pegs are incompatible with capital flows. Only the two extremes: hard peg or free floating are sustainable in the face of high capital flows. Some recent facts across the world support the vulnerability of the pegs in the face of capital mobility. More or less, countries involved in crises in the 1990s were associated with the fixed (pegged) ERR. The 1994 Tequila crisis of Mexico, the 1998 exchange rate crises of Russia and Brazil, and those of Turkey and Argentina in 2000, are few examples. Fischer (2001) mentions that in contrast to the emerging countries with pegged currencies who experienced the exchange rate crisis, other emerging countries with more flexible rates (South Africa, Israel) avoided crises of this type. The implication of this third fact is that fixed ERRs are less efficient in insulating economies from external shocks.

With a fixed ERR the country sacrifices its ability to stabilize the economy against attacks in return for credibility gains through commitments (Klein and Shambaugh, 2010). Under a fixed ERR, the slow responsiveness of the nominal exchange rate to adjust relative prices in the face of external shocks allows disturbances in real GDP (Friedman, 1953; Levy et al., 2001; Caballero, 2002; Broda, 2004, Edwards and Yeyati, 2005). Therefore, fixed regimes would exhibit more loss in their per capita outputs while the reverse is expected for floating regimes. Nevertheless, for the fixed ERR, the loss in output is expected to be compensated by lower inflation through credibility and disciplinary monetary policies associated to the commitment of pegging the domestic currency to a foreign currency that plays the role of an anchor.

Note that pegging a currency is associated with various political commitments which allow importing the anchor country's monetary policies (disciplinary mone-tary policy), reduce inflationary policies, increase the credibility of the domestic monetary authorities, reduce inflation expectations and stabilize the economy. The high political cost of fixing the exchange rate is what forces policy makers to adopt certain monetary and fiscal policies to avoid the demise of the regime. This constraint confers credibility and discipline to the fixed ERR (Meltzer, 1986; Ghosh et al. 1997; Yagci, 2001; Levy et al., 2001). On the other hand, under a flexible ERR the management of the nominal exchange rate to facilitate the quick adjustment of relative prices is associated with higher inflation expectations. In fact, the flexibility of the nominal exchange rate makes the relative price less predictable.

The correlation between inflation and the exchange rate regime is well described in the literature. The investigation of inflation persistence shows three main findings:

1) inflation rates vary over time and across countries due to the monetary policy framework; 2) the speed

of this variation differs over time; 3) there is an inflation- output trade off associated with inflation adjustment (Fuhrer and Moore, 1995; Sargent, 2001; Cecchetti and Debelle, 2006). Although not all papers directly relate inflation to the ERR, three main models are used in the literature to study inflation: the flexible and sticky price models and the sticky information model. The flexible price model argues that inflation evolves over time due to the monetary authorities' action of adjusting monetary policy very frequently. The expansionary policy of the policymakers leads to inflationary outcomes (Barro and Gordon, 1983). The pioneers of the sticky price model use the wage contract in explaining inflation (Taylor, 1979; Calvo, 1983). However, the sticky price model falls short in explaining inflation after introducing the real wage (Fuhrer and Moore, 1995). Lastly, the sticky information model developed by Mankiw and Reis (2002) shows that rather than sticky wages, prices adjust slowly because the cost of information prevents economic agents from frequently updating prices according to current macroeconomic conditions. The flexible price model has some incarnation of the ERR. In fact, the frequent price adjustment of the monetary authorities reflects the flexibility of the nominal exchange which is the foundation for the flexible ex-change rate. Conclusively, a flexible exchange rate is associated with higher inflation.

Recently, Obstfeld and Rogoff (1995) described inflation dynamic in the contest of exchange rate regimes. The theoretical framework developed by the authors focused on the cost and benefits of the fixed exchange rate regime. According to Obstfeld and Rogoff (1995), there are three main reason why countries fix (peg) their currency's foreign value. The first reason is to avoid exchange rate volatility like the one under the floating ERR. Exchange rate volatility creates uncer-tainty about future assets' prices and reduces trade and investment (Mundell, 1963; Fleming, 1962). The second reason is to import the anchor country's inflation rate. Fixing the domestic currency to a foreign one with lower inflation allows the domestic country to experience lower inflation due to the credibility by committing to disciplinary policies. The third reason, closely related to the second is the disinflationary objective. Some countries adopt the fixed ERR after they have experienced higher degrees of inflation.

Fixing (pegging) the currency in this case becomes an objective solution to reducing inflation. Among all, the main purpose and the theoretical benefit of fixing a currency's foreign value is to have price volatility under control.

Obstfeld and Rogoff (1995) also point on one incon-venience of fixing the exchange rate: the forgone control over domestic money supply that would have been used for stabilization purposes. Theoretically and practically, in the face of external shocks such as the drop in demand for exports goods, the country would adjust import and export prices by depreciating the real exchange rate. That is the monetary authorities can reduce the domestic interest rate. The reduction of the home interest rate puts demand pressure on foreign assets with a relatively higher interest rate. Therefore, the domestic currency depreciates and stimulates the short run demand for domestic goods. If quick, this adjustment reduces the impacts of the shock. But, if prices and nominal exchange rates are rigid in the short run like under the fixed exchange rate regime, firms will have to hire less or fire some workers to reduce output in the face of the lower demand for their products. In this situation, as the domestic interest rate is determined by the foreign rate, the domestic monetary authorities have no power to change it. Thus, domestic attempts to chan-ge the money supply have no effects. Indeed, under the fixed exchange rate, the money supply is out of the control of the monetary authorities.

Given these stylized facts and the theoretical frame-works about flexible and fixed exchange rate regimes, this paper tests whether the CFA franc currency union countries- whose common currency is pegged to a foreign anchor experience lower inflation rates in the short and long run compared to the others, the non-CFA countries of SSA as their benefit for scarifying output in the face of shocks.

Exchange Rate Regimes in Sub-Saharan Africa

The official classification of countries by their exchange rate regime (ERR) has been traditionally provided by the International Monetary Fund (IMF). But Calvo and Reinhart (2000) show how some countries that officially claim to have a floating regime intervene in the foreign exchange market. The mismatch between the de jure and the de facto classifications of countries has led economists in the field of international finance to make a clear distinction and reclassify countries based on their de facto regimes. The most known alternative classifications of countries based on the de facto approach are those of Levy et al. (2000a, 2003), Reinhart and Rogoff (2004), Shambaugh (2004), and Ilzetzki et al. (2008). Each of them uses different methodologies.[4] However, the classifications of SSA countries from any of the above cited classification sources match those of the IMF. For this reason, the recent IMF's de facto classification of countries pro-vided in the AREAER[5] is used in this paper.

[4]The techniques of Levy et al., (2003) are based on the exchange rate and international reserves.
Shambaugh employs the band of exchange rate fluctuation. The author classifies an ERR as peg if the exchange rate fluctuates within a narrow band over a long period and non-peg otherwise. Reinhart and co-authors use the variations in the market rates of exchange.
[5]Annual Report on Exchange Arrangements and Exchange Restrictions.

The IMF's annual report on exchange rate arrangement and monetary policy frameworks classifies exchange rate arrangements based on the degree to which the exchange rate is determined by the market. Ten key types of ERR are listed from across the world. (1) No separate legal tender (hard pegs), (2) currency board regimes (hard peg), (3) conventional peg[6] (soft peg). (4) Crawling pegs, (5) crawl-like arrangements, (6) pegged exchange rates within hori-zontal bands[7] (7) Stabilized arrangements, (8) other managed arrangement[8] regimes, (9) floating and (10) free floating[9] exchange rate regimes employ monetary aggregate target and inflation targeting as their monetary policy frameworks.

All of the above types of ERR associated with different monetary policy frame- works are at work in different countries in SSA. WAEMU and CEMAC that make up the two CFA franc zones, use the conventional peg as their exchange rate regime.

The CFA franc of CEMAC and that of WAEMU have the same rate of exchange to the euro to which they are pegged. The monetary policy framework at work in the CFA zones is the exchange rate anchor. Eritrea, Cape Verde, Comoros, Sao Tome and Principles, Lesotho, Namibia and Swaziland also use the conventional peg as their exchange rate regime. The difference between the CFA franc zones and these countries is that the zones form a currency union (the CFA franc zone countries are linked to one central bank in each zone and use a common currency: the CFA franc) while the other countries have their own central banks. Zimbabwe uses the no-separate-legal-tender regime and is pegged to the U.S. dollar.

Burundi and Rwanda use a stabilized arrangement ERR with a monetary aggregate target as their monetary policy framework. Botswana has the crawling peg regime with the currency compositely pegged. Ethiopia is pegged to the U.S. dollar under the crawl-like-arrangement exchange rate regime. Angola, Liberia, Guinea, Malawi, and Nigeria exhibit other managed arrangement regimes. Angola and Liberia are pegged to the U.S. dollar with an exchange rate anchor while Guinea, Malawi, and Nigeria use a monetary aggregate target framework. Twelve SSA countries operate under the floating exchange rate regime. Ten[10] of these target a monetary aggregate while the other two - Ghana and South Africa, have inflation targeting as their monetary policy framework. Mauritius is the only SSA country where a free floating exchange rate regime is at work. In this paper the SSA countries will be grouped as CFA and non-CFA zones, where the non-CFA zone combines pegged, floating and some intermediate ERR's.

METHODOLOGY AND MODEL

Studies of inflation have frequently used augmented Phillips curve models in which the policy preferences of the natural rate of unemployment and the expected supply of expansionary policy are incorporated. Although these models well suit inflation persistence, there is no reliable record on employment for many SSA countries; making it difficult to use such models to empirically test inflation in SSA. Other models have been used to examine the inflation effects of exchange rate regimes in many developing countries. For instance, Levy and Sturzenegger (2001) developed an inflation model in which inflation is related to the changes in money supply growth, the change in GDP growth, the real interest rate and the change in money velocity. However, their model appears as an identity[11] and thus, gives less opportunity to conduct the comparative analysis on inflation across the SSA countries. Kamin (1997) studies the linkage between inflation and the ERR for Asian, industrialized and Latin American countries. But the model does not distinguish between the short and the long run. Kamin's model is explained in Appendix II.

In this paper, a simple cross-groups comparative analysis methodology is adopted using a dummy variable technique while building on the theories about Fixed and Flexible Exchange Rate Regimes. To capture the short and the long run inflation differences between the sub-samples while avoiding estimating an identity model, a model isconstructed where inflation depends on trade openness[12] external shocks (terms-of-trade) and the lagged inflation. In this model, the CFA dummy[13] is added (Equation 1). It is important to control for the terms-of-trade shocks and the trade openness in the model, as they are potential inflationary channels. The rationale behind the inclusion of the lagged inflation rests on the potential serial correlation that can exist between current and past inflation (the inertia problem). Augmenting the model with the CFA dummy allows identifying the extent to which fixed ERR succeeds in maintaining lower inflation relative to the flexible exchange rate regime in the short and in the long run as a result of enhanced credibility and disciplined monetary policies. Sub-Saharan African (SSA) countries are subdivided into four sub- samples (S1, S2, S3, and S4) based on their exchange rate

[6]The peg regimes use an exchange rate anchor as the monetary policy framework. Under the exchange rate anchor, the monetary authority buys or sells foreign exchange to maintain domestic currency's rate of exchange at the targeted rate or within a range. The exchange rate represents the nominal anchor or intermediate target to monetary policy for these regimes (see IMF's AREAER, 2010).

[7]Pegged exchange rates within horizontal bands also use the exchange rage anchor framework.

[8]Managed arrangement regimes use exchange rate anchor, monetary aggregate target and inflation targeting as monetary policy frameworks. Under the monetary aggregate framework the targeted aggregate serves as the anchor to monetary policy. For inflation targeting framework, monetary policy decision depends on inflation forecasting and how the forecasted inflation deviates from the targeted one. Thus inflation forecast is the nominal anchor to monetary policy.

[9]Floating and free floating regimes employ monetary aggregate target and inflation targeting as their monetary policy frameworks.

[10]Congo, Dem. Rep., Gambia, Kenya, Madagascar, Mozambique, Seychelles, Sierra Leone, Tanzania, Uganda, and Zambia.

[11]$\pi_{it} = \beta_0 + \beta_1 \Delta(M2_{it}) - \beta_2 \Delta(RGDP_{it}) + \beta_3 I_{it} + \beta_4 \Delta(\nu_{it})$.

[12]Trade openness is denoted "open" and calculated as the ratio of the sum of imports and exports to GDP.

