Policy Research Working Paper 9881

Monetary, Fiscal, and Structural Drivers of Inflation in Ethiopia

New Empirical Evidence from Time Series Analysis

Léonce Ndikumana
Janvier D. Nkurunziza
Miguel Eduardo Sánchez Martín
Samuel Mulugeta
Zerihun Getachew Kelbore

WORLD BANK GROUP
Macroeconomics, Trade and Investment Global Practice
December 2021

Policy Research Working Paper 9881

Abstract

This study empirically investigates the drivers of inflation in Ethiopia using monthly data from July 1998 to September 2020. It explores short-run and long-run effects of domestic and external determinants of inflation—including demand-side, supply-side, and structural factors—using the cointegration and vector error correction methodology. Four measures of inflation are considered: cereals, food, nonfood, and all items consumer price index inflation. A key contribution to the existing literature is the investigation of the role of the fiscal sector in modeling inflation, a topic that has been neglected in the existing studies on inflation in Ethiopia. The empirical results show that disequilibria in the monetary sector, grains sector, and food markets have long-run effects on inflation. In the short run, inflation is driven by structural factors (notably, cereal output gaps and imported inflation) as well as demand-side factors (notably, money growth and public sector borrowing). The results hold when the analysis is limited to the high growth period from 2005 onward, following the end of the International Monetary Fund program in the country. The evidence provides valuable insights in the context of ongoing macroeconomic policy reforms in Ethiopia.

This paper is a product of the Macroeconomics, Trade and Investment Global Practice. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at msanchezmartin@worldbank.org.

Monetary, Fiscal, and Structural Drivers of Inflation in Ethiopia: New Empirical Evidence from Time Series Analysis

Léonce Ndikumana, University of Massachusetts Amherst
Janvier D. Nkurunziza, UNCTAD
Miguel Eduardo Sánchez Martín, World Bank
Samuel Mulugeta, World Bank
Zerihun Getachew Kelbore, World Bank[1]

Key words: Ethiopia; inflation; monetary policy; fiscal policy; agriculture; exchange rate
JEL classification codes: C22; E31, E41, E542, E62, F31, O55

[1] The authors are grateful to Steven Pennings (Research Economist at the Development Research Group of the World Bank) and Daniel Gurara (Economist at the Strategy, Policy, and Review Department of the International Monetary Fund) for their invaluable comments on a previous version of this working paper, as well as to Mathew Verghis (Practice Manager at the World Bank) and Ousmane Dione (Country Director at the World Bank) for their overall guidance. The paper also benefited from the feedback provided by members of the DAG Macroeconomic Working Group during the meetings held in April and June 2021. In particular, the authors are grateful to Ato Mezgebu Amha, chair of the Macroeconomic Working Group and Advisor at the Ministry of Finance, Ato Abebe Tadesse Director, International Financial Institutions Cooperation Directorate at the Ministry of Finance, and Ato Melesse Tashu, Senior Macroeconomic Advisor at the National Bank of Ethiopia. Both the Ministry of Finance and the National Bank of Ethiopia were also key in facilitating the collection of the data used in this report. Minna Hang Tong provided excellent editing services.

1. Introduction

Over the past two decades, high growth rates in Ethiopia have been accompanied by persistent inflation and other macroeconomic imbalances (IMF 2020). While the country recorded double-digit average growth rates since 2003, average inflation exceeded the 10 percent ceiling set in national development plans during this period.[2] Between 2003 and 2020, Ethiopia recorded the highest level of average annual inflation (15 percent) among all the countries growing at 5 percent or more. The high levels of inflation have attracted attention from policy makers as well as the research community, since high prices affect household purchasing power and overall welfare. Moreover, in a setting of negative real interest rates, high inflation is a disincentive to saving (Alem and Söderbom 2012; Ticci 2011; Geiger and Goh 2012). In 2021, the debate about inflation in Ethiopia is especially intense, as inflation has reached its highest levels since the 2012 drought.

The objective of this paper is to empirically investigate the drivers of inflation in Ethiopia, building on the existing literature (Durevall, Loening, and Birru 2013; Nell 2004). The modeling of inflation draws on structuralist approaches, given the country's dependence on shock-prone agriculture and exposure to external shocks; it also incorporates demand-side factors, namely monetary and fiscal variables. The empirical model includes the cereal output gap, import prices (grains, food, non-food, and oil), the exchange rate premium, money growth, and public sector borrowing. Overall inflation is disaggregated in various components (cereals, food, non-food), since each one may be driven by different factors, as illustrated in earlier research (Durevall et al., 2013). Long-run and short-run effects of both domestic and external factors are explored using the cointegration and error correction time series methodology.

The main contribution of this paper to the literature on inflation in Ethiopia is the incorporation of the role of the fiscal sector in modeling inflation, a factor that has been neglected in the existing literature. The fiscal theory of inflation suggests that the budget deficit may affect the price level through its impact on money demand and thus the equilibrium in the money market (Catão and Terrones 2005; Gordon and Leeper 2006). Monetary expansion resulting from government borrowing to finance the budget deficit creates pressure on the price level and exacerbates the effects of other drivers of inflation. This modeling innovation is motivated by the evidence of financial repression, dominance of public sector borrowing in Ethiopia's financial system, and active role of the central bank in financing government deficits, both directly through advances to the Treasury and indirectly through the state-owned Commercial Bank of Ethiopia lending to state-owned enterprises (SOEs) (Geiger and Goh 2012).

The study examines how various factors affect inflation in the short run and long run. The empirical results show a strong positive impact of public sector borrowing on inflation in the short run. The results from cointegration analysis indicate that in the long run, a 1 percent increase in the deficit increases real money stock by 1.02 percent, and a 1 percent increase of public credit increases real money stock by 0.36 percent. The error correction term for the fiscal sector turns out to be insignificant in the vector error correction model, reflecting the fact that fiscal deficits

[2] See Gebreeyesus (2016) and various government reports (Government of Ethiopia 2010; 2016).

mostly affect money growth, affecting inflation indirectly. This result deserves further investigation in future studies.

As a second contribution, the paper finds that monetary factors have significant effects on inflation both in the long run and short run. This contrasts with the results in Durevall et al. (2013), which found that disequilibria in the money markets have no impact on inflation in the long run.

A third contribution to the existing literature is that the study covers a longer sample period (July 1998 to September 2020) than preceding studies, such as Durevall et al. (2013) which covered only the 2000s. This is important given changes in the macroeconomic policy regime over the past decade—notably, a significant increase in credit to the public sector as financial repression was ramped up, an increase in the parallel market premium since 2014 due to foreign exchange shortages, reduced volatility of inflation as a result of interventions by the government and donors that helped cushion the effects of droughts on prices (e.g., in 2015), and the end of the IMF program in 2004.

This analysis tests the robustness of the results and the stability of the inflation models by estimating them over the period 2005-2020, which corresponds to the high growth regime and the end of the IMF program. The regression results relating to this shorter recent period are consistent with those covering the longer period.

As in previous studies, the results in the paper confirm that disequilibria in the grains and food sectors have long-run effects on cereal, food, and overall inflation. Moreover, in the short run, inflation is driven by structural factors, notably output gaps and prices of imported goods (i.e. grains, oil, and non-food items). The results also suggest that inflation exhibits inertia, with price shocks leading to high inflation, especially in the cases of food and non-food inflation. Among all inflation measures, non-food inflation exhibits a smoother pattern and is not affected by either money growth or public sector borrowing. This could be due to the fact that it is the indicator used by the monetary authority to track and control inflation, and the index includes items for which prices are controlled or closely monitored, such as fuel.

The remainder of this paper is structured as follows. Section 2 provides a brief review of the related literature on inflation. Section 3 presents stylized facts and salient patterns and relationships among key variables used in the regression analysis. Section 4 describes the specification of the empirical inflation model and the main potential determinants of inflation. The empirical methodology is presented in Section 5. The regression results are discussed in Section 6, and Section 7 concludes with a summary of the findings and some policy implications.

2. Related literature on inflation

This section provides a review of the empirical literature on inflation in Ethiopia, while drawing on the broader literature as needed. The review covers factors arising from the demand side and the supply side, as well as from structuralist analyses of inflation. This discussion motivates the empirical approach developed in Section 4.

Demand-side factors of inflation

Inflation may be driven by forces arising from the demand side or the supply side of the economy. The evidence on Ethiopia bears out this prediction. On the demand side, the empirical literature has focused on the role of monetary factors in modeling inflation. Surprisingly, however, little attention has been devoted to the role of domestic credit and fiscal deficits. This study contributes to filling this gap.

Monetary factors

The monetary theory of inflation draws on the classical quantity theory of money (QTM), which posits that inflation is mainly a monetary phenomenon, but the empirical literature offers mixed evidence on the links between monetary aggregates and inflation. First, the link varies depending on the empirical methodology and the measures of inflation used in the analysis. The study by Durevall et al. (2013) finds that disequilibria in the monetary sector influence non-food inflation but not cereal price inflation or food inflation. The effects also vary between the short run and long run. Durevall et al. (2013) find no long-run relationship between money and inflation. In the short run, the study finds that money growth affects only non-food prices.

Fiscal deficits and inflation

The relationship between inflation and fiscal deficits has attracted substantial attention in developed and developing countries. The fiscal view of inflation holds that high and persistent inflation originates primarily from excessive monetary financing of fiscal deficits. The statement below sums it up clearly:

> Milton Friedman's famous statement that inflation is always and everywhere a monetary phenomenon is correct. However, governments do not print money at a rapid rate out of a clear blue sky. They generally print money to cover their budget deficit. Rapid money growth is conceivable without an underlying fiscal imbalance, but it is unlikely. Thus rapid inflation is almost always a fiscal phenomenon (Fischer and Easterly 1990, pp. 138–39).[3]

Conceptually, the relationship between fiscal deficits and inflation arises from the need to finance the government budget deficit. In particular, financing the deficit through advances from the central bank increases the monetary base, which creates upward pressure on inflation (Sargent and Wallace 1981). In the context of portfolio choice and intertemporal optimization, the price level is influenced by both current and future government decisions on the level and mode of financing of the deficits. This establishes a dynamic relationship among deficits, money growth, and inflation (Cochrane 2001; Fischer, Sahay, and Végh 2002; Gordon and Leeper 2006).

