The Dynamics of Inflation in Ethiopia and Kenya

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Abstract

This study provides an assessment of the main drivers of inflation in Ethiopia and Kenya by developing single-equation error correction models for the Consumer Price Index in each country. This approach takes into account a number of potential sources of the recent surge in inflation, including excess money supply, exchange rates, food and non-food world prices, world energy prices and domestic agricultural supply shocks. We find that the inflation rates in both Ethiopia and Kenya are driven by similar factors; world food prices and exchange rates have a long run impact, while money growth and agricultural supply shocks have short-to-medium run effects. There is also evidence of substantial inflation inertia in both countries. The key conclusion is that there is no nominal anchor for inflation in either country in the form of a clear and well-functioning monetary or exchange rate policy.
1. Introduction

Ethiopia and Kenya have experienced strong economic growth for over nearly a decade. However, inflation, which was thought to be under control, has become a major challenge. High, and volatile, inflation is a threat to good economic performance and has negative effects on many of the poor. Table 1 summarizes the recent performance. Economic growth took off in 2004 in both Ethiopia and Kenya, but alongside higher growth there has been rapid inflation and large inflation volatility. For example, during 2011 inflation peaked at over 40 per cent in Ethiopia and 20 per cent in Kenya.

The rise of inflation in Ethiopia and Kenya is not an isolated event; other African countries are facing the same problem (AfDB, 2011). Yet, there is no consensus on the causes of the rise in inflation. A common view is that expansionary monetary policy, primarily due to large government expenditures, is the main cause, possibly in combination with negative domestic food supply shocks (AfDB, 2011; IMF, 2008; 2012a). Another view is that world food price increases raised domestic food prices (Abbott, and de Battisti, 2011; Durevall et al., 2010). Rising food prices have then led to devaluations and feedback effects on consumer prices in general.

It is widely accepted that high inflation is a monetary phenomenon related to excess money supply. The main driving forces are that government prints money to finance its deficit, it expands money supply to stimulate aggregate demand, or expectations of higher inflation force the authorities to accommodate historical price increases. However, in many Sub-Saharan countries it is challenging for monetary authorities to control inflation even if there is a political will, due to weak institutional frameworks, thin financial markets and imperfect competition among banks. In such an environment, central banks might lack effective tools to control money supply (Mishra, et al., 2010). Exogenous shocks, such as poor harvests or energy-price hikes, might set off expectations and create persistent inflation due to a missing monetary anchor that ties prices down.

Inflation is also related to the choice of foreign exchange regime. In principle, floating rates make it possible for the authorities to choose an inflation target independently of the rest of the world as well as to isolate or dampen foreign price shocks. A fixed exchange rate, on the other
hand, can only work if domestic monetary policy is consistent with inflation rates in the country’s trading partners. A fixed regime will also make the country more exposed to foreign price shocks. Both Ethiopia and Kenya are classified as having managed peg regimes (Slovov, 2011). The difference between the two countries is that Ethiopia ran a tight peg (towards the US dollar) for a large part of the study period; the nominal exchange rate was very stable from 2000 to 2007, but during recent years there have been several devaluations. Kenya, on the other hand, has a much more flexible regime which comes close to a floating exchange rate. Thus, the exchange rate is hardly the nominal anchor in any of the countries.

Policy responses in Ethiopia and Kenya during recent years illustrate well the challenges facing monetary authorities. Inflation began to rise already in 2005 in Ethiopia. Initially there was little effective response but in 2009 bank-by-bank credit ceilings were therefore introduced to control money supply growth (IMF, 2011). Inflation declined subsequently, and monetary policy was eased as evident from rapid growth in high powered and broad money. Moreover, the birr (EBT) was devalued by 16% against the US dollar in September 2010 to boost competitiveness. Later in 2010 inflation started to rise again, and in 2011 the Ethiopian authorities sharpened the focus on monetary targeting, adopting high powered money as nominal anchor (IMF, 2012c).

Kenya differs from Ethiopia since it was not only hit by the commodity-price hike and the financial crisis, but also post-election violence in 2008. As a result, real GDP growth dropped from over 7% in 2007 to below 1.5% in 2008 (Table 1), while inflation increased to over 30%. The monetary policy response was to reduce interest rates to stimulate economic growth. In spite of lax monetary policy, inflation declined from 2009 until late 2010; a decline which also can be observed in Ethiopia. Inflation then rose again, but the authorities continued to maintain loose monetary conditions. This resulted in rapid depreciation of the Kenyan shilling (KES); its value dropped from about 80 shilling per US dollar in early 2011 to over 100 shilling per US dollar in October 2011. To prevent further depreciation of KES and rise in inflation, the monetary authorities increased the central bank rate sharply, pushing up the interbank rate to about 17%, from less than 2% in January 2011. The response seems to have been an appreciation of the KES and decline in inflation. The tight monetary policy stance was maintained during the first half of 2012.
The relatively high rates of inflation in Ethiopia and Kenya consequently raise questions about monetary authorities’ control over inflation. The first step in a discussion about controlling inflation is to econometrically identify its main drivers. This study provides an assessment of the determinants of inflation in Ethiopia and Kenya by developing a single-equation error correction model (ECM) for monthly changes in the Consumer Price Index (CPI) in each country. The error correction terms used in the ECMs, based on cointegration analysis, are designed to capture salient features of both countries, allowing for the evaluation of the impact of excess money supply, changes in food and non-food world prices, world energy prices. In addition, we construct a measure of domestic agricultural supply shocks to estimate their impact on inflation.