[13]The CFA zones dummy takes the value 1 if the country is a CFA franc currency union member or zero otherwise.

regime, and estimated the equations using OLS and the robust regression methodologies on each sub- sample (group) with inclusion of the CFA dummy. The robust regression methodology makes one to control the heteroscedasticity to avoid biased parameter estimates.

The model

$$\pi_{it} = \beta_0 + \beta_1 Open_{it} + \beta_2 TT_{it} + \beta_3 \pi_{it-1} + \beta_4 CFA_i + \varepsilon_{it} \quad (1),$$

where, π_{it} is inflation rate in country i at time t. CFA_i, $Open_{it}$, TT_{it}, and π_{it-1} represent respectively the dummy for the CFA zone, trade openness, terms of trade, and lagged inflation. The CFA dummy takes the value of 1 if country i belongs to the CFA franc currency union or zero otherwise.

For the short run, equation (1) is estimated on the full sample (sample S1 comprising CFA and all non-CFA countries); the first reduced sample (the S2- sample without pegging non-CFA countries); the second reduced sample (the S3- sample with only the CFA and floating ERR non-CFA countries); and the third reduced sample (the S4- sample with only the CFA and pegged ERR non-CFA countries) using pooled OLS and fixed effects estimation. For the long run inflation regression, the average inflation (π_i) over the data period is estimated with inclusion of the CFA dummy (Equation 2). By the theory, if the CFA countries have lower inflation relative to the other countries, it would be a result of a lower money growth. To examine the extent of money supply growth in the CFA zones relative to other SSA countries, equation (3) is estimated below. Equation (3) is similar to equation (2); however, the average growth of money supply ($growthM2_i$) is used as the dependent variable in Equation 3.

$$\overline{\pi_i} = \beta_0 + \beta_1 CFA_i + \varepsilon_i \quad (2),$$

$$\overline{GrowthM2_i} = \beta_0 + \beta_1 CFA_i + \varepsilon_i \quad (3),$$

Data description

The data used in this investigation are retrieved from the World Bank's World Development Indicators (WDI) database. The variables employed include: Consumer price index inflation (CPI), money supply (M2), real GDP, population, the terms of trade (computed as the ratio of exports to imports prices), and the trade openness (calculated as the ratio of the sum of exports and imports to GDP). The data cover a panel of 36 SSA countries over the period from 1980 to 2007.[14] Countries included in the examination are those with valid data on all variables of interest over the entire period. Countries with hyperinflation (inflation rate exceeding 50 percent and persistent over many years during the examination period) are excluded. Countries like Zimbabwe, the Democratic Republic of Congo, and Angola are not included for either the hyperinflation issue or the lack of data or both reasons. Guinea Bissau, a current member of WAEMU is excluded from the analysis, because it joined the union in 1998. So, this country has been a member for less than 20 years according to the data period. Benin and many other countries were not included for lack of data on key variables over many years.

The hypotheses

Based on the theory and the stylized facts discussed above, if a fixed exchange rate regime provides lower inflation, then inflation rates should be lower within the CFA franc groups both, the short and the long run compared to those in the non-fixed exchange rate regime countries. Thus, in equation (1) where CFA reflects the CFA franc group dummy, one would expect β4 to be negative and statistically significant, and in equation (2), β1 to be negative and statistically significant. The negative signs of these coefficients would imply that the CFA franc countries exhibit lower inflation relative to the non-CFA countries. Theoretically, there is no incentive to increase the money supply in an attempt to lower the nominal interest rate under a fixed exchange rate regime. Under a fixed ERR, inflation can be reduced by maintaining lower money supply growth. From this point of view, one would expect β1 in equation (3) to be negative and statistically significant. In addition, if the main source of lowering inflation is the extent of money suppy growth, then the magnitude of β1 in equation (3) would match the size of β1 in equation (2). However, if there is any mismatch between β1 of equation (2) and that of equation (3), then other sources might be influencing the inflation rates. These sources could be the extent of the growth of the real GDP per capita and/or the growth of money velocity.

To see how the growth of the real GDP per capita and money velocity influence inflation in the CFA zones, equation 3.1 and 3.2 are estimated below.

$$\overline{RGDP/cap_i} = \beta_0 + \beta_1 CFA_i + \varepsilon_i \quad (3.1),$$

$$\overline{Velocity_i} = \beta_0 + \beta_1 CFA_i + \varepsilon_i \quad (3.2),$$

where, $\overline{RGDP/cap_i}$ and $\overline{v_i}$ are respectively, the average of the growth of real GDP per capita and that of the growth of money velocity over the data period. CFA_i is the CFA dummy. Theoretically, we would expect a nega-tive correlation between inflation and money velocity growth. Also, a higher growth of output would contribute in lowering inflation. If there is a mismatch between the sizes of β1 in equations 2 and 3, then the coefficient restriction on β1 in equation 3.1 and 3.2 will depend on the type of the mismatch.

Discussion

Case 1: |β1 | in equation (3) > |β1| in equation (2)

If the size of β1 in equation (3) is larger than that of β1 in equation (2) in absolute value, this would imply that the extent of the Real GDP per capita is rather resisting to the reduction of inflation. This resistance will be reflected in a negative coefficient of β1 in equation (3.1). Nevertheless, a negative β1 in equation (3.1) would mean the CFA countries face a loss in their output per capita, which could be detrimental to welfare. Moreover, if the sum of β1 in equation (3) and β1 in equation (3.1) still mismatches the size of β1 in equation (2), then the growth of the money velocity should have some influences on the inflation rates.

In the case where the sum of β1 in equation (3) and in equation (3.1) is larger in absolute value than the magnitude of β1 in equation (2), that would imply the presence of a positive growth of money velocity in the CFA zones relative to that in other non-CFA countries. Whereas, a positive growth of the money supply velocity leads to higher real interest rate. Real interest rates being the costs of borrowing, the economic consequences of having higher real interest rates can be in two folds. Higher real interest rates induce banks and consumers to avoid keeping money.[15]

[14] The data is linearized to capture the long run effects.

[15] Consumers would like to put money in a saving to benefit from the higher interest rates rather than investing in activities that would provide outputs; on the banks' side, they would like to lend at the higher rates.

Thus, higher interest rates reduce domestic money demand and allow faster circulation of money (that is higher growth of money velocity). In either case, higher interest rates (implying higher growth of money velocity) and/or output loss would decay the economic performance of the CFA countries. Higher interest rates can reduce investment per capita and output. Moreover, the welfare of individuals depends on how much goods and services they can consume. Hence, output loss directly reduces people's welfare.

Case 2: |β1 | in equation (3) < |β1| in equation (2)

If the size of β1 in equation (3) is smaller than that of β1 in equation (2) in absolute value, we would expect the reverse scenario from case 1. Note also that for the comparison between the CFA and the pegged non-CFA (sample S4), if the CFA countries perform better, this would be the currency union effect as both parties in the sample have the pegged ERR. The only difference is that the CFA zones are currency unions while each country of the non-CFA group with pegged ERR has its own central bank.

RESULTS AND İNTERPRETATİON

Long run estimations

Keeping inflation lower

The focus on Sub- Saharan Africa (SSA) and the distinction between CFA and non- CFA countries in this examination reveals important information on the exchange rate regimes (ERR)' influences on economic performances across SSA countries. Tables 1, 2, 3, and 4 provide respectively the long run inflation, money growth, output per capita growth, and money velocity growth in the CFA countries relatively to: 1) all other non-CFA countries, 2) non-CFA-non-pegged ERR countries, 3) the non-CFA with floating regimes, and the non-CFA pegged ERR countries. Estimations are performed separately for each sample (S1, S2, S3, and S4) with inclusion of the CFA dummy in the model. Moreover, for each sample, the OLS and the robust estimations are performed respectively.

The OLS estimation of the long run inflation shows that the CFA countries have respectively 11, 13, 16, and 3 percent less inflation relative to all other non-CFA, the non-CFA-non pegged, the non-CFA-floating countries, and the non-CFA pegged ERR countries (all the results are statistically significant at a 99 percent level of confidence) (see OLS estimations -column 1 of each sample in Table 1).

It is good to note that the OLS estimation does not correct the heteroscadasticity problems, while over the period considered, in some Sub-Saharan African (SSA) countries there has been some temporally inflation peaks causing the heteroscadasticity problems within the inflation data. In fact, at different occasions over the data period, there have been temporary hyperinflations in some non-CFA countries. However, after the peaks, the countries quickly recovered and inflation rate became as usual. For instance, in the early 1990s, Zambia experienced an occasional hyperinflation mounting up to 183 percent. But after this period, the inflation rate declined back to its common rate around 25 percent. Similarly, Uganda experienced some brief, but severe hyperinflation in the late 1980s; Ghana was subject to an inflation of 122 percent in 1983. In 1995, the inflation in Nigeria reached 72 percent; Uganda had its highest inflation (56 percent) in 1986 and Mozambique's inflation peak of 63 percent occurred in 1994. None of these countries have a peg regime. Rather, they are all floating regime countries; that is why there is no big difference between the long run results of the sample S2 (using non-CFA without the pegs) and that of the sample S3 (using the non-CFA floating regimes only).

As the occasional inflation peaks highlighted above do not reflect the usual average inflation rate of these non-CFA floating regime countries, these inflation peaks by creating the heteroscedasticity (outliers) problem in the data pump up the period average inflation rates of the non-CFA countries as a whole and make as if the CFA countries have relatively very lower inflation rates in the long run.

Given that the classical estimation methods such as the ordinary least square (OLS) are outlier sensitive, the presence of outliers causes the OLS estimation to be inefficient; leading to inflated and bias estimates of the residuals (Mia et al., 2008). To correct this mitigation, the robust regression methodology is used. The robust regression is the estimation methodology that aims to control heteroscedasticity in the data to avoid biased parameter estimates. There is an extensive literature on how outliers occur and how to limit their effects on the parameter estimates. Across literature, the most used method to correct heteroscedasticity in the data is the robust estimation methodology (Fellner, 1986).

After accounting for heteroscadasticity in the model, the inflation rates of the CFA countries turn out to be in average 5 percent less than that of other countries samples, and only 0.4 percent less than that of other non-CFA countries with pegged ERR (see Robust estimation- second columns for each sample in Table 1). As a result of the robust estimation, the CFA countries exhibit lower inflation relative to their SSA counterparts, even though the inflation gap between the CFA and others is not too large. This out performance of the CFAs on keeping inflation lower over other non-pegged ERR can be attributed to fixed ERR effect. Noticeably, the difference in inflation between the CFAs (pegged under currency union) and the non-CFAs with pegged ERR (but non currency union members- having each their own central bank) is very small (0.4 percent). Even though negligible, this small difference in inflation

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While domestic borrowers might not be willing to borrow at high costs, foreigners borrowers might.

Table 1. The long run inflation estimation in Sub-Saharan Africa.

Variables	S1		S2		S3		S4	
	OLS	Robust	OLS	Robust	OLS	Robust	OLS	Robust
	$\overline{\pi_i}$	$\overline{\pi_i}$	$\overline{\pi_i}$	$\overline{\pi_i}$	$\overline{\pi_i}$	$\overline{\pi_i}$	$\overline{\pi_i}$	$\overline{\pi_i}$
CFA_i	-11.3***	-4.7***	-13.3***	-5.1***	-16.3***	-6.9***	-2.9***	-0.4***
	(0.692)	(0.2)	(0.7)	(0.2)	(0.8)	(0.1)	(0.2)	(0.1)
Constant	15.5***	8.9***	17.6***	9.4***	20.5***	11.2***	7.1***	4.6***
	(0.4)	(0.1)	(0.4)	(0.1)	(0.6)	(0.1)	(0.1)	(0.1)
Obs.	1,026	1,026	891	891	648	648	459	459
R-sq.	0.21	0.30	0.30	0.43	0.40	0.75	0.34	0.04

S1 is the CFA versus all other non-CFA, S2 is the CFA versus the non-CFA-non-pegged ERR,
S3 is the CFA versus the non-CFA-floating ERR, and S4 is the CFA versus non-CFA-Pegged ERR. Note: *** p < 0.01, ** p < 0.05, * p < 0.10
The heteroscedasticity-consistent standard errors are in parentheses.

