



# AfDB Brief

## Inflation Dynamics in selected East African countries: Ethiopia, Kenya, Tanzania and Uganda

### 1 Introduction

In spite of good macro performance over the past decade (see Table A.1 in the appendix), inflation in four leading East African economies – Ethiopia, Kenya, Tanzania and Uganda – has spiraled out of control recently (Box 1 and Figure 1). Sharp increases in inflation could reduce economic growth and exacerbate poverty levels. This note unpacks the factors behind the recent high inflation rates in these four countries. It builds upon previous research indicating that inflation is caused by various factors ranging from macroeconomic imbalances to supply-side constraints and external pressures (Box 2). The brief attempts to stimulate debate by providing a first empirical evidence of the drivers of inflation in East Africa. It is meant to be a reference tool for further and deeper empirical analysis. We also take into account the specificities of each country, such as the innovative use of mobile telephone for banking services, in explaining the recent inflation hike.

### Main findings

We find that the main driver of short-run inflation in Ethiopia and Uganda is a surge in money supply, accounting for 40 percent and one-third, respectively. In Kenya and Tanzania, oil prices seem to drive inflation, accounting for 20 and 26 percent respectively, although money growth has also made a significant contribution to the recent increases in inflation in these two countries. The difference in inflationary effects may be explained by differences in the intensity of expansionary monetary policies. Inflationary pressures in Ethiopia reflect monetization of the fiscal deficit while growth in private sector credit is the main source of broad money growth in Uganda and Kenya, resulting in an accumulated monetary expansion. With regard to world food prices, our estimates show that the effect ranges from 9 percent at the lower end in Tanzania to the upper limit of 13 percent in Ethiopia and Uganda. Although changes in domestic cereal production do not seem to have had a large

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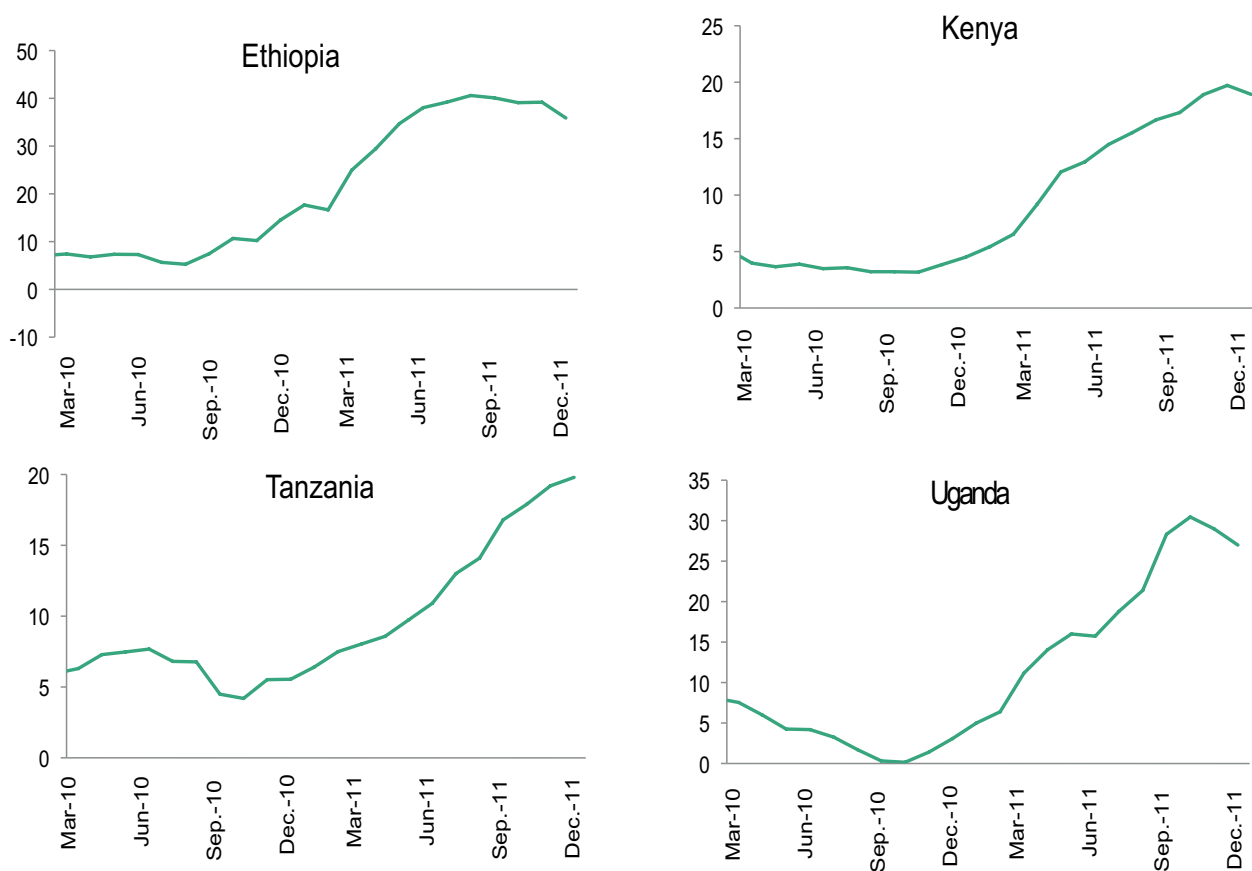
The note was produced by Anthony Simpasa (Principal Research Economist) and Daniel Gurara (Senior Research Economist), supervised by Abebe Shimeles (Manager) and Désiré Vencatachellum (Director, Development Research Department), under the guidance of the Chief Economist and Vice President, Prof. Mthuli Ncube. The brief has benefited from very useful inputs and comments from country economists covering East Africa.

impact on short-run inflation, they do matter in the long run, accounting for more than a third of long-run inflation in Tanzania.

## Policy recommendations

In light of our findings, we recommend the following policy responses. First, central banks must recommit themselves to maintaining low and stable inflation. Second, continued prudent fiscal management is required to support monetary policy, maintain growth and poverty reduction. Third, velocity increased because of financial innovations, including the advent of innovative financial products such as mobile banking. Whilst financial innovation is dynamically improving the performance of the financial sector and enhancing inclusiveness, there is need to ensure that regulatory oversight is improved to ensure that

**Figure 1 Annual inflation, March 2010 to December 2011, (percent per annum)**



Source: AfDB computations based on data from national statistical authorities data.

innovative financial products do not undermine efforts aimed at improving the effectiveness of monetary policy in curbing inflation.