The main contribution of this approach is that it takes into account a number of potential sources of the recent surges in inflation in addition to excess money supply and exchange rate changes. Hence, the empirical identification of the sources of inflation should help in formulating short-term and long-term policies to contain inflation.

The paper is structured as follows: Section 2 provides a brief review of earlier studies on inflation in Ethiopia and Kenya. Section 3 outlines the methodological approach while section 4 describes the data. Section 5 carries out the empirical analysis and section 6 concludes the paper.

2. Previous Studies on Inflation in Sub-Saharan Countries

Studies on inflation dynamics in developing countries are often based on some form of Phillips curve approach and the economy’s distance to full capacity output. Although sometimes applied to Sub-Saharan Africa countries, as in Barnichon and Peiris (2008) and Kiptui (2009), a Phillips-curve approach may not be an adequate characterisation of the inflationary process in Sub-Saharan Africa. Extensive self- and underemployment, large informal markets, and a low degree of labour-market organization all make the link between aggregate demand, unemployment and wage increases weak or even non-existent. Moreover, there can be a strong negative correlation between business cycles and inflation because positive (negative) agricultural supply shocks tend to increase (reduce) GDP growth and lower (increase) inflation. Because of the dominance of supply shocks, it would be challenging to identify a Phillips curve even if one existed.

Therefore, many studies on inflation in sub-Saharan African economies focus on the quantity theory and the supply of money. Exchange rates, and sometimes foreign prices, are added to the

Hitherto, most inflation studies have neglected the role of agricultural markets and food supply, even though food has a large weight in the consumer baskets of most sub-Saharan African countries, e.g. 0.57 in Ethiopia and 0.36 in Kenya. In fact, large changes in food supply, which are prevalent in Sub-Saharan Africa, are bound to have at least a short-run impact on inflation. The problem is that it is not obvious how to measure food supply shocks, which probably is one reason they often are neglected in empirical studies on inflation. Nonetheless, studies that include variables that reflect shocks in agricultural markets, such as food prices, rainfall, and agricultural production in key crops, find that they have a significant impact on inflation. Some examples are Durevall and Ndung’u (2001) on Kenya, Diouf (2007) on Mali, Durevall et al. (2010) on Ethiopia, and Kinda (2011) on Chad.

There are few recent econometric studies on the causes of inflation in Ethiopia. A couple of studies, drawing mainly on logical deductions and descriptive analysis, emerged in the light of rapid food price increases after 2005. The only econometric analyses that focus on the recent period are AfDB (2011) and Durevall et al. (2010). Another recent study on inflation is Wolde-Rufael (2008), but it uses data from before 2005. The situation is somewhat better for Kenya, AfDB (2011), IMF (2012b), Kiptui (2009) and Misati et al. (2012) all study the dynamics of inflation.

Rashid (2010) represents a common view about the inflation dynamics in Ethiopia during the last decade. Domestic food price increases were caused by aggregate demand, except in 2007–2008 when cereal production was much smaller than shown by official statistics. Aggregate demand in turn, was driven by excess money supply, and accordingly, strict monetary policy brought inflation under control in 2008–2009. The study by AfDB (2011) provides support for role of money supply by estimating error correction models. It is found to be by far the most important
cause of inflation, accounting for over 50% of the variation in the long run. A consequence of
this is that world food prices are not seen as an important source of (food price) inflation.

Durevall et al. (2010), using monthly data from 2000-2009, model inflation in Ethiopia by
including error correction mechanisms for food and non-food prices. In contrast to other studies
on inflation, they specify separate long-run relationships for the monetary, domestic food, and
external food and non-food sectors, though they ignore long-run effects of energy prices. Their
findings are that the external sector largely determines inflation in the long run. Specifically,
domestic food prices adjust to changes in world food prices, measured in local currency (EBT),
and non-food prices adjust to changes in world producer prices. Domestic food supply shocks
also have a strong effect on inflation but it is a short-run effect. The evolution of money supply
does not affect food prices directly, though money supply growth significantly affects non-food
price inflation in the short run. Hence, in the long run, money supply seems to be adjusting
passively to demand.

Most studies on inflation in Kenya do not explicitly deal with the role of food prices For
example; Kiptui (2009) focuses on the exchange rate and oil prices using a generalized Phillips
curve. The results show that both variables drive inflation in the short run, but that the exchange
rate is by far the most important variable. Aggregate demand, measured by the deviation of GDP
from trend, has a positive, small and barely significant, effect. Misati et al. (2012) estimate a
VAR model that includes GDP, money supply, fiscal expenditure and exchange and interest
rates. Using innovation accounting they find that M3 is the main driver of prices. The study by
AfDB (2011) also reports that monetary expansion is a key driver of inflation in Kenya, but it
only accounts for 30% of the variation in the long run. In fact, the exchange rate seems to explain
a large part of the variation according to its coefficient, but no details are provided.