Table 2. The Long Run Growth of Money in Sub-Saharan Africa

Variables	S1		S2		S3		S4	
	OLS	Robust	OLS	Robust	OLS	Robust	OLS	Robust
	$\overline{M2_i}$	$\overline{M2_i}$	$\overline{M2_i}$	$\overline{M2_i}$	$\overline{M2_i}$	$\overline{M2_i}$	$\overline{M2_i}$	$\overline{M2_i}$
CFA_i	-10.7***	-7.6***	-12.2***	-9.5***	-16.6***	-10.9***	-5.3***	-7.1***
	(0.7)	(0.3)	(0.7)	(0.5)	(0.7)	(0.5)	(0.5)	(0.3)
Constant	20.7***	16.3***	22.3***	18.6***	26.6***	19.7***	15.3***	15.6***
	(0.3)	(0.2)	(0.4)	(0.3)	(0.5)	(0.3)	(0.4)	(0.2)
Obs.	1,053	1,053	891	891	648	648	486	486
R-sq.	0.23	0.32	0.28	0.28	0.45	0.46	0.21	0.6

S1 is the CFA versus all other non-CFA, S2 is the CFA versus the non-CFA-non-pegged ERR,
S3 is the CFA versus the non-CFA-floating ERR; and S4 is the CFA versus non-CFA-Pegged ERR. The dependent variable is the average growth of M2 growth.
Note: *** p < 0.01, ** p < 0.05, * p < 0.10
The heteroscedasticity-consistent standard errors are in parentheses.

between the CFAs and the non-CFA pegged ERR group can be considered as the pay-off of the currency union membership. Basically, there is a lower inflation advantage to the CFA countries from having a fixed ERR and being a currency union.

Keeping money growth under control

Theoretically, lowering inflation should be handled by maintaining lower money growth. The theory holds for the case of the CFAs as they seem to maintain lower rates of money growth relative to their counterparts as their tool of lowering inflation. Table 2 provides the estimation results on money growth in the CFAs relative to the other group. Considering the results of the robust regression (second columns for each sub-sample in Table 2), the CFA countries have respectively 7.6, 9, 11, and 7 percent less growth in their money supply relative to all other non-CFA, the non-CFA-non-pegged, the non-CFA-floating, and the non-CFA countries with pegged ERR. The CFA countries seem to have a restraint growth of money supply.

However, the aftermath in comparing the extent of the money supply growth in the CFA countries to their lower inflation level reveals a mismatch. The CFA countries do not have as much lower inflation as they would in accordance to their restraint money growth. Across each sub-sample, the magnitude of the negative money growth is larger than that of inflation (money growth: -7.6 percent versus -4.7 percent in inflation in S1; money growth: -9.5 percent versus -5 percent in inflation in S2; money growth: -11 percent versus -7 percent in inflation in S3; and money growth: -7 percent versus -0.4 percent in inflation in S4).

Output loss

The observed mismatch might be caused by two phenomena within the CFA zones. First, it could be that the fixed ERR is having negative effects on the growth

Table 3. The long run growth of the RGDP per capita in Sub-Saharan Africa.

Variables	S1		S2		S3		S4	
	OLS	**Robust**	**OLS**	**Robust**	**OLS**	**Robust**	**OLS**	**Robust**
	$\bar{y}_i$	$\bar{y}_i$	$\bar{y}_i$	$\bar{y}_i$	$\bar{y}_i$	$\bar{y}_i$	$\bar{y}_i$	$\bar{y}_i$
CFA_i	-0.1	-1.0***	-0.2	-0.7***	0.6	-1.3***	0.2	-1.7***
	(0.4)	(0.1)	(0.5)	(0.1)	(0.4)	(0.2)	(0.5)	(0.15)
Constant	4.8***	3.6***	4.9***	3.3***	4.1***	4.0***	4.5***	4.3***
	(0.2)	(0.1)	(0.3)	(0.1)	(0.3)	(0.1)	(0.4)	(0.12)
Obs.	1,053	1,053	891	891	648	648	486	486
R-sq.	0.00	0.049	0.00	0.03	0.00	0.09	0.00	0.21

S1 is the CFA versus all other non-CFA, S2 is the CFA versus the non-CFA-non-pegged ERR, S3 is the CFA versus the non-CFA-floating ERR, and S4 is the CFA versus non-CFA-Pegged ERR. The dependent variable is the average growth of RGDP per capita.
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$
The heteroscedasticity-consistent standard errors are in parentheses

of output per capita and secondly, the growth of money velocity within the CFA zones might be higher than needed. As underlined in the hypotheses section, lowering inflation can be achieved through higher growth of output. However, this cannot be the case in the CFA zones since the CFA countries exhibit negative output per capita growth relative to the non-CFA states (Table 3).

The results of the robust regression in Table 3 show that the real GDP growth within the CFA zones is lower than in any other comparative group in SSA. The real GDP growth within the CFA zones is about 1 percent lower compared to that in all other SSA countries together with the non-CFA non-pegged, and the non-CFA flotting ERR countries. But, the gap between the CFAs and the non-CFA group with pegged ERR is much larger on output growth: the non-CFA group with a pegged ERR outperforms the CFAs on output growth by about 2 percent.

The negative coefficient of the RGDP per capita growth indicates that fixed ERR reduces the extent of output growth in the CFA zones relative to other countries. Most importantly, the larger gap in output growth between the CFAs and the non-CFA group with pegged ERR reveals that those countries with a pegged ERR which have their own national central banks perform much better on output growth than others in general and than the currency union, in particular.

This result implies that the CFA economies are hurt not only through the fixed ERR effects, but also for being locked in a currency union (a common currency-a common central bank for all countries in each CFA zones). The direct consequence of the lower output growth in the CFAs is the weak impact of money growth on inflation; in other words, the lower output growth diminishes the effects of money growth on inflation. Doing the math from Tables 2 and 3, in S1, S2, and S3, about 1 percent of the lower money growth compensates for output loss. In S4, 2 percent of the lower money growth compensates for the output loss.

Money velocity growth

Recall the discussion point in ”case 1”, and it appears that the sum of β1 in equation (3) and in equation (3.1) is larger in absolute value than the magnitude of β1 in equation (2) (doing the sums of β1 in Tables 2 and 3 across the samples, especially in the robust estimation). This result means the CFA zones have positive growth of money velocity (or higher growth in money velocity) relative to that in other non-CFA countries. The results on money velocity support the assumption and imply that the impact of the restrained money growth on inflation in the CFA countries is also reduced by the growth of money velocity (Table 4).

From Table 4 and under the robust estimation, the CFA countries have respectively 1.6, 2 and 1 percent higher growth of money velocity relative to all the non-CFA, the non-CFA-non-pegged, and the non-CFA-floating ERR countries. So, the impact of the restrained money growth on inflation in the CFA countries is reduced respectively by these amounts of money velocity growth across the sub-samples. The higher growth of the money velocity in the CFA zones might mainly stem from the higher interest rates in these countries as demonstrated in Figure 2 of Appendix I.

After subtracting the sizes of the sum of β1 for output per capita growth in Table 3 and β1 for money velocity growth in Table 4, from β1 for money growth in Table 2, the difference is about the magnitude of the extent of the lower inflation in the CFA countries (for S1, S2, and S3). However, the mismatch persists for S4 where the CFAs are compared to the non-CFA countries with pegged ERR. The CFAs have 7 percent lower money supply growth compared to the non-CFA group with

Table 4. Long run money velocity growth in Sub-Saharan Africa.

Variables	S1		S2		S3		S4	
	OLS	Robust	OLS	Robust	OLS	Robust	OLS	Robust
	$\bar{v}_i$	$\bar{v}_i$	$\bar{v}_i$	$\bar{v}_i$	$\bar{v}_i$	$\bar{v}_i$	$\bar{v}_i$	$\bar{v}_i$
CFA_i	3.6***	1.6***	4.3***	2.2***	1.9***	1.3***	0.8**	-0.3
	(0.36)	(0.21)	(0.40)	(0.21)	(0.30)	(0.21)	(0.4)	(0.2)
Constant	0.5***	1.5***	-0.1	0.9***	2.2***	1.8***	3.4***	3.4***
	(0.20)	(0.12)	(0.23)	(0.13)	(0.21)	(0.15)	(0.3)	(0.2)
Obs.	1,026	1,026	891	891	648	648	459	459
R-sq.	0.09	0.05	0.12	0.11	0.06	0.06	0.01	0.00

S1 is the CFA versus all other non-CFA, S2 is the CFA versus the non-CFA-non-pegged ERR, S3 is the CFA versus the non-CFA-floating ERR, and S4 is the CFA versus non-CFA-Pegged ERR. The dependent variable is the average growth of money velocity.
Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$
The heteroscedasticity-consistent standard errors are in parentheses.

pegged ERR, but the difference in terms of inflation between the two groups is only 0.4 percent. In addition, the difference in money velocity growth between the CFAs and the non-CFA countries with pegged ERR is insignificant and the CFAs have up to 2 percent loss in output against the non-CFA countries with pegged ERR. The sub-sample S4 reveals that the non-CFA countries with pegged ERR have the ability to maintain lower inflation rate (closely as much as in the CFA countries), exhibit similar rates of money velocity growth, and have a higher growth of their output per capita relative to the CFA countries.

The size of the output loss in the CFA being larger than the CFAs' extent of lower inflation in comparison to the scenario within the group of pegged ERR non- CFA indicates that the CFA franc currency union membership could be economically harmful. Gurtner (1999) warns that the CFA zones do not meet the required conditions for an optimum currency area (OCA). According to Gurtner (1999), the CFA countries follow different supply cycles. Thus, they face growth barriers at different points of time. The paths of the GDPs of the CFA countries depend on the fluctuation of the prices of the primary commodities that underline the economies of these countries.

Moreover, there is no trade intensive within the zones that necessitate the reduction of transaction cost by using a common currency. In addition labor mobility across countries within the zones is not intense (only the labor mobility in the informal sector seems to be fulfilled, according to Gurtner (1999). As the CFA union countries do not meet the requirements of the OCA, it is not surprising that locking countries with such heterogeneous cyclical patterns under a common currency could erode their economic performances. The reason of the pronounced difference between the CFA and the other pegged non-CFA in economic performance is the difference in interest rates between the two groups. As shown in Figure 4 of the Appendix I, the pegged non-CFA has more investment per capita relative to the CFA zones. This higher investment per capita could be a result of a lower cost of borrowing (lower interest rates).

In general, the difference in inflation between the CFA and non-CFA countries is decreasing while the gap in investment per capita between them is enlarging (Figure 1 versus Figure 4 in Appendix I). The inflation gap between the CFA and the non-CFA is decreasing over time. The inflation rates of the CFA countries are increasing while that of the non-CFA is diminishing on average. This convergence is due to the fact that output is growing faster in the non-CFA zone and slower in the CFA zones.

The inflation-growth trade-off is a major question in the discussion of the economic performance of developing countries like the CFA states. Is it worth sacrificing output for ”lower” inflation? The lower extent of output in the CFA zones is a result of different macroeconomic problems which slow economic activities. In fact, having higher nominal interest rates, the CFA countries experience higher real interest rate which is the cost of borrowing. As shown in Figure 2, the real interest rate has been high and more volatile in the CFA countries than in the non-CFA states. As real interest rate reflects the cost of capital in the production process, facing high real interest rate can limit investments and output growth (Figure 4 in Appendix I supports the lower rate of investment under the CFA zones as a result of higher real interest rates).

The evidence from the hypothetical money model states three main benefits from keeping lower inflation. The first is the transaction cost reduction. The second is the reduction of the capital income tax and the third is the reduction of uncertainty. However, Aiyagari (1990) studies the benefits and the costs of maintaining lower inflation. He mainly shows that the costs of such policy outweighs it benefits. For instance, the reduction of

Table 5. Short run inflation estimation: CFA vs. All Non-CFA countries.

Variables	Pooled Panel OLS π_{it}	FE π_{it}	Pooled Panel OLS π_{it}	Pooled Panel OLS π_{it}
π_{it-1}	0.7***	0.6***	0.7***	0.6***
	(0.02)	(0.03)	(0.02)	(0.03)
$Open_{it}$	-0.01	0.02	-0.003	-0.005
	(0.01)	(0.02)	(0.01)	(0.01)
TT_{it}	2.3***	2.4***	2.4***	2.6***
	(0.7)	(0.8)	(0.8)	(0.8)
CFA_i	-3.1***	-	-3.2***	-3.5***
	(1.02)	-	(1.13)	(1.13)
$growthM2_{it-1}$	-	-	0.04	0.05*
			(0.02)	(0.02)
$GrowthRGDP_{it-1}$				-0.005
	-	-	-0.01	(0.03)
$M2Velocity_{it-1}$	-	-	(0.03)	-0.004
				(0.004)
Constant	2.4*	0.3	1.3	1.6
	(1.4)	(1.9)	(1.6)	(1.6)
Observations	807	807	723	713
R-squared	-	0.41	-	-
Number of Groups	37	37	37	37

transaction could be achieved by creating more forms of money useable in transaction to earn market rates of interest. Moreover, he argues that reducing money supply in an attempt of keeping lower levels of inflation might not systematically reduce the variability of inflation. Thus, the impact of a lowering-inflation policy on welfare could be marginal (Aiyagari, 1990). Therefore, instead of an inflation lowering policy, which is associated with higher costs, one could simply implement alternative policies, save in costs and reach the same benefits. In addition, a study like Hercowitz (1982) shows that supply shocks have stronger effects on relative prices than the changes in money supply (inflation), at least for the US data.