In developing countries, various structural and institutional conditions create an environment for the fiscal view of inflation (see Cukierman, Edwards, and Tabellini (1992) and Calvo and Végh (1999)). The first is the lack of a sufficiently developed financial system that can absorb a high volume of newly issued government bonds, which forces the government to resort to central bank financing, borrowing from the domestic banking sector, and external borrowing. The second feature is fiscal dominance, whereby lack of independence of the central bank forces it to accommodate the Treasury's financing needs. The third factor is chronic shortage of foreign exchange reserves that maintains pressure for exchange rate depreciation, perpetuating an inflationary environment.

[3] Cited in Agénor and Montiel (2015, p. 111), which provides an elaborate discussion on the topic.

While a large body of literature explores the fiscal deficit—money growth—inflation nexus, the empirical evidence remains mixed and contingent on country context. Several factors may influence the timing and strength of this nexus (Agénor and Montiel 2015). If the deficit is financed by bonds rather than money creation, the short-run relationship may be weak. Moreover, if the government resorts significantly to external borrowing, the relationship between the consolidated government deficit and inflation may be weak. Other factors would have to be considered in explaining high inflation in such contexts. Finally, the impact of deficit monetization on inflation may be weakened or delayed in the presence of unstable money demand and slow inflation adjustment due to inertial forces such as sticky wages and price controls.

Evidence from African countries is generally supportive of a positive relationship between fiscal deficits and inflation (Ahmad and Aworinde, 2019). In the case of Ethiopia, a study by Alemu, Mulugeta, and Wassie (2016) finds evidence of a positive impact of the fiscal deficit on inflation in both the short run and long run.

This study contributes to the literature by providing both a theoretical and institutional motivation for the impact of the fiscal sector—including the deficit and public sector borrowing—on inflation. The analysis distinguishes between long-run effects (through adjustment to equilibrium in the fiscal sector) and short-run effects (through the impact of increased borrowing by the central government and state-owned enterprises).

External factors of inflation

External factors play an important role in fueling domestic inflation, notably through imported food and energy products as well as exchange rate movements, although the relative impacts of these factors need to be further explored in future research. For Ethiopia, empirical evidence has shown that rising world food prices exert upward pressure on local food prices (Durevall et al. 2013). However, the transmission of global food prices to domestic prices remains unclear. According to UNCTAD trade statistics, Ethiopia is a net exporter of basic foods, while it is a net importer of cereals and cereal preparations. This issue deserves further empirical investigation.

Another channel of external pressure on domestic prices is imports of petroleum and related products. Petroleum and related products represent 10-20 percent of Ethiopia's total imports. The country is therefore exposed to the vagaries of international energy prices which filter through the domestic cost of production of goods and services, ultimately fueling inflation.

The exchange rate also plays an important role in any economy that is import-dependent, as is the case for Ethiopia. In the event of a devaluation, the weakening of the domestic currency raises the cost of imports, which in turn increases the domestic price level. In an economy facing foreign exchange constraints, a devaluation can set off an inflationary spiral whereby devaluation causes domestic prices to rise, causing an appreciation of the real exchange rate which discourages exports. Further devaluation aimed at preventing the deepening of the trade deficit can ignite other rounds of domestic price increases while raising expectations of further exchange rate devaluation. Under tight foreign exchange reserve constraints and dependence on imports, inflation can indeed offset some of the intended benefits of devaluation. The World

Bank concluded that a key reason why the 2010 devaluation of the Ethiopian birr did not yield the desired outcomes is that "inflation 'ate-up' most of the positive real exchange rate gains."[4]

The study by Durevall et al. (2013) found that the exchange rate, along with international food prices, affected the long-run level of domestic food prices. However, according to the study, short-run and episodic food price inflation appears to be driven more by international prices and agricultural production, while the exchange rate has minimal effect. One important problem in assessing the impact of the exchange rate on inflation is that the impact of devaluation can be offset or amplified by unrelated movements in money supply or aggregate demand. This underscores the fundamental question of whether the central bank can manage the exchange rate (to avoid real exchange rate overvaluation) while at the same time controlling inflation.

Structuralist approach to inflation

The determinants of inflation cannot always be neatly delineated between demand-pull and supply-push factors. Structuralist models of inflation were developed specifically to address this complexity. Structuralist models of inflation focus on specific features of underdeveloped countries that do not fit neatly in and are not accounted for by conventional inflation theories (Seers 1962; Olivera 1964).[5]

The structuralist model incorporates several features of underdeveloped countries. The first feature is the dominance of the agriculture sector with price-inelastic and shock-prone production, which is a source of food price inflation. In turn, the latter is the major driver of overall inflation. The second feature is rapid population growth and urbanization which exert pressure on food prices due to rising demand for food. Rising food prices then exert pressure on urban sector wages, which can unleash a price-wage inflation spiral, conditional on the bargaining capacity of labor and the nature of labor market regulations. The third feature is high dependence on export of primary commodities, which is associated with volatility of foreign currency inflows. The fourth feature is dependence on imported capital goods and manufactures, which contributes to imported inflation. The last feature is imperfect financial markets and financial repression, with strong influence of fiscal policy on money demand. In this context, broad money stock is an inadequate indicator of monetary policy.

The empirical literature contains some evidence of the role of structural factors of inflation in Ethiopia, especially shocks to agricultural production and food prices. In fact, inflation in Ethiopia is by and large food inflation. Moreover, foreign exchange constraints and dependence on imported manufactures are important factors of the dynamics of inflation in Ethiopia (Durevall et al. 2013).

[4] See, among others, Woldie and Siddig (2019) for evidence on the negative (contractionary and inflationary) effects of exchange rate devaluation in Ethiopia.

[5] The new structuralist models of inflation consider inflation as the outcome of conflict (or bargaining) between workers and capitalists over the distribution of income between wages and profits (Cardoso 1981; Taylor 1983; Taylor 1991).

3. Data sources and stylized facts from the data

Data sources

This paper uses monthly series spanning the period from July 1998 to September 2020. The data are obtained from the National Bank of Ethiopia (NBE), except for the import prices which are sourced from World Bank Commodity Price Data (The Pink Sheet) and the Federal Reserve Bank for the U.S. manufacturing producer price index (as a measure of import prices of non-food items other than oil). The fiscal variables are transformed into monthly frequency from annual series using interpolation. The list of variables used in the regressions as well as the data sources are provided in Table A1 in the Appendix.

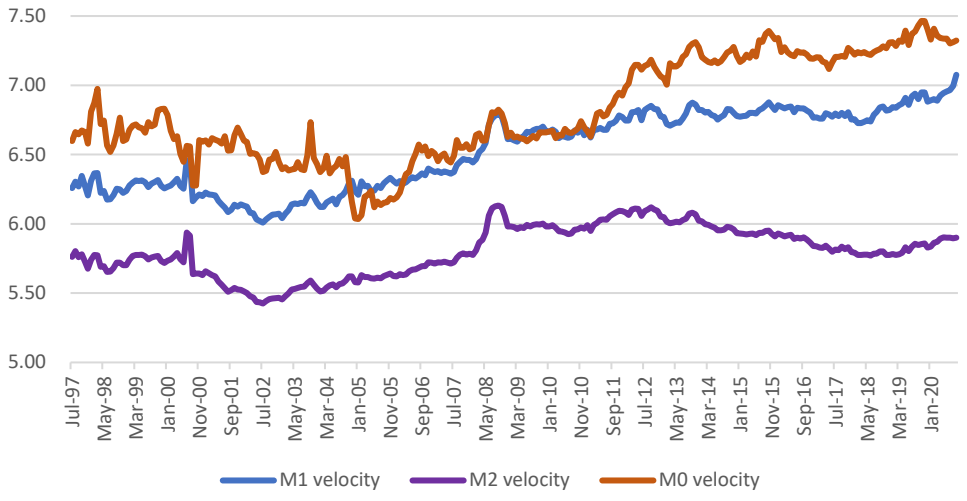
Before moving to the empirical methodology, some highlights from the data and salient relationships among the key variables of interest are provided below.

Trends of monetary aggregates

The trends of money stocks show three phenomena. The first is a divergence of broad money (M2) from narrow money (M1) and base money (M0), which became increasingly pronounced starting from 2010/2011 as M2 grew faster than the two other aggregates. The rapid growth of M2 was driven by rapid growth in savings deposits, which grew from 35.4 percent of M2 in 1997 to 60.7 percent in 2020, and it is also reflected in an increase in the money multiplier from 2011.

The second and third phenomena are trends in the velocity of money, both of which reflect important developments in Ethiopia's financial system. Specifically, the second phenomenon is an increase in the velocity of money starting in 2002 (Figure 1), which reflects the acceleration of monetization of the economy. The velocity of money was declining for all three money stocks until mid-2002 (end 2004 for M0). The velocity of M0 and M1 then rose steadily, while that of M2 peaked in October 2008 then went on a downward trend. The third phenomenon is a decrease in the velocity of broad money starting from the end of 2008, which reflects the beginning of deepening of the financial system from the early 2000s. Financial deepening is reflected in the rising share of savings and time deposits in the public's portfolios and the declining velocity of M2, reflecting its faster growth relative to nominal GDP.