The most recent study on Kenya is IMF (2012b), which reports results from work in progress on
a small monetary model with Kenya-specific features. The parameters are calibrated, not
estimated, which allows for a more complex model specification. According to preliminary
findings, imported food price shocks and poor harvests explain some of the inflation dynamics,
both in 2008 and 2011. However, loose monetary policy drove inflation above trend in 2008 and
2011, and monetary policy tightening is needed to reduce inflation to one-digit level.
To conclude, many studies assert that expansionary monetary policy is the key cause of high inflation, but there is little consensus on the role of international food prices and very little focus on international energy prices. Nonetheless, to our knowledge no study uses econometric methods to jointly test the role of excess money supply, world food and energy prices, as well as domestic food supply shocks.

3. Modelling Inflation in Agricultural Economies

We use single-equation error correction models to empirically determine the factors that drive inflation. These models embed different theoretical propositions, and allow us to test various hypotheses concerning the sources of inflation in agricultural dependent countries rather than imposing a priori restrictions on the models.

The approach recognises that inflation can come from three sectors: i) the money sector, ii) the external sector and iii) the internal sector. In each sectors we search for linear steady-state relations, in the form of cointegrating vectors, which might explain domestic price levels in the long-run. Deviations from these cointegrating vectors are used as error correction terms that reflect long-run drivers of inflation. Since cointegrating vectors exist independently of variables outside their vector autoregressive system, each sub-sector that affects inflation can be analysed independently in search of long-run steady state relations.

Specifically, we focus on three main factors that affect inflation: i) the supply and demand for real money balances, ii) the effects of external (foreign) inflation on domestic prices and iii) internal supply shocks in the agricultural sector. A basic error correction equation (in logs) capturing excess supply of money on inflation ($EC_{rmb}$) is

$$EC_{rmb} = (m_t - p_t) - \beta_1 y_t + \beta_2 r_t$$

(1)

where $(m_t - p_t)$ is real balances, $y_t$ is real income (ln GDP) and $r_t$ represents the opportunity costs of holding money. A short term money market yield (Treasury bill) rate is usually used to represent the opportunity cost. For developing countries, with less developed financial markets,

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3 The estimation of this equation requires interpolation of yearly (and when available deseasonalised quarterly) GDP series to monthly data.

4 The interest rate is usually expressed as compounded returns, i.e. if $R$ is the three-month Tbill rate in percent per annum, $r = \ln(1+R/1200)$. 
market-determined money market yields are either non-existent or not representative of the actual opportunity cost. Under these circumstances, inflation and nominal depreciation can be used instead of interest rates.

The error correction term (EC_rmb) measures deviations from an assumed long-run steady-state relation between the supply and demand for real money balances. Whether, or not Equation (1) forms a long-run steady state error correction expression is determined by testing for cointegration. If cointegration is found, the error correction term is inserted and tested for significance in the inflation equation.

The effects of foreign prices are captured by deviations from purchasing power parity relationships. The standard purchasing power parity relationship relates domestic CPI with the exchange rate and foreign CPI. In economies dominated by the agricultural sector, the overall CPI is not likely to be related to the CPI (or wholesale prices) in the US or EU, which we tested and confirmed (results are available for authors). Instead, since the domestic CPI is dominated by food and energy prices, it is more likely that domestic prices are related to world food or agricultural prices and world energy prices. Food and energy are typically two important goods in the CPI basket for agricultural-based developing countries, which leads to the following potential error correction terms (in logs),

\[ EC_{food, t} = cpi_{food, t} - \beta_1 wfp_t - \beta_2 s_t \]

where \( EC_{food, t} \) measures deviations from long-run steady state (the cointegrating vector). In the long run, the level of domestic food prices (\( cpi_{food, t} \)) adjusts to world market food prices, \( wfp_t \) in USD and \( s_t \) is the USD foreign exchange rate. A similar relation can be set up for energy prices,

\[ EC_{energy, t} = cpi_{energy, t} - \beta_1 woilp_t - \beta_2 s_t \]

where is \( EC_{energy, t} \) is the changes in domestic energy prices driven by an adjustment towards world market oil or energy prices in USD.

Finally, inflation is affected by aggregate supply shocks, in the form of deviations around the optimal full-capacity production. One important source is the agricultural sector. The lack of
high frequency data forces us to seek some simplifications. First, annual observations need to be interpolated to monthly observations. Second, we assume that the long-run trend in agricultural output represents the full-capacity output, so that a Hodrick-Prescott filter can be used to identify swings around the long-run trend as supply shocks. Since the interpolated series measure the annual evolution of agricultural production, the constructed series only capture annual shocks; price effects due to seasonal variation are captured by seasonal dummies. The fact that the interpolated series is highly persistent with distinct swings makes the filtering robust to the choice of method. Thus the error correction term becomes,

\[ \text{output \_ gap}_t = \text{lrg}_t - \text{srt}_t \] (3)

where \( \text{lrg}_t \) represents the (interpolated) actual agricultural output and \( \text{srt}_t \) is long-run trend estimated such that \( \text{output\_gap}_t \) represents cycles around the long-run assumed full capacity output growth. The use of the Hodrick-Prescott filter is common in the literature on business cycles (Ravn and Uhlig, 2001). It also works as a feasible substitute for a cointegration analysis when data is scarce.\(^5\)