Finally, while little can be done in the short run to mitigate shocks such as rising oil and food prices, a diversification program would have significant medium and long-term pay off. This must be implemented as part of broader policy framework aimed at addressing binding structural bottlenecks in order to improve efficiency of intra-regional trade and distribution of goods (such as cereals) from surplus areas to deficit regions.

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### Box 1 Recent trends on inflation

**The inflation rate in Ethiopia was nearly 40 percent in October before leveling off to 35.9 in December 2011.** Inflation in Ethiopia has been building for some time, even before the onset of the current episode of high food prices, driven by expansionary monetary policy. Credit to the public sector grew by more than 45 percent in 2011, triggered largely by the monetization of the fiscal deficit. Although commercial banks were compelled to purchase government bonds, this did not significantly slow down the rate of monetary growth.

**Despite decelerating to 27.0 percent in December 2011 from a high of 30.4 percent in October, inflation in Uganda is still far higher than expected,** given the 3 percent rate at the end of 2010. Year-on-year food inflation spiked to 45.6 percent in October 2011, while non-food inflation has been increasing steadily, moving to 22.8 percent from 5.5 percent in December 2010.

**Kenya saw its inflation peak at 19.7 percent in November 2011, before dropping to 18.9 percent in December.** This is a sharp reversal to previous years, when the authorities succeeded in bringing it down from 26 percent in 2008 to 4 percent in 2010. The central bank attributes the persistence of inflation to supply shocks, currency depreciation and emerging demand pressures driven by rapid growth in private sector credit.

**Tanzania inflation reached 19.8 percent in December 2011, well above the 10 percent average for the last few years.** However, in 2010, inflationary pressures started to build, fuelled by soaring food and energy prices, while the government's fiscal outlays added to the inflationary pressure. Since October 2010, inflation has more than tripled, reaching 17.9 percent in October 2011. Although food inflation has slowed recently, it is unlikely to offset other inflationary pressures.

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### Outline of the paper

The rest of the brief is organized as follows. Section 2 teases out the key drivers of inflation in the region. Section 3 assesses other possible causes of inflation. Section 4 discusses recent policy responses that the authorities have adopted in each of those countries with the view of taming inflation. Finally Section 5 provides a conclusion and the way forward. The results of the multivariate analysis are reported in an appendix.

## 2 Drivers of inflation

Our analysis of the causes of inflation in Ethiopia, Kenya, Tanzania and Uganda includes as determinants: (a) exogenous factors (i.e., world food and fuel prices); (b) structural characteristics (i.e., domestic production); and (c) policy variables (i.e., monetary, fiscal and exchange rate policies). In the short run, exogenous factors and structural characteristics are outside the influence of these countries, mainly due to production capacity constraints. Adverse weather conditions in recent years have further worsened the food situation in the region, causing a sharp increase in food prices. Added to this, rising global oil prices have been transmitted to domestic inflation, exacerbated by rapid depreciation in exchange rates across all four countries.

In order to account for the key inflationary factors, we estimate a standard inflation equation with broad money supply, nominal exchange rate, domestic food production and world price as explanatory variables. The specification of the model and the accompanying short- and long-run estimates are provided in the appendix.<sup>1</sup> We then use these estimates to decompose observed inflation into its main drivers. These decompositions are summarized in Table 1 and discussed below. The

**Table 1 Short and long term contributions to inflation in 4 East African countries (from inflation equations in the appendix)<sup>2,3</sup>**

Countries	July 2010-July 2011		% of inflation explained by			
	Observed inflation (%)	Observed broad money growth (%)	Monetary expansion	World Oil prices	World food prices	Cereal production
<b>Ethiopia</b>	39	30				
Short run			40	27	13	1
Long run			52	10	5	4
<b>Kenya</b>	16	17				
Short run			14	20	11	ns
Long run			31	18	10	18
<b>Tanzania</b>	13	16				
Short run			20	26	9	5
Long run			19	ns	ns	34
<b>Uganda</b>	19	25				
Short run			32	21	13	ns
Long run			52	ns	ns	14

Source: AfDB computations.

Note: ns denotes not statistically different from zero. The short run contributions are computed by using estimates for the short run equation (3) reported in Table A.3. Similarly, the long-run contributions are from the estimates for equation (1) reported in Table A.2.

<sup>1</sup> The absence of disaggregated data on CPI components constrains a more in-depth interrogation of the inflation issue.

<sup>2</sup> The choice of sample period used for estimating the model is constrained by data which must be available for all the variables used in the specification.

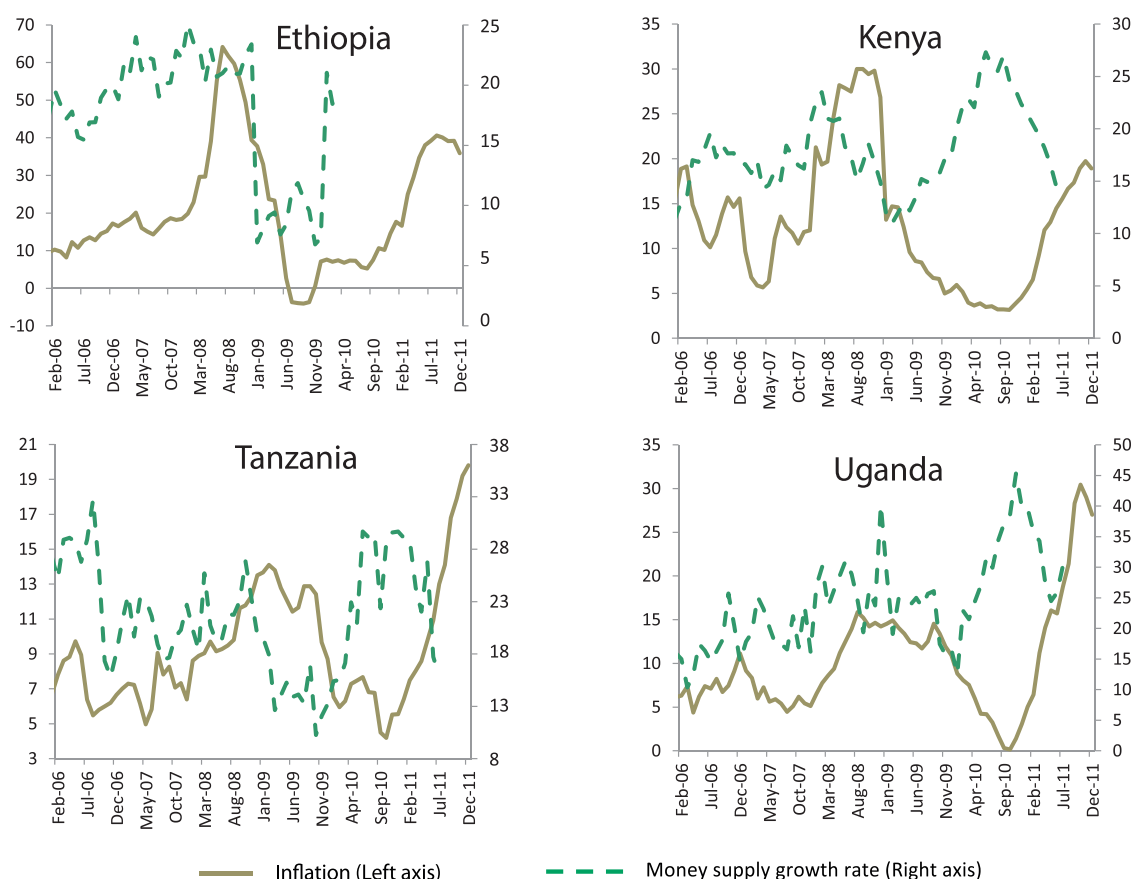
<sup>3</sup> Short-run factors may be transitory, but provide signals when authorities are confronted with an immediate policy challenge of containing inflation caused by exogenous shocks and short-term demand pressures. In the longer-term, the overall policy package must be holistic in nature. The case of Rwanda provides concrete demonstration of a broader policy approach to addressing macroeconomic and structural imbalances.