Figure 1: Trends of velocity of money

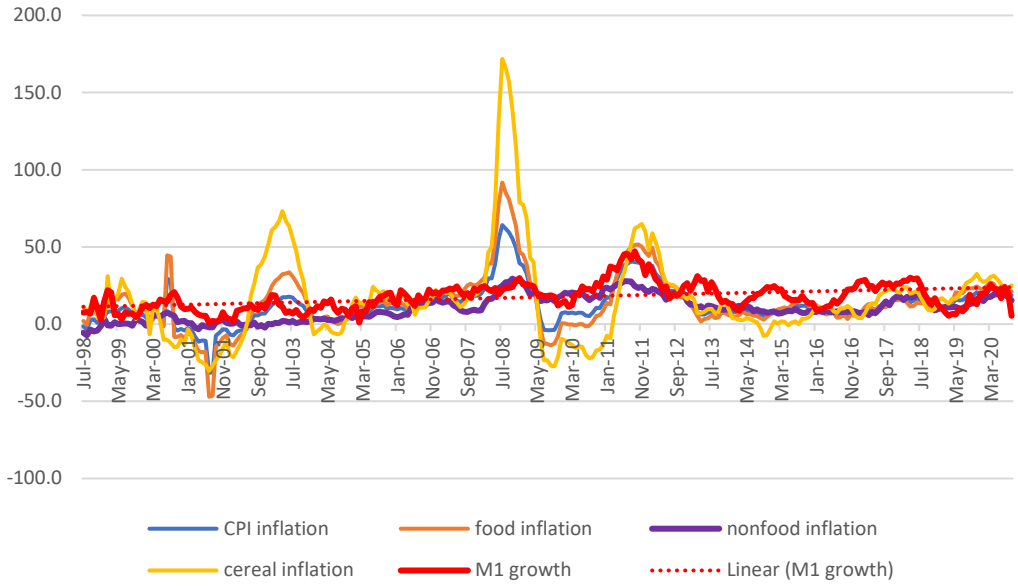


Source: Authors' construction using data from NBE's database.

Money growth and inflation

The data shows that in the short run, inflation is more volatile than money growth due to shocks to agriculture and cereal production in particular (Figure 2), but in the long run, inflation and money growth follow a similar pattern. Money and non-food inflation followed an upward trend from 2002 until end 2011, followed by a downward trend over the period 2011-2017.

Figure 2: Money growth and inflation (month-on-month growth rates, percentage)



Source: Authors' construction using data from NBE database.

World prices and Ethiopian prices

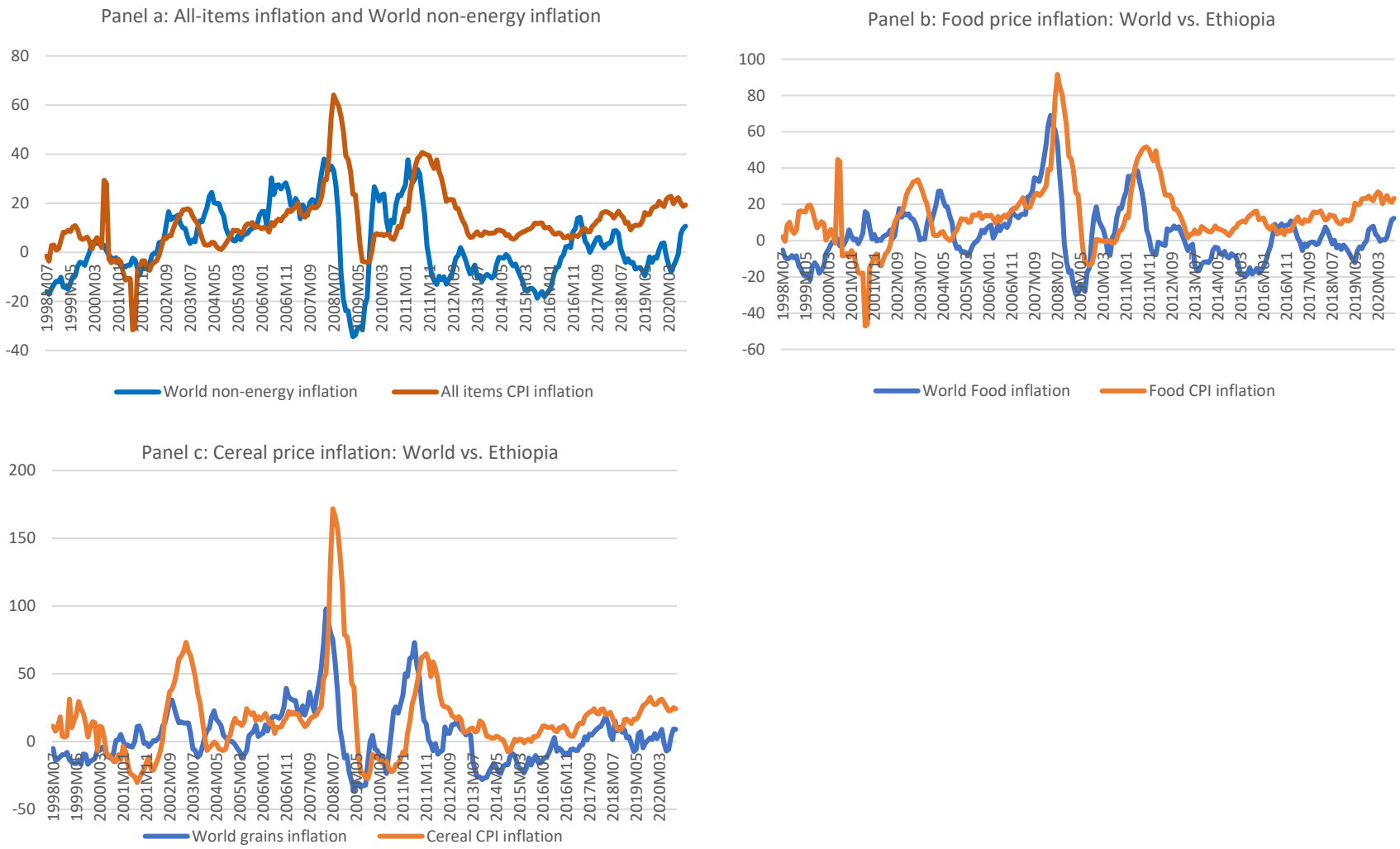
The data shows close co-movement between Ethiopian inflation and world inflation. Figure 3 displays the co-movement between Ethiopian all-items CPI inflation and world non-energy inflation, world food inflation and Ethiopian food inflation, and world grain inflation and Ethiopian cereal inflation. Both Ethiopian and world inflation exhibit sharp swings in 2008 and 2011 due to global food and energy crises.

This study examines the relative price of foreign goods in terms of Ethiopian goods. This relative price is defined as $P/(E.P_f)$ or in logarithm form as $lnP - (lnE + lnP_f)$, where P_f is the world price, *P* the domestic price, and *E* the exchange rate of the birr against the U.S. dollar.[6] The series plotted in Figure 4 are centered around the mean.

The trend of relative prices exhibits three regimes. In the first period, relative food prices and cereal prices are relatively stable, while the all-items and nonfood relative price inflation rates are rising. In the second period, the trend of all the series is punctuated by a major drop in relative prices followed by a quick V-shaped reversal. Third, after this reversal, the series reach a peak and begin to accelerate (appreciate) and later stabilize again.

[6] The relative price thus defined represents the amount of foreign goods (e.g., number of U.S. goods) per unit of Ethiopian good (e.g., per kg of coffee). Thus, an increase in the ratio means real appreciation of the Ethiopian currency.

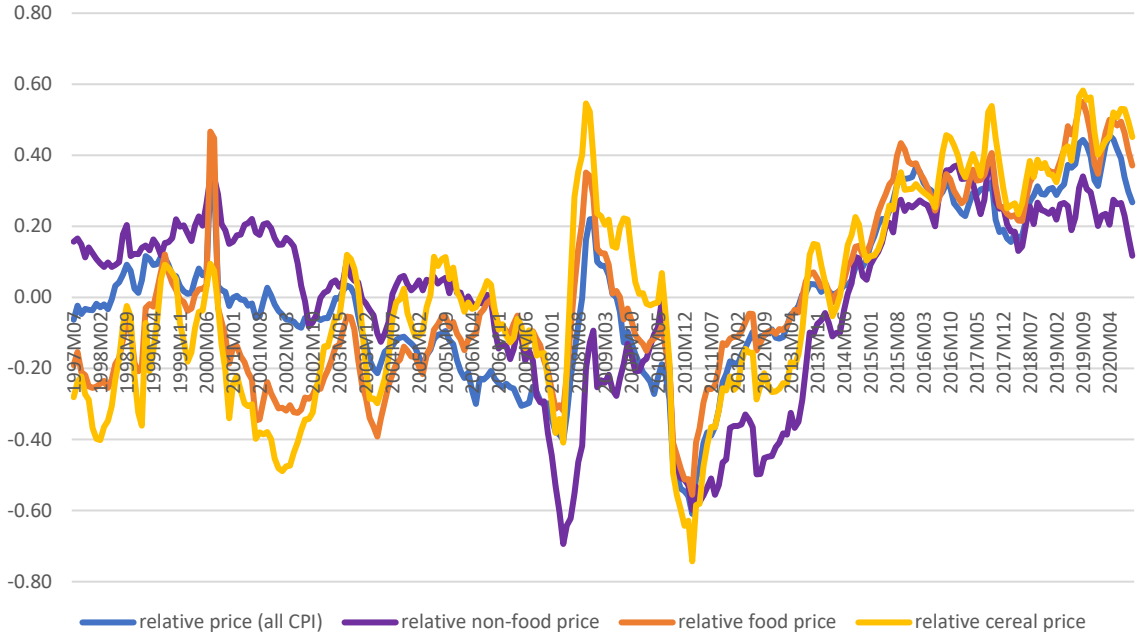
Figure 3: Ethiopian inflation and world inflation



Sources: Authors' construction using data from NBE database and the World Bank's Commodity Markets database.[7]

[7] https://www.worldbank.org/en/research/commodity-markets

Figure 4: Relative prices (World vs. Ethiopia)



Sources: Authors' construction using data from NBE database and the World Bank's Commodity Markets database.
Note: An increase represents a real appreciation in favor of Ethiopia.