Ideally, we would analyze all the variables in a simultaneous system, but because of the small sample we adopt an alternative strategy. First, equations (1)—(3) are estimated and tested separately and the results from these estimations are used to form single-equation error correction models. The exact specifications vary for each country, but the representative ECM for (monthly) inflation \( \Delta p_t \) is of the form:

\[
\Delta p_t = \sum_{i=1}^{k1} \gamma_i \Delta p_{t-i} + \sum_{i=0}^{k2} \pi_i \Delta x_{t-i} + \phi \mathbf{D}_t + \alpha_1 \text{EC \_ rmb}_{t-1} \\
+ \alpha_2 \text{EC \_ food}_{t-1} + \alpha_3 \text{EC \_ energy}_{t-1} + \alpha_4 \text{output \_ gap}_{t-1} + \varepsilon_t
\] (4)

where the error corrections terms are defined as above, \( k1 \) and \( k2 \) indicates (variable) lag lengths, \( \Delta x_{t-i} \) is a vector of (lagged) explanatory variables in first differences where \( \Delta x_t = (\Delta m_t, \Delta y_t, \Delta r_t, \Delta wfp_t, \Delta s_t, \Delta woilp, \ldots) \) which potentially includes all variables in the system that might contribute to explaining inflation, \( \pi_i \) is a parameter vector, \( \mathbf{D}_t \) is a vector of

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deterministic variables and associated parameters $\phi$, including a constant, seasonal dummies and intervention dummies for outliers, and $\varepsilon_i$ is the residual.

Equation (4) is estimated with a general to specific approach that starts with long lag structures of all first differenced variables in the equation. Insignificant lags, starting from the least significant parameters, are then systematically removed from the equation until only significant variables remains. The end result should be a parsimonious model with a NID$(0, \sigma^2)$ residual process that replicates the data generating process and identifies the significant drivers of inflation in each country.

In Equation (4), the adjustment to the long-run consists of the potential error correction terms, which allow for discrepancies between the log-level of the price and its potential determinants to impact on inflation the following period. The $\alpha_i$ parameters associated with the error correction terms show how inflation adjusts to the long-run steady-state relations, while the first differences show the short-run dynamics of inflation.

4. Empirical Analysis of the Long Run Relations

All variables that are used here can be classified as being non-stationary in (log) levels and integrated of order one,\(^6\) which leads to the formulation of VAR models and cointegration tests for the long-run relationships in Equations (1) to (3). In order to estimate Equations (1) to (3) we interpolate GDP and agricultural production from yearly to monthly observations using cubic spline functions. Interpolation does not add any new information, but it preserves the long-run trend in the data series. The interpolated series therefore work well in cointegration analysis. However, the monthly fluctuations of the series are usually not useful.

Figure 1 and 2 highlight some of the relationships in the data for Ethiopia and Kenya, respectively. Table 1A in the appendix provides information about data sources. The upper left corner in each figure plots twelve-month log changes in CPI and domestic food prices. To measure food prices we use cereal CPI for Ethiopia and food CPI for Kenya. It is preferable to

\(^6\) All variables have been tested for the order of integration with Augmented Dickey-Fuller tests and for stationarity within each estimated VAR model with Johansen’s VAR test for stationarity. The only variable that is not integrated of order one is the EBT/USD exchange rate, which comes out as stationary during the sample period.
use cereal CPI since the index for cereals is closer to the index for world market grain prices than the food CPI is to the index for world food prices. However, cereal CPI is not publicly available for Kenya. The graphs show that inflation rates are quite volatile, and that they are strongly correlated with food price inflation in both countries.

The (interpolated) monthly real GDP and the real money stock are reported in the upper left corner. All series have positive trends as expected. The real money stock fluctuates much more than the real GDP, indicating that the estimate of the coefficient on real income in Eq. (1) is sensitive to the sample. It is also noteworthy that real money grows much faster than GDP in both countries during the last years of the sample.

The US dollar exchange rates are plotted in the lower left corner. The graphs highlight the difference in exchange rate policy: Ethiopia has a heavily managed exchange rate that is devalued occasionally, while Kenya has a more flexible exchange rate. They also show that the Ethiopian exchange rate has varied greatly during the study period, in spite of the peg to the US dollar. The real exchange rates, plotted in the bottom right corner, have also moved significantly: Ethiopia’s real exchange rate exhibit long swings, while the real rate in Kenya appreciates slowly during most of the sample.

We use the Johansen approach to test for long-run relationships. For Ethiopia we find that the best fitting stationary vector is between local price index of cereals, $cereal_t$, and world grain prices in USD, $wgrain_t$, in combination with the EBT/USD rate. The empirical version of Equation 2a becomes,

\[ EC_{food} = cereal_t - 1.35 \times wgrain_t - 0.17 \times ebt/usd_t \]  

For Ethiopia there is also a long-run vector for local energy prices, world oil prices (in USD) and the ETB/USD rate. However, this vector is never significant in the estimated inflation equation.