Table gives observed growth rates of broad money (Table 1, Column 2) and inflation rates (Table 1, Column 3) between July 2010 and July 2011 for each of those countries. As expected the drivers of inflation have different immediate and long-term effects because of differences in the intensity of monetary policy and inter-temporal structural adjustments, especially related to food production.

## Box 2 Survey of selected literature on inflation in African countries<sup>4</sup>

Previous research has shown that, in the long-run, the main determinants of inflation in Kenya emanate from the money market and external sector. Further evidence shows that inflation in Ghana is due to a combined effect of internal and external factors, with real output growth having the greatest impact while in Nigeria, exchange rate depreciation money supply and real gross domestic product play the dominant role in driving inflation. Another thread of evidence argues in favor of monetary factors and against the output gap as the main source of inflation in 17 African countries. For Ethiopia, the evidence shows in the long-run, non-food inflation is caused by monetary growth, interest rates and inflation expectations. For Ethiopia, this means that achieving fiscal balance and control of the money supply are essential policy tools for stabilizing inflation over the longer term.

**Figure 2 Inflation and money growth<sup>a</sup>**



Source: AfDB computations using data from national authorities

<sup>a</sup> Money supply (latest available data, July 2011, except for Ethiopia, March, 2010).

<sup>4</sup> Interested readers can consult: Sichei, M. M and J. Wambua (2011); Sichei, M. M and J. Wambua (2011); Adu G. and G. Marbuah (2011); Imimole, B and A. Enoma (2011); Peiris, S and Barnichon (2007); Geda, A and K, Tafere (2008); Wolde-Rufael (2008).

From Table 1, we note that monetary expansion seems to be the main driver of inflation in Ethiopia and Uganda in the short-run, accounting for 40 percent and one-third respectively. In Kenya and Tanzania, oil prices are the main drivers of the recent inflation episode accounting for 20 and 26 percent respectively, although expansionary monetary policy still contributes a significant proportion of inflation. These results are corroborated by the synchronization of inflation and money growth, though with substantial lag (Figure 2).

These differences can be explained by the intensity of expansionary monetary policies in each country. For instance, inflationary pressures in Ethiopia reflect monetization of the fiscal deficit (Figure 3). Net claims

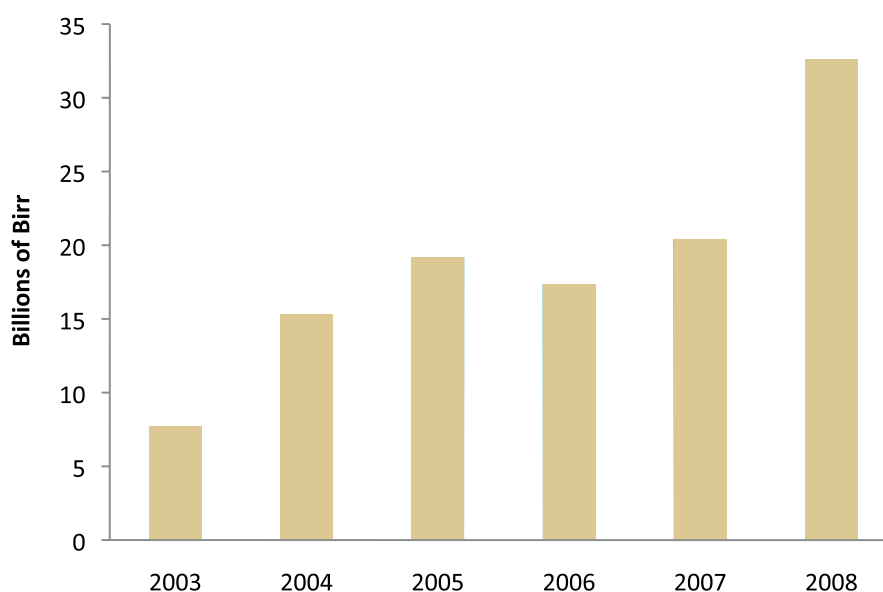
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### Box 3 Gold in Ethiopia

The monetary expansion in Ethiopia may also be partly explained by portfolio shift, as the central bank has recently been buying large quantities of gold from local producers, particularly small-scale artisan miners. In the first quarter of 2011/12 fiscal year, the central bank purchased USD 109.5 million worth of gold from artisan miners, which is higher than its target by 52 percent. The supply of gold to the central bank has increased recently due to a five percent premium over the international market price, leading to higher than planned purchases. Although the government had planned to purchase 5,250Kg of gold from artisan miners at the end of the five year economic plan (2010/11-2014/15), actual purchases of 6,615Kg have surpassed this target in the 2010/11 fiscal year. This unprecedented purchase of gold by the central bank has an effect similar to quantitative easing, as the monetary authority is injecting more money into the economy while reallocating its portfolio and building up its gold reserves.

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**Figure 3 Ethiopia Central Bank's net claims on Government<sup>a</sup>**



Source: AfDB computations using data from IFS.