4. Modeling inflation in Ethiopia

The modeling approach adopted in this study accounts for structural features of the Ethiopian economy, notably: (i) exposure to agricultural shocks that affect food prices and the general price level; (ii) import dependence and exposure to shocks to international prices, particularly grains, food, and oil prices; and (iii) financial repression with strong pressure from direct and indirect financing of the fiscal deficit. This approach draws from the study by Durevall et al. (2013) regarding modeling and estimation methodology, as well as Nell (2004) in incorporating structural factors of inflation. This section presents the main blocks of the inflation model.

Structural factors of inflation

Drawing on the studies by Nell (2004) and Durevall et al. (2013), this analysis models inflation as driven by deviations of output from its trend level due to shocks as well as changes in the prices of imported goods that are transmitted into domestic prices. This can be represented by the following equation:

$$\pi_t = \alpha_0 + \alpha_1 \pi_t^M + \alpha_2 gap_t + \varepsilon_t \qquad (1)$$

where π is the domestic inflation rate, π^M is import price inflation, and *gap* is the output gap.

The extent to which changes in the exchange rate are reflected in the price of imported goods (P^M), or exchange rate pass-through, can be represented by the following equation:

$$P_t^M = E_t^{\beta_1} P_{ft}^{\beta 2} \qquad (2)$$

where *E* is the nominal exchange rate and P_f is the world (foreign) price. The above equation can be written in growth form as:

$$\pi_t^M = \beta_1 e_t + \beta_2 p_{ft} \quad (3)$$

Substituting equation (3) into equation (1) yields the following baseline structuralist inflation model:

$$\pi_t = \theta_0 + \theta_1 e_t + \theta_2 \pi_{ft} + \theta_3 gap_t + \varepsilon_t \quad (4)$$

The exchange rate can affect domestic inflation through the demand side via the impact of the cost of imported goods and through the supply side via the cost of inputs and the resulting impact on production. The demand-side channel is arguably "the most rapid transmission channel of monetary policy to inflation in an open economy" (Agénor and Montiel 2015, p. 171).

In the long run, the linkages between the price level and the exchange rate are reflected in the trend of the real exchange rate or the terms of trade of domestic goods in terms of foreign goods through the 'law of one price' or purchasing power parity. The equilibrium condition can be expressed in logarithm terms as:

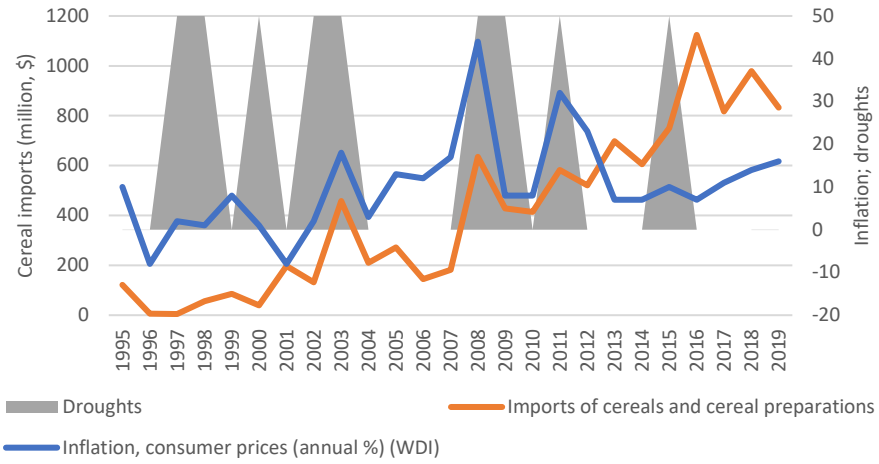
$$lnE + lnP_f - lnP = 0 \quad \text{or } e + p_f - p = 0 \quad (5)$$

This relationship is tested using the cointegration procedure. In addition to the all-item price index, similar relationships are specified for non-food prices, food prices, and cereal prices.

Accounting for the importance of the agriculture sector

The behavior of the agriculture sector is an important driver of inflation in Ethiopia. First, the exposure of agricultural production to weather shocks generates large and frequent changes in output, resulting in price spikes. For example, the droughts of 2002/2003, 2008/2009, and 2011 ignited drastic increases in food prices, which resulted in overall high inflation. Second, as food is an important component of the consumption basket for most of the population, movements in food prices drive overall inflation dynamics. Third, negative shocks to domestic food production induce an increase in food imports. Indeed, the three major droughts mentioned above were accompanied by increased imports of cereals. Through the shock-induced rise in cereal imports, imported inflation exacerbates and prolongs the overall inflation effects of droughts. These effects can be seen in Figure 5, which illustrates movements of cereal imports and inflation around the drought periods.

Figure 5: Droughts, cereal imports, and inflation



Source: NBE database; IMF, Direction of Trade Statistics, International Financial Statistics.

This approach to modeling inflation accounts for these features of the agriculture sector in three ways. First, in addition to headline inflation, this analysis models and estimates the determinants of cereals, food, and non-food inflation. Within the food basket, cereals are singled out given their important share in production, food imports, and food consumption. Second, this study considers the cereal production gap instead of overall GDP gap as a determinant of inflationary pressures arising from the supply side. Third, this analysis includes dummies capturing sharp spikes or drops in inflation that are typically associated with shocks to food production.

Demand-side factors

On the demand side, the two prominent approaches to inflation modeling are the monetary theory and the fiscal theory of inflation (Gordon and Leeper 2006; Sargent and Wallace 1981). The two theories are interrelated but are often treated separately in empirical studies of inflation. Under the monetary theory of inflation, movements in the price level are determined by movements in the money supply, given the demand for real balances. Under the fiscal theory, movements in the price level are driven by changes in government borrowing, given the fiscal deficit.

Monetary factors of inflation

Under the monetary view, inflation arises from excessive expansion of the exogenously determined supply of money relative to demand for real balances. Put differently, inflation results from imbalances in the money market. Letting λ and -ρ be the elasticities of money demand with respect to output and the interest rate, respectively, the money market equilibrium can be represented as:

$$m - p = \lambda y - \rho r, \text{ or } (m - p) - \lambda y + \rho r = 0 \qquad (6)$$

The variables *m, p, y,* and *r* are the logarithms of the stock of money, price level, output, and interest rate.

In an open economy, the above characterization of the money market equilibrium can be expanded to include the role of the exchange rate for portfolio decisions. Changes in the exchange rate affect the returns on foreign assets and therefore their demand relative to domestic assets. Moreover, in the absence of foreign exchange controls, expected appreciation or depreciation will influence the demand for foreign assets as a substitute for local currency. Therefore, the demand for real balances is influenced by the exchange rate. Taking this into account, the equilibrium in the money market can be represented as:

$$(m - p) - \lambda y + \rho r + \gamma e = 0 \qquad (7)$$

The coefficient γ is the elasticity of money demand with respect to the exchange rate (e).

This analysis empirically examines the long-run relationships among real balances, output, and the exchange rate using cointegration analysis. In reality, the exchange rate in Ethiopia has been heavily controlled and is therefore not a true measure of the relative returns to foreign assets compared to domestic assets. The empirical analysis uses the parallel market exchange rate premium, which embodies movements in the official exchange rate as well as disequilibria between demand and supply of foreign exchange. The interest rates are left out, given that they have been fixed for most of the sample period.

Fiscal deficits and inflation

The fiscal theory of inflation can be motivated from an intertemporal optimization model where equilibrium inflation is related to the ratio of the fiscal deficit to the stock of money (Catão and Terrones 2005; Gordon and Leeper 2006). In such a model, consumers maximize lifetime utility, subject to a sequence of budget constraints given by (Catão and Terrones 2005, 533–34):

$$c_t + \frac{B^p_{t+1}}{R^*_t} + \frac{M_{t+1}}{P_t} = y_t - T_t + b^p_t + \frac{M_t}{P_t} \qquad (8)$$

where c is consumption; B and b denote nominal and real value of household holdings of one-period risk-free bonds, respectively; R* is the gross return on bonds; M is household's holdings of money balances; y is income; T is a lump-sum tax; and P is the price level.

Households allocate time between leisure (l) and shopping (s) (with $l + s = 1$), where the amount spent on shopping is directly related to consumption and inversely related to the amount of real balances held by the household:

$$s_t = S\left(c_t, \frac{M_{t+1}}{P_t}\right) \qquad (9)$$

The first-order condition with respect to c, l, b, and M yields a money demand function of the form:

$$\frac{M_{t+1}}{P_t} = M^d(c_t, R^*_t, \pi_t) \qquad (10)$$

The government finances its expenditures (G) by tax (T), borrowing, and seignorage (money creation), so its budget constraint is:

$$\frac{B^g_{t+1}}{R^*_t} = T_t + B^g_t - G_t + \frac{\Delta M_{t+1}}{P_t} \qquad (11)$$

The economy-wide stationary equilibrium yields a relationship between inflation and the ratio of the fiscal deficit and real money balances as follows:

$$\pi = \psi \frac{(G-T)}{M} \qquad (12)$$

The fiscal theory of inflation suggests that the fiscal deficit may affect the price level through its impact on money demand and thus the equilibrium in the money market. In particular, government borrowing to finance the deficit results in monetary expansion, which raises inflation. This study empirically explores the fiscal theory of inflation using an expanded version of equation (12) that incorporates public sector borrowing as follows:

$$\frac{M}{P} = F(G-T, \Delta pubcred) = \delta_1(G-T) + \delta_2 \Delta pubcred_t \quad (13)$$

The coefficients δ_1 and δ_2 represent the long-run effects of the primary fiscal deficit and public sector borrowing on real money demand. The study considers total public sector borrowing rather than just central government borrowing to capture the comprehensive financing of the deficit through both direct and indirect mechanisms. The analysis tests for the existence of long-run relationships among the real stock of money, the deficit, and public sector borrowing using the cointegration methodology.