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7 The (first) significant cointegrating vector for log cereal prices are found in a VAR(3) model with unrestricted constant estimated over 1999:12-2011:01. Tests of stationarity, within the VAR, reject that cereal prices and world grains prices are stationary I(0) variables. The log EBT/USD (ebt/usdt) rate is found to be stationary I(0), in the VAR during the sample period. Thus, the trace-test indicates two cointegrating vectors. This is so because the official rate remains stationary during most of the sample. The vector presented above and used as an error correction term comes from imposing one cointegrating vector on the VAR.
For Kenya we use CPI for the food prices, and the energy, transport and housing indexes, the indexes for cereal and energy prices are not available. We find cointegrating purchasing power relations for both the food price index and the energy, transport and housing index. However, as for Ethiopia only the food price vector is significant in explaining inflation, using the following empirical error correction (2a) term for Kenya,

\[ EC_{food} = cpi_{food} - 1.28 \times wfp - 0.71 \text{kes/USD}, \]  

(7)

\[ T \]

The significant cointegrating vector is found in a VAR(3) with an unrestricted constant and a dummy for 2008:10, estimated over 1991:01-2011:01. The VAR pass all standard misspecification tests, and tests for stationary reject that the three variables in the model are stationary I(0) variables.
Figure 1. Data for Ethiopia

Figure 2. Data for Kenya

Note: D12 stands for annual change, i.e., Jan-Jan. Real exchange rates are measured as the log of US producer price index multiplied by the nominal dollar exchange rate divided with local CPI.
We use cereal production to construct agricultural supply shocks, though total agricultural production and cereal production follow each other closely, so in practice the choice of variable is not likely to matter. Cereal production is the most volatile component of agricultural production and the one most likely to affect food prices strongly, as cereals constitute a large component of the diet of most people in Ethiopia and Kenya. Moreover, the measure of cereal production is based on its weight, so it is probably more accurate than agricultural production that is based on its nominal value deflated by the price level. We could have added tubers and roots to cereals, but then we would have had to make ad hoc adjustments for weights. The Hodrick-Prescott filter is used to separate temporary output gaps in agricultural production around the long-run trend, as in Equation (3) above.

The potential importance of domestic agricultural supply shocks are easy appreciate, as agriculture value added is 47% of GDP in Ethiopia and 25% in Kenya (on average for 2007-2010), so particularly Ethiopia is heavily dependent on agriculture (World Bank, 2012). Agriculture in turn is affected by external factors such as rainfall and world market production. A positive supply shock in local agricultural production is likely to reduce inflation, since unless the surplus is exported the excess supply reduces prices in the domestic market and thus lowers inflation. And a negative supply shock is likely to drive up prices, unless increased imports are allowed to cover for the excess demand. This variable is significant for Ethiopia, but a borderline case for Kenya (as reported in Table 2).

4.1 The Dynamics of Inflation in Ethiopia

The specific error correction model for Ethiopia, obtained from general-to-specific modelling, is presented in Table 2. There is one significant error correction term, which shows that world market grain prices, measured in domestic currency, have a long-run effect on inflation. The agricultural output gap is also significant showing that sustained output above the long-run trend reduces inflation.

The short-run dynamics are driven by inflation inertia: the first lag of inflation enters with a parameter of 0.36. The fourth lag of the USD exchange rate (EBT/USD_{t-4}) indicates that devaluations raise inflation after a quarter, though the coefficient is small, 0.03. Money supply growth also affects inflation. Since the estimated lag structure of growth in money indicates a
second order moving average process, new variables representing mean growth in money supply over two periods are constructed as $\Delta m_{-2} = \left[\left(\Delta m_{t-2} - \Delta m_{t-3}\right)/2\right]$ and $\Delta m_{-8} = \left[\left(\Delta m_{t-8} - \Delta m_{t-9}\right)/2\right]$. The sum of the coefficients is 0.30, so the short run impact is substantial above the long-run trends. The only variable that is significantly correlated with the contemporaneous inflation (at time $t$) is world market grain price inflation, which enters with a relatively small coefficient. Thus shocks in international food prices might have some immediate effects in Ethiopia, though the rapid response of domestic inflation is surprising and needs to be investigated further. The long-run error correction terms discussed above that do not enter into the model are the ones for world energy (oil) prices, foreign goods prices and the domestic money market.

Out of the original eleven seasonal dummy variables, only two are significant. In addition an impulse dummy variable enters to capture extreme short-run price volatility during 2008; related to almost explosive food price increases (see Figure 1). These increases were probably due to a combination of world food price inflation and perceived domestic supply shortages (see Rashid, 2010). Finally, as reported in Table 2, the model passes all standard misspecification tests.

4.2. The Dynamics of Inflation in Kenya
The specific model for Kenya’s inflation displays dynamics that are similar to the Ethiopian one, though they are more complex. Table 3 reports two models, the specific model, which is the result of the general-to-specific analysis and, and an alternative model that highlights the role of shocks in agriculture supply.

The main result is that the error correction term for world food prices, $EC_{food}$, is clearly significant and that domestic inflation is quite dependent world food prices in the long run, while agricultural production captured by the term $output_{gap}$ does not enter the model (see Table 3, Specific model). However, there is a link between the world food price error correction term and shocks in local agricultural production, so the $output_{gap}$ can substitute for the $EC_{food}$. This is shown by Alternative model in Table 3. Positive shocks in agricultural production (i.e. increased

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9 The effect of creating this type of moving average variables, and create second differences, in the lag structure is to reduce the number of estimated parameters, and make the explanatory variables more orthogonal against each other, i.e., to reduce multicollinearity.
production) reduce local prices in the same way as a reduction in world food prices. The correlation between the output gap and the error correction term could be related Kenya’s openness to international trade, but it could also be due to the crudeness of our measure: it is a constructed series supposed to capture annual, not seasonal, supply shocks.