Since wage contracts are usually not fully indexed to price level variability, as the real value of money increase due to inflation reduction, the money amount of the contract is less likely to fully change and compensate for the change in the price levels. Thus inflation reduction is associated to welfare loss (Okun, 1978; Fischer, 1984). Fischer (1984) estimates the sacrifice ratio[16] at 6 percent. Okun (1978), Fischer (1984), and Aiyagari (1990) argue that what matters in improving welfare is the variability of personal consumption of goods and services. Thus the CFA countries incur welfare loss through their alignment to a fixed ERR and a common currency as they experience higher output loss in the long run.

[16]The sacrifice ratio is the cost (output loss) incurred in the economy in an attempt to fight inflation.

Short Run Inflation Estimation

The short run inflation estimation is performed using the pooled panel OLS methods, as there is no need to control heteroscadasticity in the short run. Tables 5, 6, 7, and 8 contain respectively the results of the short inflation estimation of the CFA countries relative to all non-CFAs, non-CFAs-non-pegged ERR, non-CFAs with floating ERR, and non-CFAs with pegged ERR. In each table, lag variables of major inflation factors are progressively introduced in the main equation (equation 1), though previous columns are occasionally used as illustration. The progressive introduction of the lags allows testing for stability in the parameter estimates across the regressions. For each table, the results interpretation focuses on the last column where all lags are introduced in the equation.

From the short run inflation estimation, the CFAs have about 3 percent less inflation relative to their SSA counterparts in the short run (Table 5). The CFA dummy is omitted from the fixed effect estimation as it is time invariant. Against the non-CFA non-pegged as well as against the non-CFA-floating ERR groups, the CFAs have about 2 percent less inflation (Tables 6 and 7); while the short run difference in inflation between the CFAs and the non-CFAs with pegged ERR is almost insignificant (Table 8). Basically, like in the long run, the CFA countries face the inflation-growth trade-off also in the short run. This implies that in the short run, the member countries of the CFA franc currency unions experience welfare loss through this trade-off.

Table 6. Short run inflation estimation: CFA users vs. Non-CFAN onP egs.

Variables	Pooled Panel OLS π_{it}	FE π_{it}	Pooled Panel OLS π_{it}	Pooled Panel OLS π_{it}
π_{it-1}	0.7***	0.6***	0.7***	0.6***
	(0.02)	(0.03)	(0.03)	(0.03)
$Open_{it}$	-0.007	0.02	-0.01	-0.02
	(0.01)	(0.02)	(0.01)	(0.01)
TT_{it}	2.3***	2.6***	2.8***	2.8***
	(0.8)	(0.9)	(0.8)	(0.8)
CFA_i	-3.3***		-2.1*	-2.1**
	(1.1)	-	(1.1)	(1.1)
$growthM2_{it-1}$			0.100***	0.191***
	-	-	(0.03)	(0.03)
$GrowthRGDP_{it-1}$			-0.02	-0.03
	-	-	(0.03)	(0.03)
$M2Velocity_{it-1}$				-0.002
	-	-	-	(0.004)
Constant	2.5*	0.2	-0.2	-0.05
	(1.5)	(2.04)	(1.5)	(1.5)
Observations	726	726	692	691
R-squared	-	0.42	-	-
Number of Groups	32	32	32	32

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$
The heteroscedasticity-consistent standard errors are in parentheses.

Table 7. Short run inflation estimation: CFA users vs. Non-CFAF loating.

Variables	Pooled Panel OLS π_{it}	FE π_{it}	Pooled Panel OLS π_{it}	Pooled Panel OLS π_{it}
π_{it-1}	0.7***	0.6***	0.7***	0.6***
	(0.02)	(0.03)	(0.03)	(0.03)
$Open_{it}$	-0.01	0.02	-0.01	-0.02
	(0.01)	(0.03)	(0.01)	(0.01)
TT_{it}	2.3***	2.6***	2.8***	2.8***
	(0.8)	(0.9)	(0.8)	(0.8)
CFA_i	-3.3***		-2.1*	-2.1**
	(1.1)	-	(1.1)	(1.1)
$growthM2_{it-1}$			0.1***	0.2***
	-	-	(0.03)	(0.03)
$GrowthRGDP_{it-1}$	-		-0.03	-0.03
		-	(0.03)	(0.03)
$M2Velocity_{it-1}$	-			-0.002
		-	-	(0.004)
Constant	2.5*	0.2	-0.2	-0.05
	(1.51)	(2.04)	(1.53)	
Observations	726	726	692	(1.5)
R-squared		0.42	-	691
Number of Groups	32	32	32	32

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$
The heteroscedasticity-consistent standard errors are in parentheses.

Table 8. Short run inflation estimation: CFA users vs. Non-CFAP egged.

Variables	Pooled Panel OLS π_{it}	FE π_{it}	Pooled Panel OLS π_{it}	Pooled Panel OLS π_{it}
π_{it-1}	0.2***	0.2***	0.2***	0.2***
	(0.05)	(0.05)	(0.05)	(0.05)
$Open_{it}$	0.03***	0.04*	0.03***	0.04*
	(0.01)	(0.02)	(0.01)	(0.02)
TT_{it}	0.1	0.3	-0.02	0.5
	(0.8)	(0.8)	(0.8)	(0.8)
CFA_{i}	-1.5		-2.5*	-
	(1.1)	--	(1.5)	
$growthM2_{it-1}$			-0.03	-0.02
	-	-	(0.02)	(0.02)
$GrowthRGDP_{it-1}$			-0.01	-0.01
	-	-	(0.02)	(0.02)
$M2Velocity_{it-1}$			-0.02	-0.21**
	-	-	(0.04)	(0.08)
Constant	2.5	0.8	3.1*	1.8
	(1.6)	(1.6)	(1.8)	(1.7)
Observations	365	365	327	327
R-squared	-	0.06	-	0.11
Number of id	17	17	17	17

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$
The heteroscedasticity-consistent standard errors are in parentheses.

Another major finding in this paper is the inflation persistence in the CFA countries. As shown by the coefficient of the lag inflation in Tables 5, 6, and 7, there is a remarkable inflation inertia in the CFA zones. The magnitude 0.7 (0.6 for the fixed effect estimation) of the coefficient of $\pi it-1$ indicates that 70 (or 60) percent of the current inflation is due to the past inflation history. The past output growth and money growth have less effect on current inflation compared to the past inflation itself (see the coefficients for the lag of money growth, lag of output growth, and the lag of money velocity growth in each short run estimation table). This finding on the inflation inertia in the CFA zones endorses Chopra (1985) and Loungani and Swagel (2001) who showed that inertial components are more influential in the inflation process in developing countries, especially those with fixed exchange rate regimes.

In summary, the CFA countries exhibit lower inflation relative to their SSA counterparts. Thus, the hypothesis by which fixed ERRs provide a lower inflation is proven for the CFA countries. Nevertheless, the Friedman hypothesis that predicts more loss of output under a fixed ERR relative to a flexible ERR holds also for the CFA countries (see estimation results in Table 3 and also Figure 3). These two theories and the findings in this paper indicate that the inflation-growth trade-off is at work in the CFA zones. However, the goal of an economic policy in any country is to increase the wellbeing of the citizens. Given the empirically proven fact that the costs associated to maintaining lower inflation outweigh its benefits on the country's welfare, one can conclude that fixing the foreign value of their currency is distortive to the CFA countries' economies. Hence, the monetary authorities of the CFA countries could have use alternative policies to improve the countries' welfare rather than lowering inflation.

Conclusion

This paper finds an empirical support for the inflation-growth trade-off associated with a fixed exchange rate regime (ERR) in the case of the CFA franc currency union countries of Sub-Saharan Africa (SSA). Despite the relatively lower inflation in the CFA countries compared to the non-CFA countries of SSA, the CFA countries experience output losses through their alignment to a fixed ERR and belonging to a currency union. The CFA countries pay high costs in the form of output loss in return to a slightly lower inflation level compared to their SSA counterparts. As lowering inflation has less impact on welfare than the change in output, this trade-off is detrimental to the CFA economies. In fact, the economic objective of any individual is to improve her propensity to consume goods and services. In other words, economic policies of countries should be oriented to the improvement of their welfare. The CFA countries could therefore employ alternative policies to avoid the welfare loss associated with a fixed ERR, and their alignment to a single currency. The welfare loss relative to all other non-CFA countries in general and that relative to the pegged non-CFA countries in parti-cular lead to the conclusion that the CFA countries would have performed economically better under an alternative ERR, and/or by not belonging to the CFA franc currency union.

Conflict of Interests

The author has not declared any conflict of interests.

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Appendix I. Figures

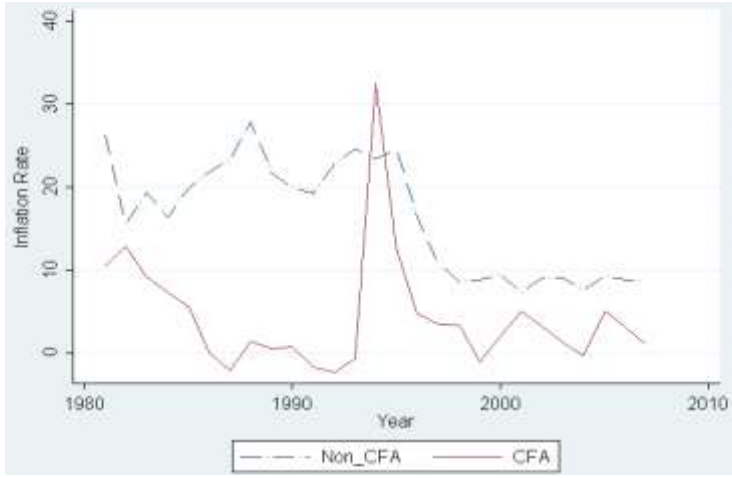

Figure 1. The convergence of inflation rates between the CFA and Non-CFA Groups in SSA.

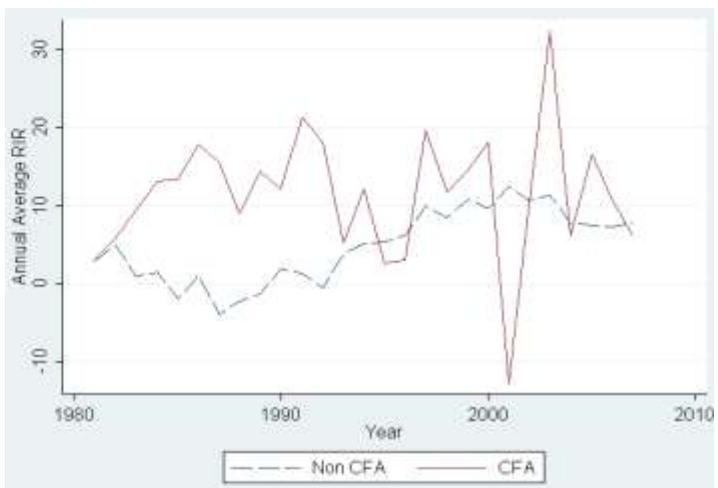

Figure 2. The annual average real interest rates (RIR): CFA vs. Non-CFA.

Figure 3. The RGDP growth: CFA vs. Non-CFA.