Expanding the structuralist model in equation (4), this analysis specifies two versions of the vector error correction model: a baseline model including the monetary sector and an alternative model including the fiscal sector to capture the fiscal view of inflation. The model incorporates long-run relationships in the monetary sector (equation 6) and alternatively the fiscal sector (equation 13) and food and non-food market (relative prices for food and non-food—equation 5), as well as short-run effects of money growth, public sector borrowing, the exchange rate, foreign prices, and inertial effects of domestic prices.

It should be noted that the coefficients reflect the elasticities of inflation relative to the relevant variable (in growth rate form), so even a small coefficient may imply a large economic impact. Except for the cereal output gap, the regression variables in levels are converted in logarithms so that the change in the variable denotes the growth rate of the variable. It is important to keep this in mind in the interpretation of the results, especially the magnitudes of the implied impacts. So, for example, the coefficient on money growth is the impact of a change in the growth rate of money on inflation, not the impact of a change in the stock of money on the price level.

The baseline model is specified as follows:

$$\Delta p_t = \theta_0 + \sum_{j=2}^{k} \theta_{1j} \Delta p_{t-j} + \theta_2 cergap_{t-1} + \sum_{j=2}^{k} \theta_{3j} \Delta m_{t-j} + \sum_{j=2}^{k} \theta_{4j} \Delta p_{f,t-j} + \sum_{j=2}^{k} \theta_{5j} \Delta prem_{t-j} + \theta_6 ECM_m + \theta_7 ECM_{fcer} + \theta_8 ECM_{nfood} + \sum_{i=1}^{n} \theta_{9j} D_i + \varepsilon_t \qquad (14)$$

The model is estimated for four measures of inflation (Δp): cereal ($cerp$), food (fp), non-food (nfp), and all-item inflation (p). The variable *cergap* represents the cereal output gap, m is real

money stock, p_f is foreign price (grain price $wgrainp$, food price wfp, non-food price represented by the U.S. manufacturing producer price index $wmanup$, oil price $oilp$), $prem$ is the parallel market premium, and *D* are dummies for sharp price spikes and drops as well as the main harvest season (*Meher*). The terms *ECM* stand for cointegration equations (disequilibria) for the money market, relative prices for food (grains), and non-food markets, respectively.

The ECM equation for the monetary sector is a modified version of equation (7) that excludes the interest rate (fixed) and replaces the exchange rate with the parallel market premium:

$$(m - p) - \lambda y + \gamma prem + c = 0 \quad (7a)$$

where the variables are defined as above, and *c* is a constant.

The ECM equation for the grains sector and the non-food sector are respective versions of equation (5):

Grain (food) sector: $(eus + wgrp) - \alpha p + c = 0$ (5a)

Non-food sector: $(eus + wmanp) - \beta nfp + c$ (5b)

The alternative model incorporating the fiscal sector is specified as:

$$\Delta p_t = \theta_0 + \sum_{j=2}^{k} \theta_{1j} \Delta p_{t-j} + \theta_2 cergap_{t-1} + \sum_{j=2}^{k} \theta_{3j} \Delta pubcred_{t-j} + \sum_{j=2}^{k} \theta_{4j} \Delta p_{f,t-j} + \sum_{j=2}^{k} \theta_{5j} \Delta prem_{t-j} + \theta_6 ECM_{fiscal} + \theta_7 ECM_{food} + \theta_8 ECM_{nfood} + \sum_{i=1}^{n} \theta_{9j} D_i + \varepsilon_t \quad (15)$$

The variable $pubcred$ represents borrowing by the public sector, and ECM_{fiscal} is derived from the cointegration equation for the fiscal sector (equation 13).

The estimated ECM for the fiscal sector is as specified in equation (13) with constant term (*c*):

$$\frac{M}{P} = \delta_1 (G - T) + \delta_2 \Delta pubcred_t + c \quad (13a)$$

The estimation procedure is described in Section 5.

5. Empirical methodology

Before presenting and discussing the empirical results, a brief discussion of the empirical methodology provides a bird's-eye view of the steps leading up to the results.

As highlighted in previous sections, the data used for econometric modeling show strong changes over time, with macroeconomic variables displaying different patterns depending on the period considered. Spikes in the inflation series also need to be accounted for in the modeling process. For example, Figure 4 shows several spikes in cereal and food inflation. The most prominent were in July and August 2000 due to drought and from May to November 2008 due to price hikes in international food markets. Another price spike in March 2011 was followed by what appears to be a new regime of high food prices. Hence, modeling inflation for Ethiopia should consider the existence of potential outliers and devise ways of dealing with the challenge. Dummy variables

are constructed to account for these potential issues, but they are used parsimoniously in the empirical modeling process.

All variables entering the inflation models are tested for their order of integration and are found to be integrated of order 1 in levels (and stationary in first differences), with the exception of the output gap variable which is stationary in levels. The results are presented in Table A2 in the Appendix. The output gap is extracted from cereal production series using a Hodrick-Prescott filter. The use of the cereal output gap is motivated by the fact that the Ethiopian economy is highly dependent on agriculture, so agricultural production is a better measure of output trend than GDP.

Time series econometric modeling is used to estimate four models (cereals, food, non-food, and all-item inflation) through a two-step process. The first step establishes long-run relationships in the monetary and fiscal sectors as well as in the external food and non-food sectors. After specifying the long-run relationship in each sector, the existence of cointegrating vectors is established using the Johansen methodology. One cointegrating vector is uncovered for each sector. Next, the estimation of the cointegrating relationship provides coefficients of the cointegrating vector used to compute deviations from equilibrium. The error correction residuals are then tested to verify that they are stationary. Indeed, all the cointegration models produce stationary residuals. The equations of the residuals—representing deviations from equilibria—are then included in the error correction models. The results of the cointegration tests are presented in Table A3 in the Appendix.

In the second step of the empirical analysis, error correction models are estimated for cereals, food, non-food, and CPI inflation. Applying the general-to-specific methodology, the analysis starts with over-parameterized models where short-term variables have 12 lags each. Parsimonious models of inflation are derived through a process of model reduction. Ultimately, the number of significant lags varies by regressor.

Each model considers three groups of inflation determinants: long-run determinants, short-run domestic factors, and short-run external factors. Long-run determinants are represented by the cointegrating vectors derived through cointegration analysis in the first step. Short-run determinants are lags of first differences of the variables of interest, which are all stationary. Dummy variables capturing shocks to prices and seasonal effects associated with the main harvest season (*Meher*) are included in the relevant models as appropriate.

6. Discussion of empirical results

Discussion of empirical results from the baseline model

The empirical results confirm that inflation in Ethiopia is determined by several long-term and short-term factors (Table 1). Long-term determinants are associated with the monetary sector and the external food and non-food sectors, while short-run effects are associated with the monetary sector, external and domestic food prices, oil prices, output gap, and exchange rate market premium. The results are discussed thematically below. Similar to the point mentioned earlier, even though estimated coefficients may appear small, they represent monthly effects—this should be kept in mind in making inferences on the economic significance of the relationships between inflation and its determinants.

Effects of monetary factors on inflation

The empirical results suggest that monetary policy and developments in the monetary sector are important determinants of inflation in Ethiopia in the long run. As can be seen in the cointegration residual equation (the ECM term for the monetary sector), $(m_1 - p) - 1.04y + 0.29prem + 6.46$, excess money supply has a long-term positive impact on the price level even after controlling for the key determinants of money demand, namely GDP and the parallel exchange rate premium (the latter being a proxy for the opportunity cost of holding liquidity in the domestic currency). In the long run, a 1 percent increase in GDP increases money demand by 1 percent, and a 1 percent increase in the premium reduces money demand by 0.29 percent.

The results show that disequilibria in the monetary sector (as represented by the coefficient on the cointegration equation residual—ECM term) exert inflationary pressure on cereals prices, food prices, and overall price level (all-item CPI), but adjustments to equilibrium seem relatively slow. When there is disequilibrium in the money market, about 2.7 percent of it is removed every month through variations in domestic cereal prices. The speed of return to equilibrium in the food sector is even slower, at only 2 percent every month. For overall CPI, 1.5 percent of the disequilibrium is removed each month.

In the short run, money growth strongly affects prices in the food and non-food sectors, but it has no impact on cereal price inflation. The effect of a shock on money growth occurs in the third month after the shock for food prices and during the twelfth month after the shock for non-food prices. This latter delayed reaction may give a false impression of a disconnect between money supply and the different components of inflation. With respect to the magnitude of the short-term response of prices to money growth, econometric results suggest that a 1 percent increase in money growth increases food prices by 0.13 percent and non-food prices by 0.05 percent. This response may appear weak but, considering the large increases of money supply particularly over the last ten years (by over 20 percent per year according to the NBE data), the impact on prices is indeed very strong.

Even though these results are in line with economic theory, they are different from those of some previous influential studies that did not find any long-term effect of excess money supply on inflation in Ethiopia, notably Durevall et al. (2013). The reason might be that this study covers a longer sample period. The behavior of monetary aggregates as presented in Section 3 suggests that they were stable during most of the period covered by the Durevall et al. study (January 2000 to December 2009). The longer and more updated sample period covered by this study (up to September 2020) captures a period of rapid increase in money stock and money velocity relative to the previous period.