In Table 3, the output gap enters with a dynamic lag structure with two lags with opposite signs but of similar magnitude, showing that changes in the output gap are important. For Ethiopia the level of the output gap enters with a negative sign and one lag only. These results are interesting because they highlight the importance of domestic supply shocks, often neglected in studies on inflation.

Inflation is also driven by inflation inertia, lagged money growth, EU producer price inflation, and lagged changes in world food prices. Inflation is inertial, since two lags of inflation enter with a combined coefficient of 0.17. EU producer price inflation has a coefficient of 0.29 and enters lagged two months. It seems to have a substantial short-run impact on domestic inflation. Surprisingly exchange rate changes are insignificant, but this is probably due to their tendency to fluctuate at high frequency around a relatively stable mean. Firms are unlikely to alter prices up and down because of small frequent temporary changes in costs, but they adjust them when there are major changes that are perceived as permanent.

World food price inflation comes out significant at the fourth lag with a negative sign in the specific model. This is counterintuitive and might be a coincidence. The coefficient is very small, -0.04, and the t-value declines to 0.88 in the alternative model. Thus, this result is not robust as it disappears when the error correction term is replaced by the output gap in the alternative model in Table 3.

Finally it should be noted that three impulse dummies, May 2003, August 2004 and January 2006, are needed to control for large outliers and obtain a well-specified models. They constitute events that the explanatory variables fail to capture in the general model, in spite of being heavily over-parameterized.
5. Conclusions
This paper analyses the drivers of inflation in Ethiopia and Kenya, focusing on the period from 2000. The main purpose is to improve our understanding of the recent experience, where both countries have seen high and volatile inflation. To this end, it applies a general-to-specific error correction modelling approach starting from the pragmatic view that inflation might arise from a combination of excess money supply, increases in world prices and domestic supply shocks. The econometric models are estimated as single-equation error correction models with monthly data with the rate of change of CPI as the dependent variable. The paper thus extends and updates the model by Durevall et al. (2010) by including the recent spurt in inflation. As far as we know, no similar study exists for Kenya.

We find that inflation rates in both Ethiopia and Kenya are driven by similar factors. World food price increases, measured in domestic currency, lead to domestic inflation in the long run in both countries. As a result, the large swings in world food prices since 2007 are clearly reflected in similar swings in inflation in Ethiopia and Kenya. Excess money supply is not significant in any of the models, so the logical consequence is that recent price shocks have been accommodated by the money supply process. Money supply growth affects inflation, but its impact is short-run.

Domestic food supply shocks are clearly important in Ethiopia, where large harvests reduce inflation through its effect on domestic food prices. The evidence for Kenya is not as strong; we need to remove the error correction term for world food prices from the model to make domestic food supply shocks significant. The reason might be that the food component in CPI is relatively small in Kenya compared to Ethiopia, but it could also be that our proxy for food supply shocks is too crude.

Lagged inflation enters both models, which can be interpreted as presence of inflation inertia. The degree of inertia is 0.36 in Ethiopia and 0.17 in Kenya. It implies that reduction in inflation is relatively slow, unless changes in expectations affect the degree of inertia.

Inflation is also affected by changes in world food prices and the dollar exchange rate in Ethiopia, and EU producer price inflation in Kenya. These are short-run effects, which generally are challenging to capture in models with monthly data.
It is also noteworthy that international energy prices or goods prices do not enter any of the models. The link between domestic and international energy prices might be weak due to market interventions and imperfect competition. Moreover, increases in energy costs might be swamped by other cost increases occurring at the same time. The lack of impact of international goods prices could be due to inadequate price measures, but it is more likely to be because of rapid increases in world food prices and the large role played by food CPI inflation in overall CPI inflation.

For both countries, our results point to the fact that there is no anchor for inflation, arising from clear and well-functioning monetary or exchange rate policies. This could be due to the manner the authorities have dealt with inflationary shocks historically. In both countries there were periods without firm policy response. For example, in Kenya the monetary authorities seem to have expected that the commodity price increase in 2011 would soon revert and therefore delayed policy responses (IMF, 2012a). This could be a dangerous policy if the money supply process cannot be controlled effectively. Another possibility is that traditional monetary policy lacks power, as might be the case in countries that lack well-functioning financial markets (Weeks, 2011). For example, in Ethiopia bank-to-bank credit ceilings had to be introduced to rein in money supply, as most banks had large excess reserves. The main message of the study is thus that food price shocks are significant drivers of inflation and that improvements in monetary policy, and possibly financial sector reform, are required to reduce feedback effects and anchor inflation expectations.