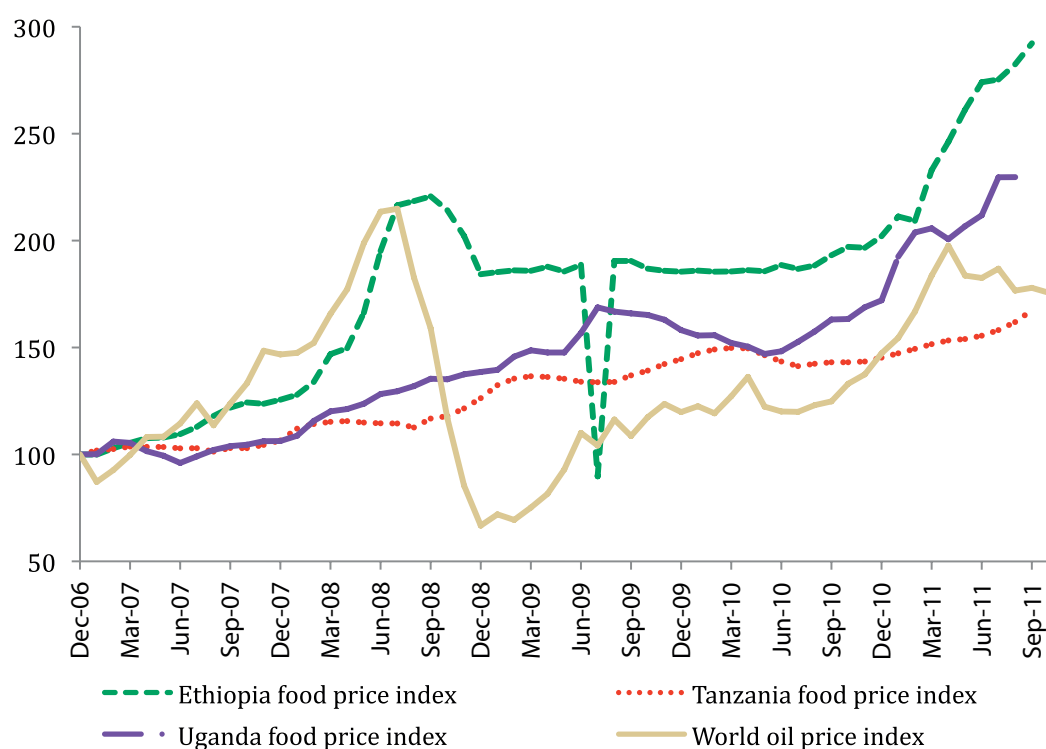
<sup>a</sup> Latest available data 2008,

on the central government by the National Bank of Ethiopia have been increasing since 2001. This is evidenced by the high rate of growth in credit to the public sector of 46 percent between July 2010 and July 2011. In Uganda, monetary expansion has been driven largely by growth in credit to the private sector. Between July 2010 and July 2011 credit to the private sector grew by 35 percent. On the other hand, monetary expansion was relatively lower in both Kenya and Tanzania at 17 and 16 percent, respectively.

## Imported inflation

The estimates in Table 1 also show that higher oil prices explain on average a fifth of the recent high inflation episode in the four countries. The transmission of high oil prices into domestic inflation in the region is well documented, with higher energy and transport costs the most

**Figure 4 Food and World Oil Price indices (December 2006 to September 2011)<sup>a</sup>**



Source: AfDB computations.

<sup>a</sup> Latest available data, September 2011.

important factors. In Kenya, on account of surging oil prices, the transport sub-index increased 26 percent year-on-year in October 2011 against 7.6 percent in December 2010. This provides evidence of the significance of world oil prices, as contributor to the high rate of inflation.

The effect of higher world food prices on domestic inflation is estimated at the lower end of 9 percent in Tanzania and the upper limit of 13 percent for Ethiopia and Uganda. The fact that those two countries are landlocked contributes to food price inflation. In addition, a shortage of wheat in Ethiopia prompted more imports at a time when the price of wheat was increasing in world markets. As a result, the value of cereals imports increased from USD 125 million in 2006 to USD 470 million in 2010.

### **Cereal production shocks**

The recent drought in East Africa is estimated to have adversely affected cereal production by close to 10 percent in 2011 and its corresponding impact on inflation is reported in the last column of Table 1. Although changes in domestic cereal production do not seem to have a large impact on short-run inflation, they do matter in the long run, accounting for more than one third of long run inflation in Tanzania. This attests to the embedded structural bottlenecks that constrain intra-regional trade in grains from surplus regions to areas of deficit in each of the four countries.

## **3 Other possible causes of inflation**

### **Exchange rate**

A floating exchange rate regime allows domestic and foreign prices to align. Such movements in the exchange rate should therefore allow the pass-through of external developments into the domestic economy as a one-off adjustment, which may be tempered by appropriate prudent fiscal and monetary policies.

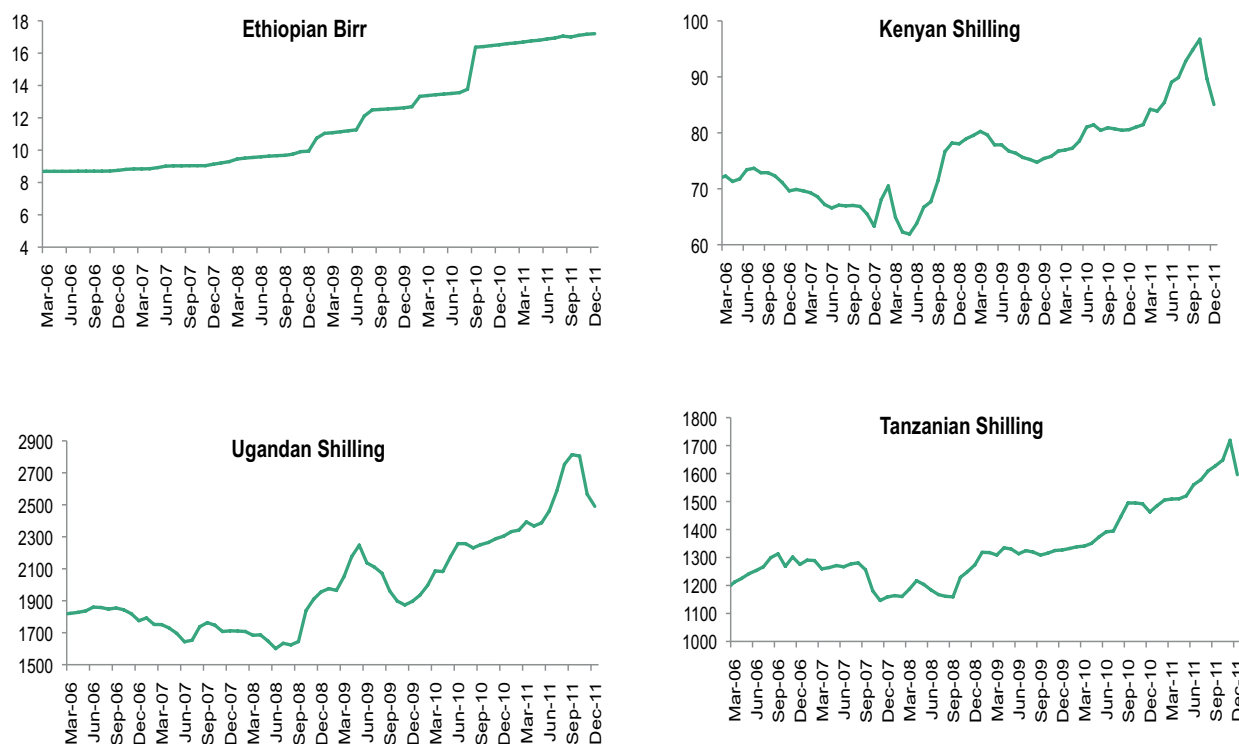
Recently, nominal exchange rates have depreciated rapidly across the region (Figure 5). On a year-on-year basis, the Kenyan and Ugandan shilling depreciated by about 23 and 24 percent, respectively in November 2011 before slowing down to 6 percent and 8 percent in December 2011. Under such conditions, we find that exchange rate depreciation contributes between 11 percent (Ethiopia) and 38 percent (Uganda) of the observed inflation in 2011. In the case of Kenya, exchange rate depreciation explains close to 17 percent of the observed inflation.