Table 1: Empirical results from baseline models of inflation (July 1998 – September 2020)

Variables		Cereals	Food	Non-food	CPI
	Adjustment effects				
EC-monetary sector	$[(m_1 - p) - 1.04y + 0.29prem + 6.46]_{t-1}$	0.027** (0.03)	0.020*** (0.01)	0.002 (0.58)	0.015*** (0.01)
EC-cereals (grains)	$[(eus + wgrainp) - 0.78cerp - 4.22]_{t-1}$	0.029** (0.04)	0.026** (0.01)		0.020** (0.03)
EC-non-food	$[(eus + wmanp) - 0.77nfp + 4.02]_{t-1}$			0.038*** (0.00)	0.025 (0.26)
	Domestic factors				
Cereal output gap	$cergap_{t-1}$	-0.136*** (0.00)	-0.060** (0.03)		-0.039** (0.02)
Money growth	$\Delta(m_1 - p)_{t-12}$	0.008 (0.86)		0.047*** (0.00)	0.026 (0.17)
Money growth	$\Delta(m_1 - p)_{t-3}$		0.130*** (0.00)		
Cereal inflation	$\Delta cerp_{t-9}$	0.062 (0.14)			
Cereal inflation	$\Delta cerp_{t-8}$				0.029 (0.17)
Food inflation	Δfp_{t-3}		0.101*** (0.00)		
Food inflation	Δfp_{t-6}				0.038** (0.04)
Non-food inflation	Δnfp_{t-12}			0.177*** (0.00)	0.073 (0.18)
	External factors				
World grain price	$\Delta wgrainp_{t-4}$	0.092** (0.04)			
World grain price	$\Delta wgrainp_{t-3}$		0.075** (0.02)		0.046* (0.06)
Exchange rate premium	$\Delta prem_{t-11}$	0.006 (0.19)	0.008** (0.01)	0.002* (0.06)	0.006*** (0.01)
Dummies included		Meher cerealpeaks cerealdeeps cerealjumps	Meher foodpeaks fooddrops cpi_jul2000 cpi_sep2000		Meher foodpeaks cpi_jul2000 cpi_sep2000
Constant		0.012*** (0.00)	0.012*** (0.00)	0.001 (0.53)	0.006* (0.09)
Observations		259	259	259	259
R-squared		0.572	0.860	0.148	0.810
DW		2.10	1.94	1.93	2.00

Robust p-values in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Note: Estimates are corrected for autocorrelation except for non-food CPI equation where no autocorrelation was detected.

Dummies: Meher = main harvest season = 1 for September-February; foodpeaks = Food price peaks = 1 for 1999:1; 2000:7; 2008:5-9; 2011:3-10; fooddrops = Food price drops: 2000:9-12; 2008:10-12; cerealjumps = Cereal price jumps = 1 for 1999:2, 6-9; 2001:1; 2005:6; 2008:3, 5-7; 2011: 3-6; 2012:3; 2017:7-11; cerealdeeps = Cereal price deeps = 1 for 1997:12; 1998:11,12; 1999:1; 2003:12; 2008:11, 12; cpi_jul2000 = 1 for 2000:7; cpi_sep2000 = 1 for 2000:9.

Effects of international food prices on inflation

In the long run, international food prices have a strong effect on domestic prices of cereals and food and on the overall price level as indicated in the estimated cointegrating equations. This highlights the integration of Ethiopia in international food markets and particularly the country's dependence on food imports. As indicated in the cointegration equation for grains price, $(eus + wgrp) - 0.78pcereal - 4.22$, in the long run, a 1 percent rise of the price of grains on the international market increases domestic cereal prices by 0.78 percent.

In Table 1, the coefficient on the ECM equation for grains in the cereal inflation equation indicates that around 2.9 percent of deviations from the equilibrium cereal price between world and domestic markets are removed every month in the domestic cereal market. The speed of adjustment is 2.6 percent in the domestic food market and 2 percent with respect to CPI.

International grain prices have short-term effects on all domestic price indices except for non-food prices. Keeping the exchange rate constant, if the price of grains on the international market increases by 1 percent, the domestic cereal price would increase by 0.09 percent; the market reaction occurs in the fourth month following the international price increase. Furthermore, a 1 percent rise in the price of grains on international markets leads to a 0.075 percent increase in food price and about a 0.05 percent increase in overall CPI during the third month after the change in the international grain price.

Effect of international non-food prices on inflation

The U.S. manufacturing price index, used as a proxy for the price of Ethiopia's non-food imports, comes out as a strong long-term determinant of Ethiopia's non-food price. As indicated in the cointegration equation for non-food price $(eus + wmanp) - 0.77nfp + 4.02$, keeping the exchange rate constant, a 1 percent increase in the U.S. manufacturing price increases the domestic non-food price by 0.77 percent. This is as strong as the effect of world grain prices on Ethiopian cereal prices discussed above.

As can be seen from the coefficients on the ECM term in Table 1, the results suggest that 4 percent of deviations from equilibrium in the non-food market are removed every month. Disequilibria in the non-food goods market have no significant effect on overall inflation.

Effects of the exchange rate

As discussed earlier, the parallel market premium captures developments in Ethiopia's foreign exchange rate markets. The official exchange rate is controlled by the government, and its value vis-à-vis external currencies such as the U.S. dollar remains fixed for relatively long periods; in other words, the official exchange rate is not market-determined. The parallel exchange market is unofficial and experiences government crackdowns from time to time. As a result, the parallel exchange rate does not fully reflect a freely functioning foreign exchange market. The advantage of using the premium is that being a linear combination of the two rates, it represents developments in both sides of the foreign exchange market.

Changes in the exchange rate premium have statistically significant effects on food, non-food prices, and on the all-items CPI but no impact on cereal prices. The empirical results indicate that when the premium increases by 10 percent (for example, due to overvaluation of the official exchange rate), the overall inflation (all-item CPI) increases by 0.06 percent, food inflation by 0.08 percent, and non-food inflation by 0.02 percent. Alternatively, if the premium declines by

10 percent through a devaluation of the official currency, for example, the inflation rates would decline by those respective magnitudes.

Notably, in addition to using the parallel market premium as a determinant of money demand, the premium also affects the different prices indirectly through the exchange rate used to convert foreign prices into domestic prices. Domestic prices of wheat, oil, and other items in the priority list for foreign exchange allocation depend on the official exchange rate, while the prices of other items outside the priority list are likely affected by the parallel market rate. The estimated magnitudes of the impact of the premium provided above do not include these indirect effects, suggesting that the exchange rate has a stronger effect on inflation when both direct and indirect impacts are considered.

The effect of the price of oil proved to be insignificant in all equations for baseline inflation models but is significant in the models incorporating the fiscal sector, as discussed further below. The insignificant effect of the oil price on inflation reflects the fact that it is closely controlled by the government given its important impact on other prices.

Effects of the output gap

The output gap, computed using cereal production, has a negative and statistically significant impact on cereal price, food price, and overall CPI inflation. Not surprisingly, the impact of the output gap is stronger on cereal inflation (more than twice the effect on food inflation). The output gap was highly unstable before 2005 due to several shocks to output emanating from a series of droughts that characterized the period. The 2002-2003 drought was the most severe shock on cereal production. The output gap reached its lowest point of -0.30 in January 2003. During the pre-2005 period, droughts contributed a large part to the changes in cereal prices and CPI.

Inflation inertia

The regression results indicate that inflation exhibits substantial persistence, with past changes in domestic prices affecting current prices with varying time lags. In the case of food price, 10 percent of current price is explained by the change in the price three months prior. It takes 12 months for a change in non-food price to materialize in the domestic non-food price. This lag is not surprising—such changes may be dominated by shocks that take place in international markets, and their transmission to the domestic economy may be delayed due to policy interventions and other constraints. The fact that these shocks eventually reach Ethiopia confirms that the country is indeed integrated into world markets.

For all-items CPI, lagged effects are tested by including the lags of its three components, with the results showing that only lagged food price inflation has a positive and significant effect on overall inflation. A 1 percent monthly increase in food inflation leads to a 0.04 percent monthly increase in CPI six months later and an annualized increase of 0.6 percent. The absence of a significant effect of cereal inflation on overall inflation is surprising and deserves further investigation.

Two points are worth mentioning regarding non-food price inflation, which has a significantly different pattern from other inflation measures. First, the non-food price index is the indicator used in the monetary policy framework by the NBE in tracking and controlling inflation. Second, the non-food consumption basket includes various goods with prices that are closely controlled—and often directly fixed—by the government, such as fuel. This may help to insulate, at least

partially, non-food prices from shocks to other prices, the monetary and fiscal sectors, as well as shocks to international markets. Even the positive effect of money growth on non-food inflation materializes only 12 months after the shock on money, creating an impression that the two variables are not related. This may explain the relatively smoother pattern of the non-food price index as well as its weaker responsiveness to domestic and external factors that affect other measures of inflation.

Empirical results with alternative models including the fiscal sector

The empirical results from the alternative inflation models incorporating the fiscal sector in lieu of the monetary sector are presented in Table 2. The evidence indicates that inflation is significantly influenced by disequilibria in the fiscal sector in the long run and by increases in public sector borrowing in the short run.

As indicated in the estimated cointegrating equation for the fiscal sector, $(m_1 - p) - 1.02\ def - 0.36\ pubcred + 1.65$, in the long run, a 1 percent increase in the deficit increases real money stock by 1.02 percent, and a 1 percent increase of public sector credit increases real money stock by 0.36 percent. Compared to the results for the monetary sector obtained in the baseline model (Table 1), disequilibria in the fiscal sector are absorbed more slowly over time. In the case of cereal prices, 0.6 percent of the disequilibrium in the fiscal sector is removed every month, compared to 2.7 percent for the monetary sector disequilibria. The rate of adjustment is even slower for food prices (0.2 percent compared to 2 percent) and overall inflation (0.2 percent compared to 1.5 percent).

The results show that the error correction term for the fiscal sector is insignificant in the vector error correction models. This could reflect the fact that the fiscal error correction term measures the government's desire to create money in response to its budgetary needs, not the private sector's desire to hold money. While inflation is the main consequence of "too much money chasing too few goods," it could be that a disequilibrium in the budget position mostly affects money growth, which then affects inflation indirectly.