The differences between Ethiopia and Kenya should be acknowledged, however. Financial sector reform is particularly needed for Ethiopia, since the monetary policy transmission mechanism is likely to be weak due to high concentration among banks and large excess reserves; otherwise the newly adopted policy of targeting High Powered Money is unlikely to work. The Central Bank of Kenya seems to aim at controlling inflation using its policy interest rate. This might explain why excess money supply does not enter the inflation model, as the money stock is endogenous in such a monetary policy framework. Moreover, the current tight monetary policy appears to be reducing inflation, indicating that the monetary authorities have some clout. However, it should be noted that price and supply shocks will continue to play an important role
in a foreseeable future in both Ethiopia and Kenya, and that there will be inflation spurts even with well-functioning monetary policy.

Since the analysis of the paper is based on single-equation models, it is unable to pick up possible feedback effects between inflation, the rate of depreciation, money growth, and more detailed aggregated output effects. Thus, for future modelling it is necessary to explore monetary and exchange rate policy intervention functions. For example, the money supply process can be analysed by modelling the relationship between money, base money and money multiplier in Ethiopia, while a monetary policy rule for the interest rate might be more adequate for Kenya. Moreover, since agricultural output plays a major role for both aggregate supply and demand in these economies, the effect on exchange rates of agricultural output-swings and price adjustment to world market prices may also be explored.
Table 1. GDP Growth and Inflation, in percent

<table>
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<tr>
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<tbody>
<tr>
<td>Ethiopia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Real GDP growth</td>
<td>5.9</td>
<td>7.4</td>
<td>1.6</td>
<td>-2.1</td>
<td>11.7</td>
<td>12.6</td>
<td>10.5</td>
<td>11.8</td>
<td>11.2</td>
<td>10.0</td>
<td>8.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Inflation</td>
<td>0.3</td>
<td>-11.4</td>
<td>-1.0</td>
<td>23.5</td>
<td>1.7</td>
<td>13.0</td>
<td>11.6</td>
<td>15.1</td>
<td>55.3</td>
<td>2.7</td>
<td>7.3</td>
<td>36.1</td>
</tr>
<tr>
<td>Kenya</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Real GDP growth</td>
<td>0.6</td>
<td>4.7</td>
<td>0.3</td>
<td>2.8</td>
<td>4.6</td>
<td>6.0</td>
<td>6.3</td>
<td>7.0</td>
<td>1.5</td>
<td>2.6</td>
<td>5.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Inflation</td>
<td>11.8</td>
<td>1.6</td>
<td>4.2</td>
<td>8.3</td>
<td>17.1</td>
<td>4.7</td>
<td>7.3</td>
<td>5.6</td>
<td>15.5</td>
<td>8.0</td>
<td>4.5</td>
<td>18.6</td>
</tr>
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</table>

Source: World Economic Outlook Database April 2012. Gross domestic product at constant prices, change in percent. Annual inflation, in percent, is measured end-of-year.
Table 2. Final Model for Ethiopia

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-value</th>
<th>Variable description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δcpi&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.365</td>
<td>6.43</td>
<td>Inflation lagged one period</td>
</tr>
<tr>
<td>EC_food&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.029</td>
<td>-4.97</td>
<td>Error correction term for local cereal prices adjusting to world grain prices and EBT/USD rate (in logs).</td>
</tr>
<tr>
<td>output_gap&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.033</td>
<td>-2.60</td>
<td>Agricultural supply shock</td>
</tr>
<tr>
<td>Δm&lt;sub&gt;_ma&lt;/sub&gt;&lt;sub&gt;t-2&lt;/sub&gt;</td>
<td>0.181</td>
<td>3.12</td>
<td>Growth in money supply M2; average over two successive months</td>
</tr>
<tr>
<td>Δm&lt;sub&gt;_ma&lt;/sub&gt;&lt;sub&gt;t-8&lt;/sub&gt;</td>
<td>0.137</td>
<td>2.33</td>
<td>Growth in money supply M2; average over two successive months</td>
</tr>
<tr>
<td>Δw_agri&lt;sub&gt;t&lt;/sub&gt;</td>
<td>0.092</td>
<td>2.93</td>
<td>Growth in the log of world market index price of agricultural products in USD.</td>
</tr>
<tr>
<td>ebt_usd&lt;sub&gt;t-4&lt;/sub&gt;</td>
<td>0.035</td>
<td>2.92</td>
<td>Fourth lag of log EBT/USD rate.</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.132</td>
<td>-3.88</td>
<td></td>
</tr>
<tr>
<td>Seasonal&lt;sub&gt;t&lt;/sub&gt;</td>
<td>0.010</td>
<td>2.81</td>
<td>Seasonal dummy</td>
</tr>
<tr>
<td>Seasonal&lt;sub&gt;t-5&lt;/sub&gt;</td>
<td>0.012</td>
<td>3.14</td>
<td>Seasonal dummy</td>
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<tr>
<td>Dum2008&lt;sub&gt;t&lt;/sub&gt;</td>
<td>0.033</td>
<td>7.86</td>
<td>Dummy for sharp increase in volatility during 2008</td>
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R² = 0.75
AR 1-7 test: F(7,107) = 0.36 [0.92]
ARCH 1-7 test: F(7,100) = 0.77 [0.61]
Normality test: Chi²(2) = 4.24 [0.12]
White’s hetero test: F(18,95) = 0.92 [0.55]
RESET test: F(1,113) = 2.06 [0.15]
Sample: 1999:11-2010:05
### Table 3. Final Model for Kenya