Further, we note that the forthcoming 2012 elections may have increased the level of risk aversion and triggered capital flight. Although validating this hypothesis is not possible in the absence of hard data, we acknowledge that exchange rate depreciation, whilst largely driven by fundamentals, may also partly reflect herd behavior as economic agents hedge against possible economic paralysis.

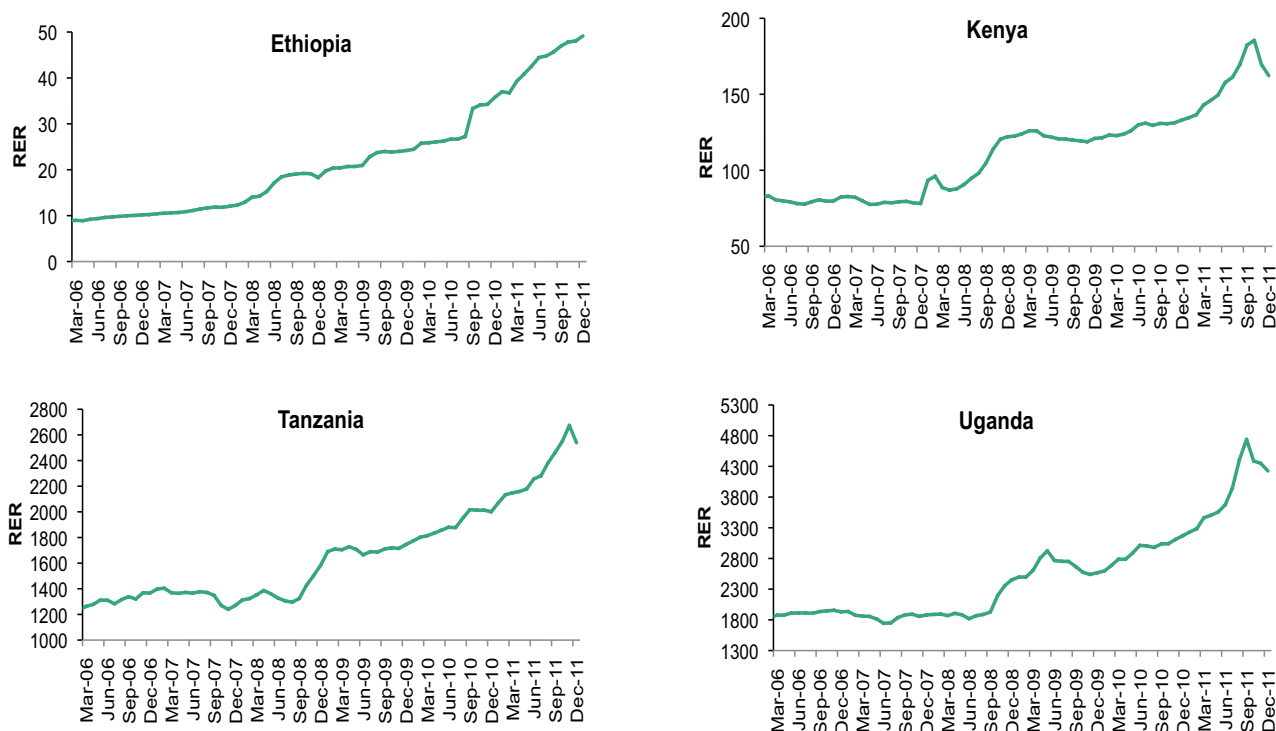
The role that the exchange rate can play in fuelling inflation has been singled out because of claims of currency speculation leading to depreciation of some of the four currencies. As a result, high inflation expectations would induce rational agents to hedge and reallocate their portfolio of currencies accordingly. Such reallocations are not necessarily motivated by currency speculation. While a direct test of currency

**Figure 5 Nominal exchange rate vis à vis the USD, March 2006 to December 2011**



Source: AfDB computations.

**Figure 6 Real exchange rates (March 2006 to December 2011)**



Source: AfDB computations.

Note: Real exchange rate (RER) is computed as the exchange rate adjusted for the inflation differential (Domestic prices divided by world prices). A decrease (increase) in the RER indicates a depreciation (appreciation).