In the short run, changes in public sector borrowing affect all the indicators of inflation except for non-food inflation. An increase in public sector borrowing leads to an increase in cereal price, food price, and all-item inflation with two- and three-month lags. A 1 percent increase in public sector borrowing leads to a 0.03 percent increase in cereal price inflation two months later and 0.04 percent three months later, with a total effect of 0.07 percent after three months. The corresponding effects on food inflation are 0.02 percent after two months and 0.03 percent after three months, with a total of 0.05 percent. Growth in public sector borrowing has a positive and significant effect on overall inflation two and three months after the change in public credit, but it is relatively smaller (0.03 percent overall), reflecting the lack of effect on non-food inflation.

The results for the other determinants are broadly similar to those found in the baseline model including the monetary sector, but a number of noticeable differences can be seen in the short-run results. On the domestic side, non-food inflation exhibits persistence as shown by the positive and significant coefficients on the second and the third coefficients. A 1 percent increase in non-food prices leads to a 0.13 percent increase in prices two months later and a 0.15 percent increase three months after the shock.

On the external side, the results from the model including the fiscal sector show that inflation is influenced by the world grain price, oil price, world food price, and non-food prices as proxied by

the U.S. manufacturing producer price index. The results show persistent effects of shocks to world grain prices on cereal price inflation as illustrated by the positive and significant coefficients on the fourth and twelfth lags. The results also show a positive effect of a change in U.S. manufacturing producer price on non-food price as well as a positive effect of a change in world food price on overall CPI.

Looking more specifically at oil price impacts, an increase in the oil price affects non-food prices and overall CPI in the 11th month after it has taken place on international markets. This long delay may be explained by the fact that retail oil prices in Ethiopia are controlled by the government, and price increases may not be immediately transmitted to consumers. For example, during the COVID-19 crisis, retail fuel prices in Ethiopia were maintained at the same level even though international oil prices collapsed, with the gains accruing to the public stabilization fund. As prices started to rebound during the last months of 2020, authorities increased retail prices in January and February 2021 by about 20 percent. This mitigates the direct link between the domestic and international oil markets. Keeping the exchange rate constant, a 1 percent increase in the international price of oil leads to a 0.01 percent rise of the non-food price and a 0.02 percent increase of the all-items CPI.

Overall, the results from the inflation models including the fiscal sector confirm the existence of statistically significant long-run effects of disequilibria in the fiscal sector on all inflation measures except non-food prices. Moreover, government borrowing has inflationary short-run effects (except for non-food inflation). This implies that fiscal imbalances as well as the way fiscal deficits are financed need to be considered in any attempt to understand the drivers of inflation in Ethiopia.

In summary, the models specified in this study perform well in explaining short-run and long-run inflation dynamics in Ethiopia over the sample period. The key regression results hold when we substitute the monetary sector by the fiscal sector to explore the impact of budget deficits and public sector borrowing on inflation. The estimated models explain over 80 percent of the variations in food inflation and overall inflation as shown by the R-squares. The explanatory power is lower for the cereal inflation model, with R-squares of 51-57 percent. This is probably because cereal inflation is more exposed to shocks, and the models have not been able to sufficiently capture the impact of these shocks even with the range of dummies included for this purpose. Overall, the behavior of non-food inflation has proven to be more difficult to model as exhibited by the low R-square and fewer significant explanatory variables, which is consistent with the observed smoother pattern over the sample period, for reasons discussed earlier.

Table 2: Empirical results of inflation models including the fiscal sector (July 1998 – June 2020)

Variables		Cereals	Food	Non-food	CPI
Adjustment effects					
EC: Fiscal sector	$[(m_1 - p) - 1.02\ def - 0.36\ pubcred + 1.66]_{t-1}$	-0.006**	-0.002*	0.001	-0.002*
		(0.02)	(0.09)	(0.19)	(0.06)
EC: cereals (grains)	$[(eus + wgrainp) - 0.78cerp - 4.22]_{t-1}$	0.053***	0.023**		0.016*
		(0.00)	(0.04)		(0.06)
EC: non-food	$[(eus + wmanp) - 0.77nfp + 4.02]_{t-1}$			0.033***	0.003
				(0.00)	(0.88)
Domestic factors					
Cereal output gap	$cergap_{t-1}$	-0.127**	-0.053**		-0.022
		(0.02)	(0.05)		(0.14)
Public sector credit	$\Delta pubcred_{t-2}$	0.027**	0.022**	0.001	0.014**
		(0.04)	(0.01)	(0.81)	(0.02)
Public sector credit	$\Delta pubcred_{t-3}$	0.038***	0.029***	0.004	0.019***
		(0.00)	(0.00)	(0.39)	(0.00)
Cereal inflation	$\Delta cerp_{t-4}$	0.081			
		(0.19)			
Cereal inflation	$\Delta cerp_{t-8}$				0.027
					(0.18)
Food inflation	Δfp_{t-10}		0.046*		
			(0.09)		
Non-food inflation	Δnfp_{t-2}			0.134**	
				(0.03)	
Non-food inflation	Δnfp_{t-3}			0.152**	
				(0.04)	
Non-food inflation	Δnfp_{t-12}				0.069
					(0.22)
Food inflation	Δfp_{t-6}				0.023
					(0.14)
External factors					
World grain price	$\Delta wgrainp_{t-3}$		0.074**		
			(0.02)		
World grain price	$\Delta wgrainp_{t-4}$	0.091**			
		(0.05)			
World grain price	$\Delta wgrainp_{t-12}$	0.121***			
		(0.00)			
Exchange rate premium	$\Delta prem_{t-8}$	0.007*			
		(0.09)			
Exchange rate premium	$\Delta prem_{t-11}$		0.008**	0.003**	0.005**
			(0.01)	(0.04)	(0.02)
US manufacturing PPI	$\Delta manup_{t-7}$			0.068**	
				(0.03)	
World oil price	$\Delta oilp_{t-11}$			0.012*	0.017**
				(0.09)	(0.03)
World food price	Δwfp_{t-3}				0.064**
					(0.03)
Dummies		Meher cerealjumps cerealdeeps	foodpeaks fooddrops cpi_jul2000 cpi_sep2000		foodpeaks fooddrops cpi_jul2000 cpi_sep2000
Constant		0.001	0.004*	0.000	0.003
		(0.77)	(0.08)	(0.95)	(0.32)
Observations		256	257	259	256
R-squared		0.51	0.85	0.18	0.82
DW		2.05	1.96	2.05	1.98

Robust p-values in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Note: Estimates are corrected for autocorrelation except for non-food CPI equation where no autocorrelation was

detected.
Dummies: Meher = main harvest season = 1 for September-February; foodpeaks = Food price peaks = 1 for 1999:1; 2000:7; 2008:5-9; 2011:3-10; fooddrops = Food price drops: 2000:9-12; 2008:10-12; cerealjumps = Cereal price jumps = 1 for 1999:2, 6-9; 2001:1; 2005:6; 2008:3, 5-7; 2011: 3-6; 2012:3; 2017:7-11; cerealdeeps = Cereal price deeps = 1 for 1997:12; 1998:11,12; 1999:1; 2003:12; 2008:11, 12; cpi_jul2000 = 1 for 2000:7; cpi_sep2000 = 1 for 2000:9.

Further robustness checks

This study tested for the robustness of the regression results and stability of the models in two ways. First, the cereal output gap was replaced with the overall GDP gap. The overall GDP gap was found to be insignificant, while the results for other regressors remained unchanged. The results are presented in Tables B1 and B2 in the Appendix.

Second, the models were estimated over the 2005-2020 period, characterized by a high-growth high-inflation regime and corresponding with the end of the IMF program. The two key differences are that the coefficients on the cereal output gap are positive, and the R-square measures are lower. The lower R-square measures are due to the fact that the sample period is shorter and witnessed less frequent supply shocks, hence less volatile inflation. All the other results remain unchanged. The results are reported in Tables B3 and B4 in the Appendix. Overall, these checks suggest that the models perform very well in explaining the determinants of inflation in Ethiopia.

7. Conclusion and policy implications

While the results are broadly in line with the findings from past studies using a similar approach, this study uncovers new insights that expand the understanding of the determinants of inflation in Ethiopia. The evidence from this study underscores the critical importance of considering structural supply-side factors, especially developments in the food sector in general and cereals in particular to understand the dynamics of inflation in Ethiopia. In the short run, shocks to cereal production—notably due to droughts—generate spikes in cereal and food prices, with spillover effects on overall inflation. In the long run, disequilibria in relative grain prices in Ethiopia vis-à-vis world markets sustain inflation in the country. These results reflect the large share of cereals in household consumption, exposure of cereal production to natural shocks, and dependence on imported grains.

Unlike some previous studies, this paper finds evidence of significant long-run effects of disequilibria in the monetary sector, with a relatively slow adjustment process. The results suggest that monetary factors have both short-run and long-run effects on inflation in Ethiopia. Non-food inflation differs from other indices in that its long-run path is not affected by disequilibria in the monetary sector or any other sectors.

The fiscal sector, which has been missing or inadequately handled in previous studies, has both long-run and short-run impacts on inflation in Ethiopia. In the long run, disequilibria in the fiscal sector are absorbed comparatively slower than adjustments in the monetary sector. Public sector borrowing has strong short-run effects on all inflation measures. This implies that the search for the determinants of inflation in Ethiopia in the existing literature may have been too narrow, so important policy insights may have been missed by not fully accounting for the effects of development in the fiscal sector in the analysis.

As in previous studies, growth in the stock of money appears to have a positive and significant effect on non-food inflation. This study finds that money growth also significantly and positively

affects food inflation. Overall, non-food inflation appears to behave differently from the other measures, with a much smoother pattern over time, explaining the difficulty in uncovering its determinants as illustrated by the smaller number of significant determinants and the low R-square.