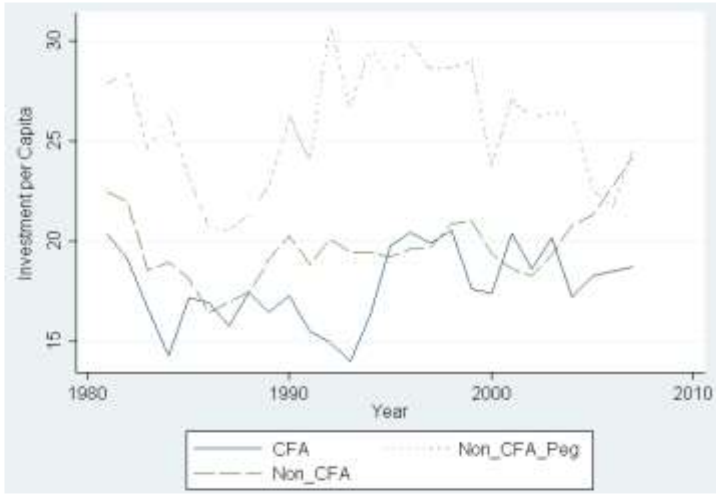

Figure 4. The average investment per Capita: CFA vs. Non-CFA, and Non-CFA pegged ERR.

Appendix II. The model by Kamin (1997)

Kamin (1997) studies the linkage between inflation and the ERR for Asian, industrialized and Latin American countries. The author constructs an inflation model that incorporate the real GDP gap, nominal and real exchange rate as follows:

$$\Delta P_t = -\alpha\lambda\psi + \lambda rer_{t-1} + \alpha\lambda\,(\overline{Q_h} - \overline{Q_h})_{t-1} + (1-\alpha)\Delta P_{*} + (1-\alpha)\Delta e_t + \beta\Delta P_{t-1} \quad (4)$$

where, Δ is the difference operator, P_t is the log of domestic CPI; rer is the log of real exchange rate; $\overline{Q_h}$ is the log of actual domestic output; $\overline{Q_h}$ is the log of potential output in domestic country; P^* is the log of foreign average weighted CPI, e_{t-1} is the log of nominal exchange rate (local t current per dollar US). t is current time index, while $t-1$ is the lag indicator (see Kamin, 1997 for the derivation of equation (4)). Equation (4) is a short run inflation equation. To estimate equation for the sample of SSA, GDP deflator inflation was used, and the potential GDP was obtained by applying the Hodrick-Prescott filter methodology. Though not reported here, the estimation of equation (4) shows that the CFA countries have only 0.6% less GDP inflation in the short run compared to the non-CFA. Using the GDP deflator to estimate the long run equation (3) gives similar results as using the CPI inflation above.

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Empirical analysis of the elasticity of real money demand to macroeconomic variables in the United Kingdom with 2008 financial crisis effects

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This research work has employed vector error correction and cointegration techniques in order to estimate the elasticity of real money demand to macroeconomic variables such as industrial production index, exchange rates and short-term interest rates in the United Kingdom. Also, global financial crisis was introduced as an impulse variable to capture structural breaks inherent in the series. Empirical results showed that long-run relationships existed between real money demand and industrial production index, short-term interest rates, and exchange rates in the United Kingdom. The study showed that in the long-run, real money demand had more than unity elasticity with industrial production index in both economies. Real money demand has an inelastic relationship with short-term interest rates and exchange rates. Furthermore, results indicated that it would take long time for real money demand to adjust to its long-run equilibrium. Impulse response analysis revealed that any increase in short term interest rates will have negative effects on the real money demand in the medium to long-term. Whilst real money demand in the United Kingdom tend to be more significant in forecasting the Euro zone money demand, the latter tends to be negatively statistically significant in the former real money demand model. The financial crisis witnessed globally had negative effects on real money demand in the United Kingdom.

Key words: Vector error correction, Cointegration, impulse response analysis, macroeconomic variables, long-run equilibrium, real money demand and financial crisis.

INTRODUCTION

Money demand models provide a structure, which helps to explain changes in money explained by advances in macroeconomic variables. They symbolize a normal yardstick against which tends to measure monetary advancements. This therefore, having a firm long-run and short-run money demand is very imperative, as the presence of a well-specified and stable relationship between money and macroeconomic variables can be seen as requirement for the use of monetary aggregates in the conduct of monetary policy.

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The stability of this relationship is usually assessed in a money demand framework, where money demand is linked to other macroeconomic variables like industrial production index (used as a proxy for real economic output) and interest rates. This research work focuses on studying the elasticity by estimating long-run and short-run money demand function for the United Kingdom by adopting the method of cointegration and error correction analysis. Many factors affect the demand for money. These factors include, level of prices, level of interest rates, the level of real national output (real GDP) and speed of financial innovation. In addition to the variables, which are usually considered within money demand analysis, exchange rates play crucial role. During periods of high inflation, some countries experience partial re-placement of domestic currencies by foreign currencies, either as a store of value or a medium of exchange. Hence, the exchange rate is an important factor ex-plaining money demand. It is assumed that the interest rates are significant in money demand models. According to Keynes theory (1936), there are three justifications for the demand of money; transactionary, precautionary and speculative motives. Keynes (1936) theory implies that interest rates have an inverse relationship with the speculative money balances and there exist an indirect transmission mechanism, which depends strongly on the interest rates effect on investment and through the multiplier effect on real sector of the economy. Theoretically, the income velocity of money is not stable and does not depend upon the rate of interest. Keynes (1936) also showed that the transactionary demand for money is positively linked to real incomes and inflation. Hence, the quantity of nominal money demand is proportional to the price level in the economy. Similarly, the precautionary is positively correlated with real incomes and inflation. The total demand for money is obtained by summing the transaction, precautionary and speculative demands.

Prior to this research, many studies have looked at the relationships between macroeconomic variables and the real money demand in the United Kingdom. This research has gone further to study the impact of real money demand in the Euro Area on the United Kingdom. This is important as it will add to literatures on the significance of the real money demand in the United Kingdom to the European Monetary Union or vice versa. There are extensively rich literatures on the relationships between money demand and determinants such as real economic activities, exchange rate, long-term interest rates and inflation. For example, Hendry and Ericsson (1991) using recursive procedures to derive cointegrated model showed that money demand model is uniquely different from models of prices because constancy holds only conditionally on long-run prices in the United Kingdom and United States. Similarly, by employing cointegration and error correction techniques, Skrabic and Tomic-Plazibat (2009) emphasized that in addition to industrial production index, exchange rate explains the most variations of money demand in the long-run while interest rates is significant only in the short-run in Croatia. Drilsaki showed that interest rate causes the largest shift in money demand in addition to industrial production in Turkey between 1989 and 2010. Frait and Komárek (2001) argued that in a monetary model of the exchange rate, a depreciation of the domestic currency is likely to induce extra demand for domestic goods from abroad and the induced rise in domestic production implies higher domestic inflation rate and a need for more money in the economy as the amount of transactions increases. However, according to the currency substitution approach, depreciation reduces the confidence in the domestic currency, thereby lowering money demand via a substitution effect with foreign money. Hence, its coefficient should be negative. Orlowski (2004) also stressed the implication of exchange rates risks for Hungary, Poland and the Czech Republic, countries well known for their inflation targeting monetary policies. Doornik et al. (1998) using practical cointegration rank under restrictive dynamics showed that the long-run ratio of money demand is negatively related with interest rates and inflation rates in the UK. Similarly, based on a correlation analysis, Antczak (2003) pointed out the importance of money growth for steadying inflation rates in some transition economies of Europe. Further, Bahmani et al. (2013) by studying the impact of economic and monetary uncertainty on money demand in emerging economies of six Central and Eastern European countries showed that money demand is transitory and monetary targeting irrespective of output and monetary uncertainty can be effectively stable. These empirical studies suggested the following functional form for the money demand function as M/CPI where M represents a narrow monetary aggregate, CPI is the consumer price index (which is CPI deflator).

This paper intend to use cointegration and error correction with unrestrictive dynamic techniques to justify the presence of contemporaneous relationships between real money demand, industrial production index, short-term term interest rates and exchange rate in the United Kingdom. In addition, the relationship between real money demand in both the UK and Euro Area was also studied. Also, impulse response function analysis was adopted to ascertain the responsiveness of real money demand to shocks in the macroeconomic variables. The pound sterling to dollar exchange rates was considered in the analysis.

The source of data

The data employed in this research work are monthly observations of industrial production index (IPI), con-sumer price index (CPI), short-term interest rates (INR), exchange rates (EXR), and narrow money supply M1.

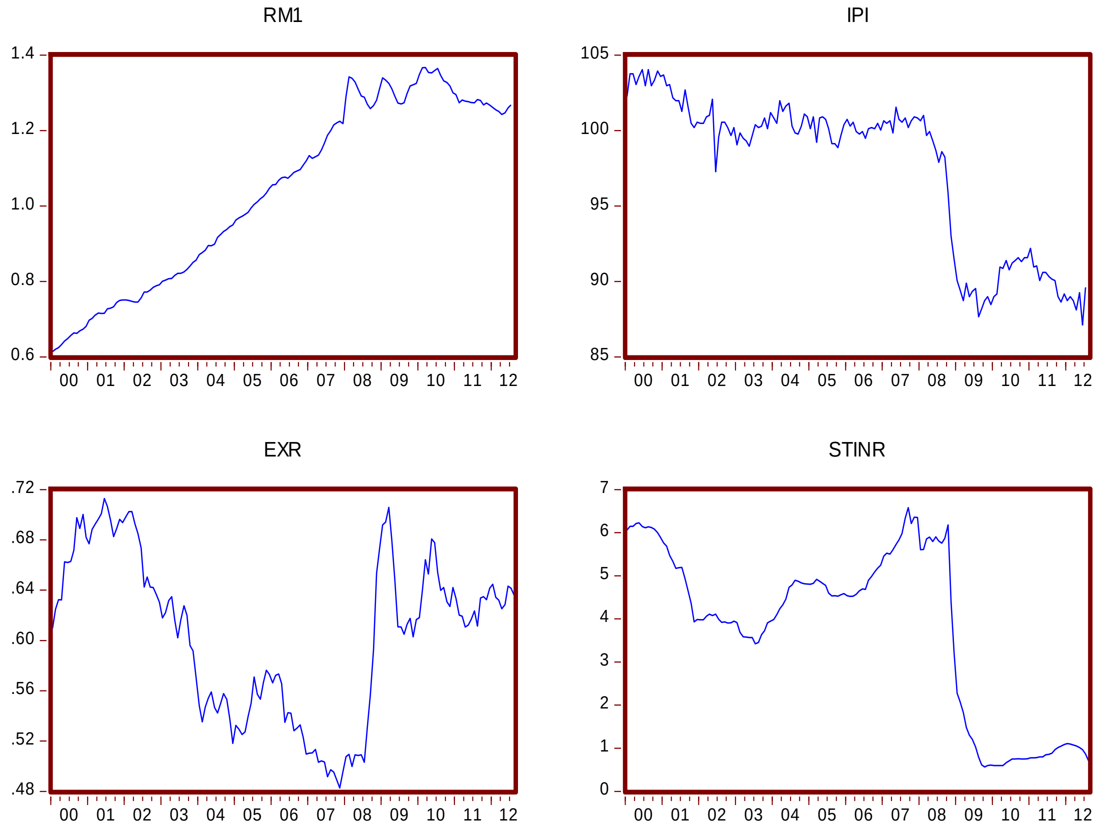

Figure 1. Time plots on Real Money Demand RM1_UK, IPI_UK, EXR_UK, INR_UK

The data on UK's Narrow Money Supply M1, Industrial Production Index, Exchange rates and Consumer Price Index were sourced from the database of Organization for Economic Cooperation and Development (OECD)[1]. While data on Euro Area's Narrow Money Supply (M1) and CPI were obtained from European Central Bank Database. Monthly data from 2000 to 2012 to build two vector autoregressive models, one for each economy was used. All data were transformed to log so that they can have same magnitude and to improve the data analysis.

DATA ANALYSIS AND RESULTS

The variables included in the analysis are short-term interest rates, exchange rates, narrow money supply, industrial production index and consumer price index. Financial crisis was introduced as a dummy variable to capture structural breaks in the models especially due to the global recession. All macroeconomic variables were converted to log. Narrow Money Supply M1 was deflated by CPI using the formula, *RM1= M1/CPI* to obtain the Real Money Demand, RM1_UK and RM1_EA in the United Kingdom and Euro Area respectively. Based on the time plots in Figure 1, we can assume random walks for all endogenous variables in this research work. To check the stationarity of our series, Augmented Dickey-Fuller unit root test (Table 1) was conducted on all the endogenous variables.