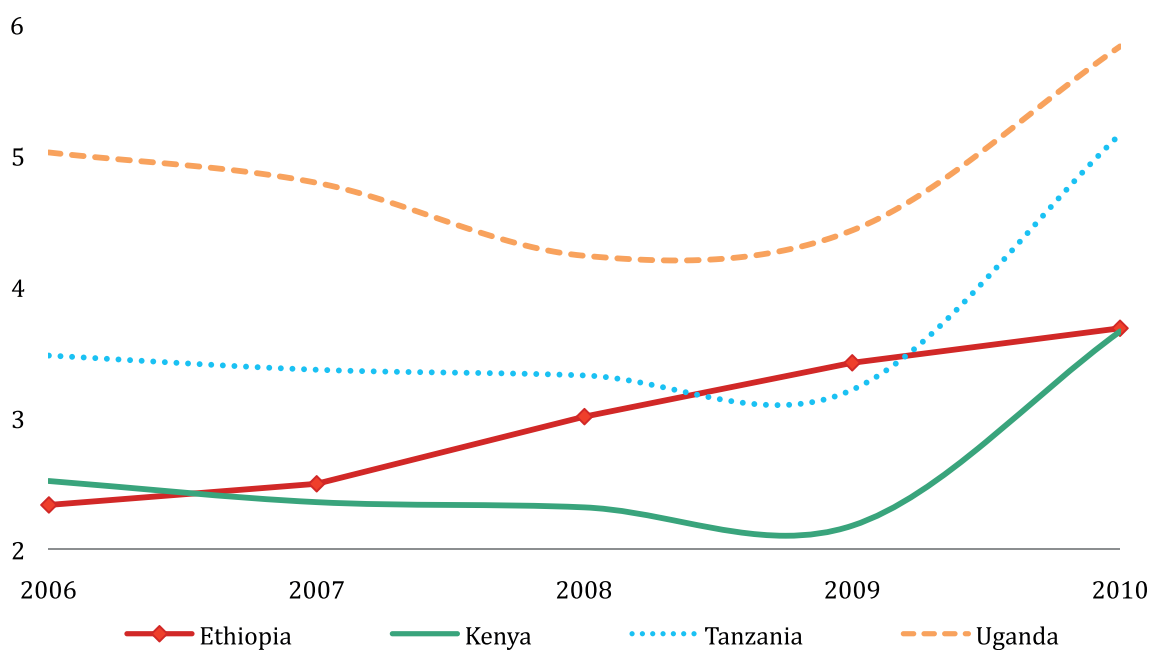
speculation is not readily available, we look at the dynamics of the real exchange rate in each one of the four countries as a means to test for such behavior. In the long run the real exchange rate should not significantly deviate from its equilibrium level.

Our computations reveal that real exchange rates have appreciated in all four countries (Figure 6) relative to 2006. It should be noted that the current real exchange rate misalignment is detrimental to export competitiveness and could exacerbate external sector imbalances, putting economic growth in further jeopardy. It is therefore crucial that inflation is brought under control; otherwise the nominal exchange rate must give way to correct for misalignment in the real exchange rate.

### Velocity of Money

Velocity of money is a key indicator of the pace of monetary transactions, and in turn helps in contextualizing current inflationary developments (Figure 7). Since 2006, the velocity of money has been on an upward trend in all four countries, with a sharp jump in Kenya, Tanzania and Uganda from 2009. The increase in velocity is largely due to financial innovations, including the advent of new products such as mobile banking. In Ethiopia, the systematic increase in velocity could be attributed to a proliferation of informal trade activities which are predominantly based on cash transactions.

Figure 7 Velocity of Money<sup>a</sup>



Source: AfDB computation.

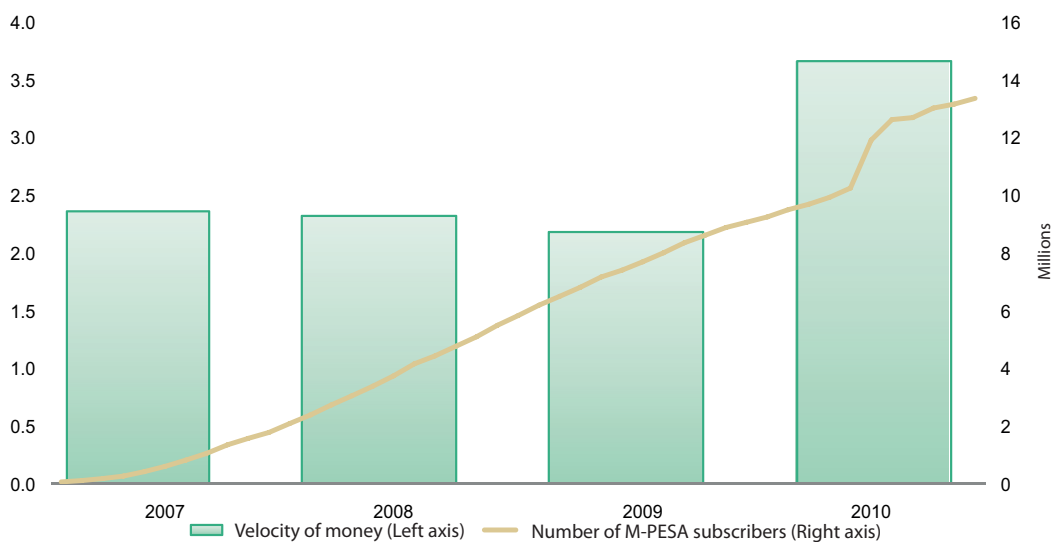
<sup>a</sup> Latest available data, 2010.

## M-PESA effects

In the case of Kenya, the advent of financial innovation such as e-money may have contributed to the increase in velocity of money as seen by the corresponding rise in the number of M-PESA subscribers (Figure 8)<sup>5</sup>. The M-PESA has brought more than 14 million customers into virtual banking. According to the IMF (IMF, 2011), M-PESA processes more transactions domestically within Kenya than Western Union does globally. The M-PESA platform also provides mobile banking facilities to more than 70 percent of the country's adult population. Evidence shows that the transactions velocity of M-PESA may be three to four times higher than the transactions velocity of other components of money.<sup>6</sup>

The increase in the velocity of money induced by these activities may have in turn propagated self-fulfilling inflation expectations and complicate monetary policy implementation. The monetary authorities may inadvertently follow looser monetary policy if the stock of e-money grows more rapidly than projected.

**Figure 8 Kenya: Trends in M-PESA subscribers and money supply**



Source: AfDB computation.

<sup>5</sup> Figure 8 shows a sustained upward trend in the number of M-PESA subscribers, coinciding with the increase in money velocity, albeit at a slower rate of growth.

<sup>6</sup> See Mbiti and Weil (2011).

Further, since effective monetary policy is anchored on a constant money demand function, under conditions of unstable money, rising velocity and deep supply shocks, monetary policy based on interest rate targeting has a limited impact in controlling inflation.<sup>7</sup>

### Effects of informal trade

In Ethiopia, increased informal intraregional and cross-border trade is primarily through cash transactions, which do not often pass through the banking sector. Although the impact of these transactions on inflation may not be very clear from a theoretical perspective, we can conjecture that the price effects generated by rising demand for agricultural commodities in the face of supply shocks has placed a high premium on Ethiopia's inflation.