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Specific model</th>
<th>t-value Specific model</th>
<th>Coefficient Alternative model</th>
<th>t-value Alternative model</th>
<th>Variable description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta CPI_{t-1} )</td>
<td>0.406</td>
<td>7.17</td>
<td>0.438</td>
<td>7.10</td>
<td>Inflation lagged 1 month</td>
</tr>
<tr>
<td>( \Delta CPI_{t-2} )</td>
<td>-0.236</td>
<td>-3.98</td>
<td>-0.217</td>
<td>-3.35</td>
<td>Inflation lagged 2 months</td>
</tr>
<tr>
<td>EC_food(_t-1)</td>
<td>-0.026</td>
<td>-6.05</td>
<td></td>
<td></td>
<td>Error correction term for food CPI, world food prices and KES/USD</td>
</tr>
<tr>
<td>( \Delta output_gap_{t-1} )</td>
<td>-</td>
<td>-</td>
<td>-0.098</td>
<td>-2.81</td>
<td>Cereal output gap</td>
</tr>
<tr>
<td>( \Delta mt_7 )</td>
<td>0.130</td>
<td>2.51</td>
<td>0.130</td>
<td>2.30</td>
<td>Growth in money stock, lagged seven months</td>
</tr>
<tr>
<td>( \Delta eupp_2 )</td>
<td>0.289</td>
<td>2.26</td>
<td>0.391</td>
<td>2.83</td>
<td>EU producer price inflation, lagged 2 months</td>
</tr>
<tr>
<td>( \Delta wfood_4 )</td>
<td>-0.042</td>
<td>-2.46</td>
<td>-0.016</td>
<td>-0.88</td>
<td>World food price inflation, lagged 4 months</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.127</td>
<td>-5.92</td>
<td>0.003</td>
<td>3.15</td>
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</tr>
<tr>
<td>Seasonal(_t)</td>
<td>-0.005</td>
<td>-2.46</td>
<td>-0.004</td>
<td>-1.69</td>
<td>Seasonal dummy</td>
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<td>Seasonal(_t_1)</td>
<td>-0.013</td>
<td>-5.84</td>
<td>-0.012</td>
<td>-4.84</td>
<td>Seasonal dummy</td>
</tr>
<tr>
<td>Seasonal(_t_6)</td>
<td>-0.007</td>
<td>-3.48</td>
<td>-0.008</td>
<td>-3.26</td>
<td>Seasonal dummy</td>
</tr>
<tr>
<td>Seasonal(_t_8)</td>
<td>-0.007</td>
<td>-3.41</td>
<td>-0.007</td>
<td>-3.03</td>
<td>Seasonal dummy</td>
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<tr>
<td>Seasonal(_t_9)</td>
<td>-0.006</td>
<td>-2.82</td>
<td>-0.005</td>
<td>-2.22</td>
<td>Seasonal dummy</td>
</tr>
<tr>
<td>Seasonal(_t_10)</td>
<td>-0.004</td>
<td>-1.78</td>
<td>-0.003</td>
<td>-1.29</td>
<td>Seasonal dummy</td>
</tr>
<tr>
<td>D2003:05(_t)</td>
<td>0.043</td>
<td>6.06</td>
<td>0.042</td>
<td>5.34</td>
<td>Dummy for 2003:05</td>
</tr>
<tr>
<td>D2004:08(_t)</td>
<td>0.043</td>
<td>6.00</td>
<td>0.044</td>
<td>5.51</td>
<td>Dummy for 2004:08</td>
</tr>
<tr>
<td>D2006:01(_t)</td>
<td>0.032</td>
<td>4.42</td>
<td>0.029</td>
<td>3.55</td>
<td>Dummy for 2006:01</td>
</tr>
</tbody>
</table>

**Preferred model**

- \( R^2 = 0.65 \)
- AR 1-7 test: \( F(7,132) = 1.94 \) [0.07]
- ARCH 1-7 test: \( F(7,141) = 1.03 \) [0.40]
- Normality test: Chi\(^2\)(2) = 3.71 [0.16]
- White’s hetero test: \( F(18,133) = 1.41 \) [0.42]
- RESET test: \( F(2,137) = 0.63 \) [0.53]
- Sample: 1999:01-2011:11
Appendix: Data Sources


Agricultural output gap: Annual agricultural production data is from the National Statistical Agency of Ethiopia and Kenya National Bureau of Statistics. The monthly agricultural output gap was estimated by interpolating annual crop production, cereals in metric ton, to monthly observations.

GDP: National Bank of Ethiopia and Kenya National Bureau of Statistics. The monthly observations were obtained by interpolating annual GDP for Ethiopia and quarterly and annual GDP for Kenya.

Money supply: Broad money M2 from the National Bank of Ethiopia and M3 from Central Bank of Kenya.

Nominal exchange rates: The exchange rates were obtained from International Financial Statistics of the IMF, monthly average rates. The parallel exchange rate from Ethiopia is from the National Bank of Ethiopia. The observations missing because of the temporary closure of the parallel foreign exchange market, March–June 2008, were interpolated.

World commodity prices: The food, grain and energy indexes are from Development Prospects Group of the World Bank (Pink sheets).

World goods prices: The EU producer price index from International Financial Statistics of the IMF.
References


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