Augmented Dickey-Fuller Test (ADF)

Augmented Dickey-Fuller test (Said and Dickey, 1984) accommodates general Autoregressive Moving Average (ARMA (p, q)) models with unknown orders. The ADF tests, the null hypothesis showed that a time series y_t is I (1) against the alternative that it is I (0), assuming that the dynamics in the data have an ARMA structure. The ADF test is based on estimating the test regression:

$$Y_t = \beta' D_t + \Phi y_{t-1} + \sum_{j=1}^{p} \Psi_j \Delta y_{t-j} + \varepsilon_t \qquad 2.1$$

where Y_t and Δy_{t-j} represents level and first difference of each endogenous variable respectively, D_t is a vector of deterministic terms (constant, trend etc.). The *p*-lagged difference terms, Δy_{t-j}, are used to approximate the

[1] Organization for Economic Cooperation and Development was established in 1960 by European leaders with aim of encouraging cooperation and reconstructions after World War II. It currently spread across Europe, Americas, and Asia-Pacific regions with 34 memberships.

Table 1. Unit root tests results

United Kingdom	Level		First Difference	
	Without trend	With trend	Without trend	With trend
Lrm1_uk	-2.7064	0.0603	*-6.9358	*-7.6539
Lexr_uk	-1.7404	-1.6724	*-8.9426	*-8.9311
Linr_uk	-0.4665	-2.0943	*-4.8332	*-4.8892
Lipi_uk	-0.3848	-1.7308	*-15.3851	*-15.3421
Euro Area				
Lrm1_ea	-1.5351	-1.5548	-2.6486***	-2.9460

Values from ADF tests. *, *** represents no unit root at the first difference either at 1 per cent or 10 per cent level of significance respectively

ARMA structure of the errors, and the value of *p* is set so that the error ε_t is serially uncorrelated. The error term is also assumed to be homoskedastic. The specification of the deterministic terms depends on the assumed behaviour of y_t under the alternative hypothesis of trend stationarity (Said and Dickey, 1984). Under the null hypothesis, y_t is I (1) which implies that $\varphi = 1$. The ADF t-statistic and normalized bias statistic are based on the least squares estimates of (2.1) and are given by

$ADF_t = t_{\varphi = 1} = (\hat{\varphi}-1)/SE(\hat{\varphi})$ 2.2

$ADF_n = T(\hat{\varphi}-1)/(1-\hat{\Psi}_1-\ldots\ldots\ldots\ldots-\hat{\Psi}_p)$ 2.3

Or alternatively, the ADF formulation is

$Y_t = \beta' D_t + \pi y_{t-1} + \sum_{j=1}^{p} \Psi_j \Delta y_{t-j} + \varepsilon_t$ 2.4

where $\pi = \varphi - 1$. Under the null hypothesis, Δy_t is I(0) which implies that $\pi = 0$. The ADF t-statistic is then the usual t-statistic for testing $\pi = 0$ and the ADF normalized bias statistic is $T\hat{\pi}/(1 - \hat{\psi}_1 - \cdot\cdot\cdot\cdot - \hat{\psi}_p)$. The test regression (2.4) is often used in practice because the ADF t-statistic is the usual t-statistic reported for testing the significance of the coefficient y_{t-1} (Said and Dickey, 1984). Many studies including Skrabic and Tomic-Plazibat (2009) have shown that economic variables behave like random walks or at least have random walk components by using unit roots tests such as ADF. As shown in Table 1. The above table reveals that after considering with and without trend, the unit root tests accepted the null hypothesis of unit root. Therefore, a further ADF and PP tests on the first differences concluded that all variables are integrated of order one that is, I (1).

2008 Global Financial Crisis Effects

From the time plots (Figure 1), it can be observed that United Kingdom experienced an increase in the real money stock over the period under consideration. Economic growth as measured by industrial production has dropped significantly in the United Kingdom especially since the periods after 2008 financial crisis. The exchange rates have stabilized in the UK after recoveries from their low figures in 2008 (it rose sharply in early 2009 and has almost stabilised to its early 2000 figures). The financial crises lead to significant drop in the short-term interest rates, in an effort to stimulate and feed economic expansion, the Bank of England intervened by consistently reducing the prime lending rates. The “credit crunch” and market liquidity made the economic downturn more protracted. Cash became “king” as investors avoided a variety of risky assets. Several financial corporations filed for bankruptcy in the United States, notably are Lehmann Brothers, IndyMac Bank, Merrill Lynch and the purchase of banking assets of Washington Mutual by JP Morgan Chase (ostensibly the biggest bank failure). Also, the insurance giant American International Group (AIG) sought an abridged loan ($US85 billion rescue package) from the Federal Reserve. Furthermore, a syndicate of 10 banks created an emergency fund of at least ($US70 billion) following the demise of Lehmann Brothers. In the United Kingdom, the government bailed out Northern Rock through nationalisation after unsuccessful take-over bids. Spanish Group Santander Bank bought Bradley and Bingley after its nationalisation in late 2008. Similarly, UK government acquired a major stake (about 84%) through partial nationalisation of the Royal Bank of Scotland Group in 2009. Mortgage Bank like Halifax Bank of Scotland, UK largest mortgage lender was merged with Lloyds TSB Group and the UK government took a 43.4% ownership in the combined group. Furthermore, in an attempt for safe-haven, most euro area banks especially from Central and Eastern European countries suffered significant capital flights inform of outflows of cross-border interbank deposits, mainly as non-affiliated depositors withdrew. There was significant drop in venture capital funding which generally results in slowed job creation and rise in unemployment rate. Below, potential growth impacted negatively on the labour force by steadily increasing the unemployment rates. There has been marginal drop in unemployment rates since the beginning of 2012 in the United Kingdom.

Table 2. Chow breakpoint test: Nov. 2007.

H_0: No breaks at specified breakpoint		
Test	**Value**	***P*-Value**
F-*statistic* : F(10,128)	1.6475	0.1004
Log likelihood ratio Chi-Square(10)	17.9197	***0.0563
Wald Statistic Chi-Square(10)	16.4755	***0.0868

Null hypothesis that there is no breaks at specified breakpoints can be rejected ***10% level of significant

This is attributable to significant downward pressure on the growth of labour earnings in the UK. On the other hand, consumer price index has shown steady rise during the period under review. The rise in inflation is partly responsible for the lower labour costs (lower-pay rises whereby companies are seen to be "hoarding labour" by retaining highly skilled staff to keep training cost down) particularly in the United Kingdom.

In 2009, there was a spike in the financial market activities in both economies. These were partly due to combination of news and improved companies earnings reports. This development was short-lived as investors failed to distract from worries about the economies. European Union banks witnessed increased reduction in assets through deleveraging Global Financial Stability Report (GFSR, 2012). Also, there was increasing market fragmentations and financial repression, which threatened the unified monetary policy of the euro area. In 2011, the ECB introduced a special scheme called the Long-term Refinancing Operations to boost the economies in the area. As a consequence of deteriorating economic conditions, persistent global financial turmoil especially in the Euro Zone, the money demand have experienced slow growth rate, which has impacted negatively on the United Kingdom economy. Furthermore, between May 2011 and July 2012, the European Union introduced some temporary and permanent financial assistance mechanisms such as the European Financial Stability Facility (EFSF), European Financial Stability Mechanism (EFSM) and European Stability Mechanism (ESM). These are measures geared towards ensuring good economic governance and fiscal discipline amongst member countries.

Presence of structural changes induced by 2008 Global Financial Crisis

The financial crisis of 2008 was included in the analysis, as a measure of the structural breaks observed in the series. This is essential because when there are breaks in the data, the regular ADF test tends to discover unit roots (non stationarity) that are inexistent. Structural change may occur for many reasons. The European integration has resulted in structural change in location, regional trade, regional fiscal coordination and economic governance. It could also occur by accident like the collapse of Lehmann Brothers and other financial institutions in late 2008. According to IMF World Economic Outlook (1998), crises may be considered to be an outcome of financial disturbances when markets suffer from a high degree of susceptibilities. These susceptibilities factors could be loss of confidence in banking system, sharp decline in assets and failure of financial institutions and financial corporations and so on. Chow Breakpoint tests (Table 2) were carried out on UK model respectively to ascertain where impacts of the global financial crisis were initially felt. After which an appropriate dummy variable was set up in the model reflecting this date. Chow breakpoint test involve comparing results of three tests statistic F-Statistic, log likelihood ratio and Wald Statistic. We tested whether there is structural change in the series before and during the 2008 financial crisis. Therefore, November 2007 was set as the breakpoint. The results of the three tests are as shown in the Table 2 below.

Test of parameter constancy

The reparameterized model is;

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Phi_i * \Delta y_{t-i} + AD_i + \varepsilon_t \qquad 2.5$$

where $\Pi = \alpha\beta'$, AD_i is the deterministic trend term which either equal to zero or not equal to zero. The dummy variable is as specified below:

$$\text{Financial crisis} = \begin{cases} 0, & \text{for } t = 01/2000 \ldots\ldots 10/2007 \\ 1 & \text{for } t = 11/2007, \ldots\ldots 08/2012 \end{cases}$$

Dummy variables are sometime referred to as indicator variables whose presence in a model may remove the impacts of outliers or in this case residuals exceeding about 2σ in absolute values or 95% confidence interval.

Table 3. Granger causality test using Toda-Yamamoto procedure.

Dependent variable: L(RM1_UK)			
	χ^2	**df**	**Prob.**
L(IPI_UK)	5.2495	2	**0.0725
L(INR_UK)	6.5135	2	** 0.0385
L(EXR_UK)	1.3970	2	0.4973
All	14.7048	6	**0.0227
Dependent variable: L(IPI_UK)			
L(RM1_UK)	2.9582	2	0.2278
L(INR_UK)	0.3639	2	0.8336
L(EXR_UK)	11.3172	2	* 0.0035
All	14.6450	6	** 0.0232
Dependent variable: L(INR_UK)			
L(RM1_UK)	2.3171	2	0.3139
L(IPI_UK)	18.1382	2	* 0.0001
L(EXR_UK)	3.0881	2	0.2135
All	26.1797	6	* 0.0002
Dependent variable: L(EXR_UK)			
L(RM1_UK)	0.6961	2	0.7061
L(IPI_UK)	7.2401	2	**0.0268
L(STINR_UK)	1.2625	2	0.5319
All	7.8436	6	0.2498

Significant at *1%, **5% level of significant

By their inclusion we may obtain a better estimate of the innovation/shock variance. Doornik et al (1998, pp. 550) suggested three ways of including "impulse" dummies. "They could be ignored, introduced unrestrictedly, restricted to the cointegration space or a mixture of the last two". However, they emphasized that the size of their effect matters sometimes when we have sample size increasing asymptotically after several Monte Carlo simulations.

Modelling real money demand in the United Kingdom

In order to avoid the situation of modelling a spurious regression amongst the endogenous variables, and the loss of long-run relationship usually associated with VAR*(p)* of random walks using the first difference, vector error correction models (VECM) was developed for the four endogenous variables using global financial crisis as an exogenous variables.

Test of granger non-causality

Granger non-causality test using the alternative procedure by Toda-Yamamoto (1995) was carried out to ascertain the causal relationship amongst the endogenous variables. This procedure was adopted because the use of Wald test statistic of linear restrictions on parameters of a VAR model where some of the series are non-stationary will not follow the usual asymptotic chi-square distribution under the null hypothesis (Engle, 1984). This is because the test's asymptotic distribution involves nuisance parameter which cannot be observed directly. In light of this reason, this research work adopted the method proposed by Toda and Yamamoto (1995). One tested for the absence of Granger causality by estimating the following VAR model:

$$Y_t = \gamma_0 + \gamma_1 Y_{t-1} + ... + \gamma_p Y_{t-p} + \varphi_1 X_{t-1} + ... + \varphi_p X_{tp} + \omega_t \quad 2.6$$

$$X_t = \upsilon_0 + \upsilon_1 X_{t-1} + ... + \upsilon_p X_{t-p} + \varphi_1 Y_{t-1} + ... + \psi_p Y_{t-p} + v_t \quad 2.7$$

Then, testing H_0: $\varphi_1 = \varphi_2 = ... = \varphi_p = 0$, against H_A: 'Not H_0', is a test that *X does not* Granger-cause *Y*. Similarly, testing H_0: $\varphi_1 = \varphi_2 = ... = \varphi_p = 0$, against H_A: 'Not H_0', is a test that *Y does not* Granger-cause *X*. In each case, a rejection of the null hypothesis implies there is Granger causality. In Summary, Granger non-causality test results show that there exist unidirectional causality from LIPI_UK to LRM1_UK, LINR_UK to LRM1_UK and not vice versa (Table 3). However, there is a reasonable evidence of granger causality from all the independent endogenous variables to LRM1_UK when considered together at 5 per cent significant level.