## 4 Assessing recent responses to tame inflation

The main response to inflation across the four countries has been monetary tightening, although with different degrees of intensity. This response is broadly consistent with our findings on the drivers of inflation. In light of our findings, we can offer the following preliminary assessment of recent policies undertaken in each of the four countries.

### Ethiopia

The policy response in Ethiopia has focused more on tackling supply shock-induced effects, initially through administrative price controls. Once price controls proved ineffective, they were suspended on all goods except for two commodities – a clear demonstration of the inefficacy of administrative action to control inflation.

### Kenya

Kenya has also found itself trapped in an inflationary spiral, with little room to maneuver. The Central Bank of Kenya has attempted to constrain growth in credit to the private sector through large interest rate adjustments, in order to rein in inflation. In 2011 alone, the Central Bank has raised interest rates from 6.25 percent in May to 18 percent in December. The Central Bank also revised the cash reserve ratio by 50 basis points, from 4.75 percent to 5.25 percent.

<sup>7</sup> The instability in the money demand function complicates the conduct of monetary policy and therefore new tools must be devised to enhance the potency of policy.

The effect of this monetary tightening on inflation may only appear after a lag, given the structural nature of liquidity and the threat still posed by rising food and energy costs, both of which make monetary policy less potent under conditions of inflation inertia. However, the current thinking is that supply shocks may soon subside, meaning that the efficacy of interest rates in managing demand pressures may increase (CBK, 2011).

## **Tanzania**

Policy responses in Tanzania have mirrored developments in Kenya. For instance, the Bank of Tanzania hiked the Central Bank Rate by 200 basis points to 9.6 percent, and increased cash reserve requirements on government deposits from 20 to 30 percent, as part of a strategy to reduce money supply. These liquidity withdrawing influences have been supported by the government's ban on food exports, in an attempt to alleviate food shortages and stem price rises.

In addition, policy makers in Tanzania took the view that currency depreciation had contributed to inflationary pressures. They responded with a downward revision in foreign exchange capital requirements for dealers from 20 to 10 percent, in order to facilitate the release of more foreign exchange into the market to shore up the shilling.

## **Uganda**

Until recently, the Central Bank of Uganda had been quite successful in controlling inflation. It used reserve money as the main operating target of monetary policy until July 2011, when it switched to the central bank rate (CBR). The Central Bank has attempted to tame inflation by focusing on demand factors, driven by rapid growth in private sector credit and more recently a widening fiscal deficit (IMF, 2011). However, expansionary fiscal policy has not drawn the Central Bank into direct monetization of the deficit, reflecting some element of departure from the pre-stabilization period when advances to government were regularly made to finance the deficit.

Recognizing that recent monetary growth has emanated mainly from an acceleration in private sector credit, the Central Bank increased the CBR by 400 basis points to 20 percent, and then to 23 percent in November. Thus, monetary growth has mainly emanated from growth in private sector credit.

However, these adjustments to the CBR have had minimal impact on inflation. This has raised questions as to the extent to which inflation can be managed by manipulating interest rates when there are multiple factors

at play, including exogenous shocks. This lack of success has been compounded by the depreciation of the Ugandan shilling. Nonetheless, the decision by the monetary policy committee to keep the CBR unchanged at 23 percent in December 2011 indicates that demand pressures, which had informed previous policy decisions, may be leveling off.

## 5 Conclusion and way forward

Inflation rates in Ethiopia, Kenya, Tanzania and Uganda are in two-digit territory, ranging from close to 18 percent in Tanzania to nearly 40 percent in Ethiopia. Our results indicate that growth in money supply account for 40 percent and one third of short-run inflation in Ethiopia and Uganda respectively. In Kenya and Tanzania oil prices are the main driver of short-run inflation accounting for one fifth and one quarter respectively. However, even in those two countries, expansionary monetary policies do play an important role.

Given strongly entrenched inflation inertia and the challenges which authorities will face to change inflation expectations, it is recommended that central banks reaffirm their commitment to maintaining low and stable inflation. In this regard, monetary authorities should continue with tight monetary policies, supported by prudent fiscal management to ensure that the macroeconomic environment remains conducive to continuing growth and poverty reduction.

In view of the huge binding structural constraints that affect efficient performance of markets, there is need to accelerate efforts aimed at addressing these bottlenecks in order to improve resource allocation and reduce costs and vulnerability. The long-term policy solution is therefore to upgrade infrastructure facilities, including ports, to reduce on inefficiency and smooth the flow of goods and services within countries and across the East African region.

Addressing structural impediments in the broader framework of macroeconomic and structural policy environment will facilitate economic diversification which in turn offers significant medium and long-term pay offs.

A rapid depreciation in the exchange rate in the context of high inflation creates self-fulfilling expectations and thus heightens inflation. Under such conditions, the real exchange rate tends to appreciate, harming export competitiveness. Thus, it is crucial to ensure that inflation is urgently addressed to maintain export competitiveness and avoid sustained external sector imbalances.

While our results are broadly in line with earlier findings in the literature, more work is needed to investigate the extent to which our estimates/findings are robust to alternative specifications or measures of the deep characteristics of these economies. For example, it would be of interest to include rainfall data to capture domestic supply shocks and to substitute world prices by import price index. Further disaggregation of the different components of CPI would also offer more insights into the different aspects of inflation. All these extensions are, however, subject to the availability of up to date data. Broadly, therefore, these results must be seen as first line of empirical evidence to serve as a reference tool for further and deeper analysis.

The Bank is convening a high level forum in East Africa on 14 February 2011 for sharing experience and best practices with a view to better design policy addressing the high inflation episode in East Africa. Governors of Central Banks of Botswana, Kenya, Morocco, Nigeria, Rwanda, Tanzania, Uganda and Vice Governor of Ethiopia have confirmed their attendance. The outcome of further research currently underway will be presented at the high level forum.

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Appendix I Table A. 1 Selected Macroeconomic Indicators (average 2000-2010)

	Ethiopia	Kenya	Tanzania	Uganda	EA-4 <sup>1</sup>
Real GDP Growth (% per annum)	8.3%	3.8%	6.8%	7.0%	6.5%
Current Account Balance (% GDP)	-5.8%	-2.5%	-6.2%	-3.2%	-4.4%
Money Growth (% per annum)	18.8%	8.2%	17.5%	15.5%	15.0%
Inflation (% per annum)	10.7%	10.3%	6.8%	6.2%	8.5%

Source: World Bank - World Development Indicators; authors own computations

<sup>1</sup> EA-4: East Africa 4: Ethiopia, Kenya, Tanzania and Uganda

## Appendix II Empirical Framework

We used a standard inflation equation of the form:

$$CPI_t = \beta_0 + \beta_1 NER_t + \beta_2 WP_t + \beta_3 M2_t + \beta_4 Y_t + \varepsilon_t \quad [1]$$

where CPI is consumer price index, NER is nominal exchange rate, WP is world price, M2 is broad money, and Y is output. To capture the effect of food supply shock, we used total cereal output instead of real GDP. All the variables are given in logarithm form.

Equation [1] embeds different models of inflation within which different hypothesis can be tested. As adjustment in macroeconomic relationship is not instantaneous, we rewrite the above equation in autoregressive disturbed lag form:

$$CPI_t = \beta_0 + \sum_{i=1}^k \beta_{1i} CPI_{t-i} + \sum_{i=0}^k \beta_{2i} NER_{t-i} + \sum_{i=0}^k \beta_{3i} WP_{t-i} + \sum_{i=0}^k \beta_{4i} M2_{t-i} + \sum_{i=0}^k \beta_{5i} Y_{t-i} + \varepsilon_t \quad [2]$$

where k is the lag length.

The lags are important to capture the adjustment process and potential simultaneity bias among macroeconomic variables. The lag length is determined using the 'Autometrics' algorithm (see Hendry et al 2008). As most macroeconomic variables are nonstationary and integrated of order one, we reparameterized eq [2] into an error correction format in eq [3].

$$\Delta CPI_t = \alpha_0 + \sum_{i=1}^k \alpha_{1i} CPI_{t-i} + \sum_{i=0}^k \alpha_{2i} NER_{t-i} + \sum_{i=0}^k \alpha_{3i} WP_{t-i} + \sum_{i=0}^k \alpha_{4i} M2_{t-i} + \sum_{i=0}^k \alpha_{5i} Y_{t-i} + \alpha_3 [CPI_t - \beta_1 NER_t - \beta_2 WP_t - \beta_3 M2_t - \beta_4 Y_{t-1}] + \varepsilon_t \quad [3]$$

The term in brackets represents the error-correction term and its parameter,  $\alpha_5$ , shows the speed at which the economy adjusts for any disequilibrium in the economy, i.e., the amount of disequilibrium transmitted in each period into the rate of inflation. The parameters of the variables in the log-difference ( $\alpha_{1i} - \alpha_{4i}$ ) show the short run responses while the  $\beta$ s represent long term responses. A significant impact from a lagged to current inflation ( $\alpha_{1i}$ ) would indicate inertia of inflation, which can build up due to expectations. We also estimated the cointegrating relationship using DOLS to obtain the long term parameters.

The model is estimated using annual data from 1961 to 2010. With such fairly long time series data, the problem of structural breaks and regime shifts are quite natural.<sup>8</sup> We used the recently developed impulse saturation technique to address the 'missing data', 'changing database', and 'break' problems, using Autometrics with impulse-indicator saturation to remove past breaks, outliers and data contamination.

## Results

**Table A. 2 Long Run Parameters (Equation 1)**

Dependent variable: CPI				
	Ethiopia	Kenya	Tanzania	Uganda
Lagged Inflation	0.61***	..	0.84**	0.83***
Money Supply	0.69***	0.30***	0.15***	0.38***
Output- Cereal	-0.07**	..	-0.49***	-0.28***
Nominal Exchange Rate	..	0.76***	0.50***	0.04**
World Price	..	0.46***	2.58***	..
Constant	-11.88***	-4.59***	-2.03*	-0.38
AR 1-2 test	[0.4367]	[0.1487]	[0.7196]	[0.2015]
ARCH 1-1 test	[0.8185]	[0.2504]	[0.7085]	[0.5238]
Normality test	[0.1697]	[0.2918]	[0.0000]	[0.4993]
RESET23 test	[0.9721]	[0.6447]	[0.8312]	[0.8837]
Sample	1967-2009	1964-2009	1967-2009	1983-2009

Impulse dummies are included. All variables are in logarithm  
 Note: \*\*\*significant at 1%, \*\*significant at 5%, \*significant at 10%

<sup>8</sup> It is important however, to underscore the fact that small sample are more problematic econometrically, not only due to low degrees of freedom, but may also result in unstable parameters. For this reason, a larger sample size in times series analyses are encouraged even though this does not eliminate all the problems associated with regime shifts and structural changes.

**Table A. 3 Short Run Dynamics (Equation 3)**  
**Dependent variable Change in CPI<sup>a</sup>**

	Ethiopia (see Table A3)	Kenya	Tanzania	Uganda
Lagged Inflation	..	0.62***	0.79***	..
Money Supply	..	0.13***	0.16*	0.24***
Output- Cereal	..	..	-0.07**	..
Nominal Exchange Rate	..	0.26***	..	0.48***
World Price	..	0.24***	0.22**	0.29**
ECM	..	-0.33***	-0.17	-0.29***
Constant	..			
AR 1-2 test	..	[0.7692]	[0.7196]	[0.2127]
ARCH 1-1 test	..	[0.0166]*	[0.7085]	[0.2041]
Normality test	..	[0.8604]	[0.0000]	[0.0466]*
RESET23 test	..	[0.6323]	[0.8312]	[0.1092]
Sample		1966-2009	1969-2009	1985-2009

Impulse dummies are included, All variables are in log-difference  
 Note: \*\*\*significant at 1%, \*\*significant at 5%, \*significant at 10%  
<sup>a)</sup> Ethiopia's results are in Table A.4

**Table A. 4 Short Run Inflation Dynamics in Ethiopia**

Dependent variable: Change in CPI			
	Period 1968-2009	1974-2009	1994-2010 Monthly
	Coefficient	Coefficient	Coefficient
Money Supply	0.48***	0.52***	..
Output-Cereal	-0.16***	-0.06***	..
Error Correction	..	-0.56***	..
Constant	..	-0.11***	..
Lagged Inflation	..	..	0.55***
Nominal exchange Rate	..	..	0.18***
World Price	..	..	0.63***
	Impulse dummies are included	Impulse dummies are included	Centered seasonal dummies and impulse dummies are included
AR 1-2 test	[0.7382]	[0.9264]	[0.9199]
ARCH 1-1 test	[0.8143]	[0.8352]	[0.9187]
Normality test	[0.7479]	[0.0918]	[0.9579]
Hetero test	[0.7529]	.	[0.9312]
Hetero-X test	[0.7085]	.	
RESET23 test	[0.7099]	[0.4510]	[0.7369]

Note: \*\*\*significant at 1%, \*\*significant at 5%, \*significant at 10%  
 All variables are in log-difference

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