Cointegration analysis of non-stationary series

The result of Augmented Dickey-Fuller Test, Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. The stationary combination may be interpreted as the cointegration, or equilibrium relationship between the variables. Regressing one random walk against another can lead to spurious results that is, conventional significance tests will tend to indicate a relationship between the variables when in fact there is none. To avoid this we may run regression with the stationary variables. However, if the variables are non-stationary (random walks) but are cointegrated running a regression with the first difference variables may lose the long-run information as the first difference regression results is for short-run. If the random walks are found to be cointegrated the regression result with variables at level are non-spurious and it also measure the long-run relationship between the variables. Therefore, the vector error correction model (VECM) was performed to investigate the short-run relationship including the Granger Causality relationship. We considered the vector autoregressive process with Gaussian white noise defined by

$$Y_t = \sum_{i=1}^{p} \Phi_i Y_{t-i} + \varepsilon_t \qquad 2.8$$

$$\Phi(B)y_t = \varepsilon_t \qquad 2.9$$

where $\mathbf{y}_{-p+1}, \ldots, \mathbf{y}_0$, are fixed and the shock or innovation ε_t is a Gaussian white noise. Since the AR operator $\Phi(B)$ can be re-expressed as $\Phi(B) = \Phi^*(B)(1-B) + \Phi(1)B$ where $\Phi^*(B) = I_k - \sum_{i=0}^{p} \Phi_i * Bi$ with $\Phi_i^* = -\sum_{j=i+1}^{p} \Phi_j$, the vector error correction model is

$$\Phi^*(B)(1-B)y_t = \alpha\beta' y_{t-1} + \varepsilon_t \qquad 3.0$$

$$\Delta y_t = \alpha\beta' y_{t-1} + \sum_{i=1}^{p-1} \Phi_i * \Delta y_{t-i} + \varepsilon_t. \qquad 3.1$$

Where Δy_t represents the first difference of endogenous variables at time t. Furthermore, Δy_{t-1} represeents the first difference of exogenous variables at time t-1 (this otherwise referred to as the short-run variables. One impulse for the VECM (p) form is to consider the relation $\beta' y_t = c$ as defining the underlying economic relations and assume that the regressors react to the disequilibrium error $\beta' y_t - c$ through the adjustment coefficient α to restore equilibrium; that is, they satisfy the economic relations. The cointegrating vector β is sometimes called the *long-run parameters*. Considering we have a vector error correction model with a deterministic term. The deterministic term D_t contains a constant and a linear trend.

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Phi_i * \Delta y_{t-i} + AD_i + \varepsilon_t \qquad 3.2$$

where $\Pi = \alpha\beta'$. The alternative vector error correction representation considers the error correction term at lag $t-p$.

If the matrix Π has a full rank ($r=k$), all components of $\mathbf{y}_t$ are I(0). On the other hand, $\mathbf{y}_t$ are stationary in difference if rank(Π). When the rank of the matrix Π is $r < k$, there are $k-r$ linear combinations that are non-stationary and r stationary cointegrating relations. The cointegration rank test determines the linearly independent columns of Π. Johansen (1991) and Johansen and Juselius (1990) proposed the cointegration rank test using the reduced rank regression. When there are deterministic cointe-grated relationships among variables, deterministic terms in the VAR (p) model will not be present in the VECM (p) form. On the other hand, if there are stochastic cointe-grated relationships, deterministic terms appear in the VECM (p) form via the error correction term or as an independent term in the VECM (p) form. In some cases, a linear combination of variables removes the stochastic trend(s), but not the deterministic trend, so there is need to account for a linear trend in the cointegration space. There are different specifications of deterministic trends. Johansen (1988) suggested two test statistics to test the null hypothesis that there are at most r cointegrating vectors. One of them is the likelihood ratio trace statistics and the other one is maximum eigenvalue statistics, to determine the presence of cointegration vectors in non-stationary time series. The trace statistics and maximum eigenvalue statistics are shown in equation (3.1) and (3.2) respectively

1. Trace Test

$$\lambda_{trace} = -(n-p) \sum_{i=r+1}^{k} \ln(1-\lambda_i) \qquad 3.3$$

2. Maximum Eigenvalue Test

$$\lambda_{max} = -(n-p) \ln(1-\lambda_{r+1}) \qquad 3.4$$

where n is the sample size, λ_i is the i^{th} largest canonical correlation between residuals from the n-dimensional processes and residual from the n-dimensional differentiate processes. After carrying out Johansen Test of cointegration on the four endogenous, one long-run relation was generated. The test of cointegration was done excluding an intercept in the VAR. This was to ensure the validity of the critical values of the test associated with Johansen Cointegration test. The error corrections term (Table 6) as this long-run relation is sometimes referred, was computed based on the trace and maximum eigenvalue as depicted in the Table 4 below. The trace test tests the null hypothesis of at most r cointegration vector against the alternative hypothesis of full rank cointegration vector, the null and alternative hypothesis of maximum eigenvalue statistics is to check the r cointegrating vectors against the alternative hypothesis of at least one cointegrating vectors. The tests could not reject the hypothesis that the rank (Π) is at most one in both cases. Toda (1994) in an experiment using limited stochastic simulation showed that both tests

Table 4. Unrestricted Johansen Cointegration Rank Test.

Trace				
Hypothesized		**Trace**	**1%**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
	0.248700	86.36395	71.47921	0.0002
At most 1	0.148050	44.04324	49.36275	0.0384
At most 2	0.126546	20.32964	31.15385	0.2097
At most 3	0.002061	0.305326	16.55386	1.0000
Maximum Eigenvalue				
Hypothesized		**Max-Eigen**	**1 %**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.248700	42.32071	37.48696	0.0020
At most 1	0.148050	23.71360	30.83396	0.0926
At most 2	0.126546	20.02431	23.97534	0.0404
At most 3	0.002061	0.305326	16.55386	1.0000

Table 5. Lag order selection.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	585.4621	NA	$3.65*10^{-09}$	-8.0764	-7.9106	-8.0090
1	1525.994	1802.138	$8.85*10^{-15}$	-21.0069	-20.5097	-20.8048
2	1580.845	102.0307	$5.14*10^{-15*}$	-21.5502*	-20.7215*	-21.2135*
3	1590.901	18.1433	$5.60*10^{-15}$	-21.4672	-20.3069	-20.9957
4	1597.965	12.3494	$6.36*10^{-15}$	-21.3422	-19.8504	-20.7360
5	1611.581	23.0422	$6.61*10^{-15}$	-21.3088	-19.4855	-20.5679

are similar but emphasized that if $r_{Ho}=0$, there is a significant difference. Lutkepohl et al. (2000), considering different deterministic terms, showed that powers of the two tests are similar. However, with small sample sizes, the trace test power performance is higher. As a result of these likelihood ratio tests, Johansen tests depend only on completely specified autoregressive process for levels of data series. It tends to find cointegration more often in finite sample than in the asymptotic distribution and is more sensitive to the misspecification of lag length than in the non-normality of the disturbances (Wen, 1995). Hence, particular emphasis was placed on the lag length selection (Table 5) and adequate use of diagnostic testing for the residuals was ensured to avoid over acceptance of cointegration (see model misspecification analysis subsection 2.5.3). Therefore, prior to the estimation of VECM with the accompanying cointegrating vector, optimal lag length of initial Vector Autoregressive (VAR) model was ascertained. Different information criteria were calculated for various lag lengths. After calculations based on different criteria, two lags was selected by the Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Criterion (SC), Hannan-Quinn (HQ) methods (Table 5). One advantage of this approach is that it can be applied to set of variables containing possibly a mixture of I (0) and I (1) regressors.

The long-run analysis shows that the cointegrating relation or error correction term with coefficients or speed of adjustment to equilibrium as measured by the multiplier α = -0.02446 is significant at 1% level. This is an indication that one can expect the LRM1_UK to converge to its long-run equilibrium at a very slow rate so as to allow the short-run dynamics. Specifically, we expect the equilibrium to be achieved in about three years after shock of real money demand. In order to evaluate the long-run relations, the cointegrating vector was normalized on LRM1_UK. The result is as shown in Table 6 below. A global test value of 13.46 is significant at 1%, which is high implies that all the endogenous variables are important in forecasting real money demand in the United Kingdom when considered together. Surprisingly, negative and significant relationship exists between real money demand and industrial production index in the long-run. However, the coefficient indicates a high responsiveness of money demand to a unit change in industrial production in the United Kingdom. The normalized coefficients indicate that all are statistically

Table 6. Normalized cointegrating coefficients.

Cointegrating Eq:	L(RM1_UK (t-1))	L(IPI_UK(t-1))	L(INR_UK(t-1))	L(EXR_UK(t-1))	@TREND (OOM 01)
CointEq1	1	-6.546987	0.326513	0.891143	-0.00633
S.E		-1.37901	-0.06105	-0.2539	-0.0013
t-statistics		[-4.74760]	[5.34795]	[3.50985]	[-4.86591]

Table 7. VECM coefficients for United Kingdom real money demand.

	Coefficient	Std. Error	t-Statistic	Prob.
α	-0.02446	0.007097	-3.4457	*0.0007
D(LRM1_UKt-1)	0.2952	0.07562	3.9030	*0.0001
D(LIPI_UKt-1)	-0.2625	0.08091	-3.2443	*0.0015
D(LINR_UKt-1)	-0.03907	0.01388	-2.8161	*0.0056
D(LEXR_UKt-1)	0.08220	0.03012	2.7294	*0.0071
Constant	0.003754	0.001062	3.5357	*0.0005
FINANCIALCRISIS	-0.003195	0.001687	-1.8943	***0.0602
R-squared	*0.3625*			
Adjusted R-squared	*0.3355*			
F-statistic	*13.4550*	Durbin-Watson statistic		1.8665
Prob(F-statistic)	**0.000000*			

Null hypothesis that estimated coefficient is equal to 0 can be rejected at *1% or ***10% level of significant

significant in the long-run. This cointegration vector relates money demand positively to short-term interest rates and exchange rates with low inelasticity (less than one). This finding confutes Doornik et al (1998) claim that the contemporaneous relation between money demand and long-term interest rate is negative in the UK. Hence, it may be argued that while long-term interest rates have a negative contemporaneous relation, short-term interest rates have a probable positive relation with real money demand in the United Kingdom. This may be attributable to higher rate of growth of M1 relative to CPI (a key component of real money demand function) despite the lingering tight liquidity especially during the financial crisis period. However, a partial test on individual endogenous variable revealed that only the first lagged variables of all the independent variables are significant in the short-run. Hence a general to specific model with only lag 1 was postulated in the case of UK real money demand. Specifically, a 1% increase in the lagged variable $LIPI\_UK_{t-1}$ results in 0.2625% drops in LRM1_UK. While LRM1_UK declines by 0.039% for every 1% increase in $LINR\_UK_{t-1}$, it increases by 0.08219% in the case of 1% increase in $LEXR\_UK_{t-1}$. The decline in real money demand is line with the theoretical evidence. Between 2009 and 2010, the BoE loosened monetary policy through large-scale purchase of assets (quantitative easing), which lead to increase in broad money by about 8% (Bridges and Thomas, 2012). Also none of the variables are weakly exogenous. If any of the endogenous/independent variable(s) is (are) weakly exogenous then parameters of this (these) variable(s) will have marginal density function bearing no relation to the parameters that determine the conditional density function of the dependent variable that is, $f_j(y,x)=f_c(y|x, \beta_i).f_m(x| \Phi_r)$. The global financial crisis has a significant negative impact on the United Kingdom real money demand during the period. If the coefficient is significant either at 1, 5 or 10% level, it can be concluded that the crisis has important impact on the real money demand. This is identified by a marginal coefficient of -0.003195 (Table 7). The VECM allows for the findings that the other endogenous variables Granger-Causes LRM1_UK or vice-versa as long as the error correction terms are statistically significant irrespective of the joint significance of the estimated coefficients.

Model misspecification analysis – Real money demand for United Kingdom

A Durbin-Watson value of 1.8665 indicates no serial correlation in the VECM system error term and confirms long-run relationships that exist between the endogenous variables. One of the major problems associated with the Johansen test of cointegration is the insensitivity to the non-normality of residuals/innovations. Therefore, in order to ensure the avoidance of over acceptance of cointegration, residual diagnostics were conducted for serial correlations, normality, ARCH effect and Heteroskedasticity. ARCH effect (*obs* R squared* = 0.3274, *p*-value = 0.2060) are insignificant at 10% level. After conducting the Breusch-Godfrey LM test of serial correlation (*obs*R squared* = 3.05, *p*-value = 0.2166) on the residuals one could not reject the null hypothesis of no serial correlation. Jarcque-Berra value of 1035.878 (*p*-value of 0.000) indicates the residuals are not multivariate normally distributed probably due to some remaining outliers otherwise the system is consistent with available evidence. The evaluation of the historical simulations using Theil inequality coefficient shows that a value of 0.01334 is close to zero, covariance accounted for 93.85%, variance 4.2% while bias proportion is 1.93% indicating a strong correlation between the actual and forecasted values. Forecast errors which are largest when most are happening in the economy usually reflect external shocks. In the case of real money demand in the UK, these shocks were observed mostly at the beginning of 1^{st} and end of 2^{nd} quarters of 2001, 2002, 2003, 2004, 2008, 2009 and 2010.

Impulse response function

The dynamic behaviour of the initial VECM model by studying impulse response function of money demand to Cholesky one standard deviation innovation or shock from independent variables was conducted. Impulse Response Function *(IRF)* helps to determine how each endogenous variable responds over time to shock in that variable and in every other endogenous variable by tracing the response of endogenous variables to such shocks. It allows one to identify shocks with specific endogenous variables so in order to ascertain how an unexpected change in one variable affects all variables over time. Therefore, an impulse response function shows the interaction between/among the endogenous variables sequence. Impulse response function (IRF) of a dynamic system is its output when presented with a brief input signal, called an impulse. More generally, IRF refers to the reaction of any dynamic system in response to some external change. A VAR can be written in the form of vector moving average (∞)

$$y_t = \mu + a_t + \varphi_1 a_{t-1} + \varphi_2 a_{t-2} + \ldots = \mu + \varphi(B)a_t \qquad 3.6$$
$$\text{Where } \mu = E(y_t) = \psi_0/(1- \psi_1- \psi_2-\ldots- \psi_p) \qquad 3.7$$

The expression in equation 4.2 shows explicitly the impact of past shock a_{t-i} (i > 0) on the current y_t. The φ_i's are known as the impulse response function of the model. If a series is weakly stationary the φ_i coefficients decline exponentially. Below is a condensed form of the procedure for the computation of IRF.

Procedure:

1. To be able to compute the IRF, the model has to be in equilibrium. This can be achieved by holding the exogenous variable constant and allowing simulation over a long period of time so that the endogenous variables stop changing.
2. Introduce a one standard deviation shock to one of the endogenous variables say real money demand, ε_1 at time t = 0. This one period shock is what is referred to as the 'impulse'. This impulse will filter through the model affecting all the variables.
3. Then introduce one period shock to the next endogenous variable and so on until the last variable.

One important use of this type of analysis is that if the variables are cointegrated that is, move together in the long-run, effects of a temporary shock tend to dissipate after several years rather than been permanent. The IRF was calculated by increasing for one month only, the error terms in the four system equations of our VECM by one standard deviation and then calculate the immediate effect and future effects of this change on LRM1_UK. The impulse response function (IRF) was computed using the covariance matrix $\sum_{4x4}$ among the four error terms ε_{lrm1_uk}, ε_{lipi_uk}, ε_{linr_uk}, ε_{lexr_uk}. Please note that these error terms represent shocks from LRM1_UK, LIPI_UK, LINR_UK, and LEXR_UK respectively.

	L(RM1_UK)	L(IPI_UK)	L(INR_UK)	L(EXR_UK)
L(RM1_UK)	0.0000654	−0.00000883	−0.000112	0.0000124
L(IPI_UK)		0.0000801	0.000110	−0.0000194
L(INR_UK)			0.001989	−0.000213
L(EXR_UK)				0.000467

Variance-covariance matrix of shocks on VECM System

The matrix of variance-covariance above shows the response of LRM1_UK to one standard deviation disturbance on LRM1_UK, LIPI_UK, LINR_UK, and LEXR_UK that is, a one period increase of 0.008087, 0.008950, 0.04460 and 0.02161 respectively. An initial effect on LRM1_UK was concentrated largely on LRM1_UK. Shocks on the LRM1_UK had positive effect on LRM1_UK throughout the 24-month periods. Increasing the standard error term ε_{lipi_uk} and ε_{linr_uk} by 0.008950 and 0.04460 respectively produced negative reaction from LRM1_UK. Shocks on LEXR_UK resulted in in a positive response from real money demand in the second period. While the effect of shock on exchange rate produced a negative response from real money demand from period-10, one standard deviation innovation on industrial production index resulted in positive response from money demand in period-7. However, responses from shocks on industrial production index and exchange rates were the same in period-8(equilibrium period). Please note that short-term interest rates will produce the highest response from real exchange rate during the forecast period. As shown in Figure 2.

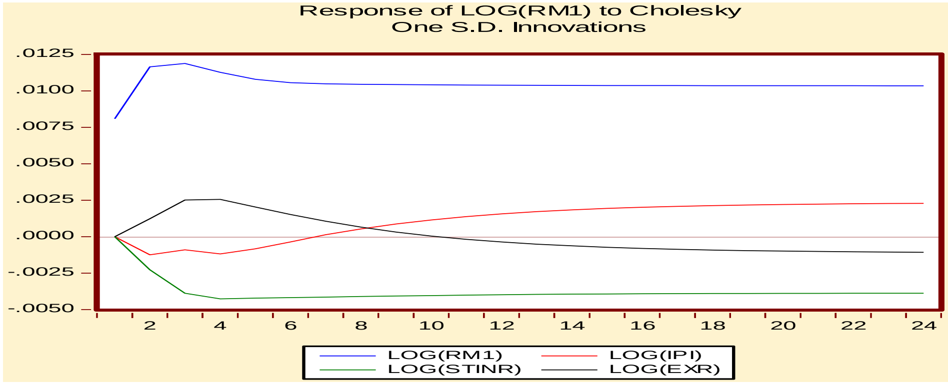

Figure 2. Response of LRM1_UK to One Standard Deviation Innovation.

Table 8. Granger causality between RM1_UK and RM1_EA.

Dependent variable: LOG(RMD_Uk)	**Chi-sq**	**df**	**Prob.**
LRMI_EA	12.07	5	0.034
All	12.07	5	0.034
Dependent variable: LRMD _EA	**Chi-sq**	**df**	**Prob**
LOG(RMI_UK)	35.987	5	0.000
All	35.987	5	0.000

Relationships between real money demand in the United Kingdom and Euro Area

In order to study the relationships between the Real Money Demand in UK and Euro Area, we remodelled the Vector Error Correction Model system equation on United Kingdom's real money demand introducing the Euro Area's real money demand as additional exogenous variable. This type of analysis is essential considering the fact that United Kingdom is not committed to the "third EMU stage" which stipulates conditions necessary to adopt the euro currency[2]. Firstly, a test of granger non-causality (Table 8) between real money demand in United Kingdom and Euro Area was conducted using Toda-Yamamoto procedure (1995) as usual. Although, both variables granger causes each other, the chi-square values signifies that the past and current values of United Kingdom real money demand (with *chi-squared-value* 35.99, *p-value* = 0.0000) is highly significant in forecasting the future values of Euro Area real money demand than does the latter (*chi-squared-value* of 12.07 and *p-value* of 0.034).

[2] EMU is the Economic and Monetary Union which was established by the European Council in the Maastricht at the end of 1991 for the integration of European Union economies through coordination of economic, fiscal and independent monetary policies and adoption of single currency (Euro currency).

Null hypothesis of no granger causality significant at 1% and 5%

Though the introduction of the first difference of LRM1_EA in the UK real money demand VECM system equation increased *R-squared* by 2.38% from 36.5% to 38.88% (adjusted R-squared 35.84%), its coefficient in the model is negative and statistically significant at all levels with a value of -0.1759 and *p-value* of 0.0020 (Table 9). Furthermore, its presence in the model had a negative effect on the speed of adjustment to equilibrium in the long-run. Specifically, the speed reduced from about three years to six years in the presence of Euro Area Real Money Demand.

CONCLUSION

In this research work, we employed vector error correction and cointegration techniques in order to estimate the responsiveness (elasticity) of money demand to macroeconomic variables in the United Kingdom between 2000 and 2012. Long-run co-movement amongst the endogenous variables was established with very low speed of adjustment from disequilibrium caused by shocks on the real money demand. The adjustment to equilibrium in the long-run is expected to take about three years in UK so as to allow short-run dynamics. Real money demand in the long-run depended on industrial

Table 9. VECM Short-run coefficients for United Kingdom real money demand.

	Coefficient	Std. Error	t-Statistic	Prob.
α	-0.0140	0.0050	-2.7728	*0.0063
D(L(RM1_UK $_{(t-1)}$))	0.3405	0.0748	4.5529	*0.0000
D(L(IPI_UK $_{(t-1)}$))	-0.2336	0.0784	-2.9787	*0.0034
D(L(INR_UK $_{(t-1)}$))	-0.0369	0.0135	-2.7339	*0.0071
D(L(EXR_UK $_{(t-1)}$))	0.0811	0.0297	2.7289	*0.0072
Constant	0.0058	0.0010	5.7055	*0.0000
D(L(RM1_EA)	**-0.1759**	**0.0560**	**-3.1420**	***0.0020**
FINANCIALCRISIS	-0.0069	0.0016	-4.4210	*0.0000
R-squared	0.3888	Durbin-Watson statistic		1.85
Adjusted R-squared	0.3584			
F-statistic	9.6251			
Prob	*0.0000			

Null hypothesis that estimated coefficient is equal to zero can be rejected at *1% level of significant
D(LOG(RM1)) = -0.0140*(L(RM1_UK(-1)) - 8.3299*L(IPI_UK (-1)) +0.4112*L(INR_UK (-1)) + 0.9906*L(EXR_UK (-1)) -0.0091*@TREND + 38.8767) + 0.3405*D(L(RM1_UK (-1))) - 0.2334*D(L(IPI_UK (-1)))-0.0369*D(L(INR_UK (-1)))+0.0811*D(L(EXR_UK (-1))) +0.0058- 0.1759*D(L(RM1_EA)- 0.0069*FINANCIALCRISIS

production index, interest rates and exchange rates with relative elasticity. During the review period, the global test of the combined effects of all the endogenous and exogenous variables turned out to be significant in forecasting the UK real money demand. The impact of the 2008 global financial crises was evaluated. The effect of this dummy variable was negative and statistically significant in United Kingdom. This exogenous variable was introduced to evaluate the effect of inherent structural breaks in the economy observed especially from November 2007 in United Kingdom. Long-run dynamics showed a more than unity elasticity between industrial production index and real money demand. The short-run dynamics revealed that only the first lagged variables of the endogenous variables are statistically significant. Increases in industrial production index resulted in decline in the real money demand. This may probably be attributable to rising inflation rates or (and) low growth rate in narrow money supply M1 due to tight liquidity particularly during the financial crisis period. Increase in exchange rates resulted in increase in the real money demand. The economic theory plays strong role in determining the models' long-run and short-run properties, which are largely data-determined. Analysis of the relationship between the United Kingdom and Euro Area real money demand revealed that while there might be long-run relationships, real money demand in the Euro Area has a negative and statistically significant effect on the United Kingdom's real money demand. But there is currently debate on the future of its membership of the European Union. In 2012, more than half of British public and some members of the current Conservative Party led coalition are strongly in support of the UK leaving the European Union. Analysis of forecast error signified the impact of important shocks from external forces on real money demand. The global financial crisis, which began in November of 2007 as a result of significant downturn in the US economy, was revealed in the forecast errors of the model. Similarly, current financial crisis in the Euro Area was also accounted for in the forecast errors. However, each economy has peculiar shocks from external forces distorting the forecast errors at various points. These were attributable to tight market liquidity caused by the 2008 global financial crisis resulting in euro area banks suffering significant outflows of cross-border interbank deposits, Spain's announcement of austerity budget which resulted in highest inflation rate in 2 years, worsening unemployment rate in the Euro Area. Further analysis of the forecast error using impulse response indicates that shocks on interest rates will have the most effects on real money demand in the United Kingdom. Future increase in interest rates will likely explain decrease in money demand. The implication is that any increase in interest rates from their current levels will probably result in a significant reduction in the money demand in the United Kingdom in not too distant future. This is certainly a monetary policy concern for Bank of England.

Conflict of Interests

The authors have not declared any conflict of interests.

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