The results from this study confirm that the Ethiopian economy is significantly integrated in the global economy. Its prices are strongly influenced by relative prices in the grain and food sector in the long run, and changes in world prices of grains, food, non-food items, and oil are transmitted into domestic prices, some with longer delays compared to the impact of changes in domestic prices. Moreover, the parallel market exchange rate premium has a positive effect on food, non-food, and overall inflation. As the premium incorporates the official exchange rate and the parallel market rate, the results imply that exchange rate policy that keeps the rate out of line with the market rate has an impact on inflation.

A number of policy implications may be drawn from the findings of this study. First, the results suggest that strategies to stabilize inflation in Ethiopia must include interventions to alleviate supply-side constraints. In particular, this entails increasing and stabilizing cereal production to meet the needs of the rapidly growing demand arising from high population growth and urbanization.

Second, containing government borrowing should be part of the general toolkit for controlling inflation. However, the implications of government borrowing for inflation are complex, as they operate through both the demand and supply sides. To the extent that the loans are used to finance public investments that enhance productivity and expand the economy's productive capacity, such as infrastructure, technology, and innovation, the supply-side effects may alleviate demand-side inflationary pressures over time. This calls for effective coordination of monetary and fiscal policies as well as rationalization and efficient management of debt-funded government expenditures, including by strengthening public investment management and project design and screening.

Finally, full implementation of the planned monetary and exchange rate policy reforms would likely bring substantial benefits in terms of controlling inflation. The empirical results suggest that keeping money growth in check is desirable to avoid exacerbating other pressures on inflation from the demand and supply sides. So far, the NBE has been targeting base money growth in relation to the targeted nominal GDP growth (which has been around 20 percent a year) in the development plans. The NBE has committed to shifting toward a modern monetary policy framework, including by developing liquidity management tools and reviving the use of the interest rate as a tool for monetary policy. In addition, the move toward a market-clearing exchange rate, coupled with the progressive phasing out of foreign exchange restrictions as envisaged in the Exchange Rate Reform Roadmap endorsed by the NBE, is expected to gradually eliminate the parallel market premium and mitigate its effects on inflation.

References

Agénor, P. R., and P. J. Montiel. 2015. *Development Macroeconomics*. 4th edition. Princeton, NJ: Princeton University Press.

Ahmad, A. H., and O. B. Aworinde. 2019. Are fiscal deficits inflationary in African countries? A new evidence from an asymmetric cointegration analysis. *The North American Journal of Economics and Finance* 50: 100999.

Alem, Y., and M. Söderbom. 2012. Household-level consumption in urban Ethiopia: The effects of a large food price shock. *World Development* 40 (1): 146–62.

Alemu, M., W. Mulugeta, and Y. Wassie. 2016. Monetary policy and inflation dynamics in Ethiopia: An empirical analysis. *Global Journal of Human-Social Science: Economics*, 16(4).

Calvo, G., and C. Végh. 1999. Inflation stabilization and bop crises in developing countries. In Taylor, J., and M. Woodford (Eds.). *Handbook of Macroeconomics*, Vol. C., pp. 1531–1614. Amsterdam: North-Holland.

Cardoso, E. A. 1981. Food supply and inflation. *Journal of Development Economics* 8 (3): 269–84.

Catão, L. A.V., and M. E. Terrones. 2005. Fiscal deficits and inflation. *Journal of Monetary Economics* 52 (3): 529–54.

Cochrane, J. H. 2001. Long-term debt and optimal policy in the fiscal theory of the price level. *Econometrica* 69 (1): 69–116.

Cukierman, A., S. Edwards, and G. Tabellini. 1992. Seigniorage and political instability. *American Economic Review* 80 (3): 537- 555.

Durevall, D., J. L. Loening, and A. Y. Birru. 2013. Inflation dynamics and food prices in Ethiopia. *Journal of Development Economics* 104 (September): 89–106.

Fischer, S., and W. Easterly. 1990. The economics of the government budget constraint. *The World Bank Research Observer* 5 (2): 127–42.

Fischer, S., R. Sahay, and C. A. Végh. 2002. Modern hyper-and high inflations. *Journal of Economic Literature* 40 (3): 837–80.

Gebreeyesus, M. 2016. Industrial policy and development in Ethiopia. In Newman, C., J. Page, J. Rand, A. Shimeles, M. Söderbom, and F. Tarp (Eds.). Manufacturing Transformation: Comparative Studies of Industrial Development in Africa and Emerging Asia. Oxford: Oxford University Press, pp. 27–49.

Geiger, M., and C. Goh. 2012. *Ethiopia Economic Update: Overcoming Inflation, Raising Competitiveness*. Washington, DC: The World Bank.

Gordon, D. B., and E. M. Leeper. 2006. The price level, the quantity theory of money, and the fiscal theory of the price level. *Scottish Journal of Political Economy* 53 (1): 4–27.

Government of Ethiopia. 2010. *Ethiopia Growth and Transformation Plan I Vol I.* Addis Ababa, Ethiopia: National Planning Commission.

———. 2016. *Ethiopia Growth and Transformation Plan II-GTPII*. Addis Ababa, Ethiopia: National Planning Commission.

IMF. 2020. Federal Democratic Republic of Ethiopia. 2019 Article IV Consultation. International Monetary Fund, *Staff Report* No. 20/29.

Nell, K. S. 2004. The structuralist theory of imported inflation: An application to South Africa. *Applied Economics* 36 (13): 1431–44.

Olivera, J. H. G. 1964. On structural inflation and Latin-American 'structuralism.' *Oxford Economic Papers* 16 (3): 321–32.

Sargent, T. J., and N. Wallace. 1981a. Some unpleasant monetarist arithmetic." Federal Reserve Bank of Minneapolis Quarterly Review 5 (Fall): 1–7.
Seers, D. 1962. A theory of inflation and growth in under-developed economies based on the experience of Latin America. *Oxford Economic Papers* 14 (2): 173–95.
Taylor, L. 1983. *Structuralist Macroeconomics*. New York: Basic Books.
———. 1991. *Income Distribution, Inflation and Growth*. Cambridge, Massachusetts: MIT Press.
Ticci, E. 2011. "Can inflation be a good thing for the poor? Evidence from Ethiopia." *Development in Practice* 21 (4–5): 629–41.
Woldie, G. A., and K. Siddig. 2019. Macroeconomic and distributional impacts of exchange rate devaluation in Ethiopia: A computable general equilibrium approach. *Heliyon 5 (12).*

Appendix

Table A1: List of variables

Variable name	Symbol in the empirical models	Source/computation
All-items CPI	*p*	National Bank of Ethiopia (NBE), base December 2016=100
Cereal CPI	*cerp*	NBE, base December 2016=100
Food CPI	*fp*	NBE, base December 2016=100
Non-food CPI	*nfp*	NBE, base December 2016=100
Money stock (M1)	*m*	NBE
Public sector borrowing	*pubcred*	NBE
Primary deficit	*def*	NBE
World grain price	*wgrainp*	World Bank Commodity Price Data (The Pink Sheet)
World food price	*wfp*	World Bank Commodity Price Data (The Pink Sheet)
U.S. manufacturing PPI (proxy for world non-food price)	*Manup*	U.S. Federal Reserve Bank database)
Oil price	*oilp*	World Bank Commodity Price Data (The Pink Sheet)
Exchange rate Birr/USD	*eus*	NBE
Exchange rate premium	*prem*	Authors' computation

Table A2: Results for Augmented Dickey-Fuller unit root tests

Variable	Variables in levels Test statistic	First differenced Test statistic
y (real GDP)	-0.34	-3.74***
p (all-items CPI)	1.09	-13.40***
fp (food price)	0.42	-13.83***
nfp[a] (non-food price)	3.85	-15.30***
cerp (cereal price)	0.02	-10.65***
eus (Birr/US$)	1.89	-13.43***
eeuro (Birr/Euro)	0.17	-10.96***
premium (parallel market premium)	-2.39	-16.00**
m1 (real M1)	1.13	-17.31***
cergap (cereal output gap)	-5.17***	n.a.
pubcred (public sector credit)	-0.90	-11.15***
wgrainp (world grain price)	-1.39	-11.90***
wfp (world food price)	-1.28	-10.76***
manup (U.S. manufacturing PPI)	-1.17	-11.52***
oilp (world oil price)	-2.14	-13.01***

Critical values: -3.58 (1%), -2.78 (5%), -2.57 (10%).

Notes:

[a] Non-food CPI (*nfp*): The Phillips-Perron t-test statistics is 3.08 in level and -16.05 in first difference.

[b] M2: The Phillips-Perron t-test statistics is 3.53, in level and -15.42 in first difference.

Table A3: Results of cointegration analysis

A3.a: Monetary sector

Money stock: M1	Maximum rank		
Null hypothesis for rank test	$r = 0$	$r \leq 1$	$r \leq 2$
Eigenvalue		0.09	0.03
Trace statistic [critical value at 5%]	35.15 [29.68]	9.75** [15.41]	0.14 [3.76]
Standardized Eigenvector: $(m_1 - p) - 1.04y + 0.29prem + 6.46$ [standard errors] [0.12] [0.06 Dickey-Fuller test: -4.65 (critical value: -2.88 at 5%)			

Note: The VAR model includes 2 lags for each variable. The results indicate one cointegrating vector.

A3.b: External sector: Cereal price and world grain price

	Maximum rank		
Null hypothesis for rank test	$r = 0$	$r \leq 1$	$r \leq 2$
Eigenvalue		0.05	0.00
Max statistic [critical value at 5%]	15.03 [14.07]	0.01** [3.76]	
Standardized Eigenvector: $pcereal - 1.28(eus + wgrp) + 5.397$ [standard errors] [0.09] Normalized on world grain price: $(eus + wgrp) - 0.78pcereal - 4.22$ Dickey-Fuller test: -3.27 (critical value: 2.88 at 5%)			

Note: 2 lags included in the VAR model. The results indicate one cointegrating vector.
World grain price is used as measure of world cereal prices.
Max statistic reported instead of trace statistic; the latter suggests no cointegrating vector.

A3.c: External sector: non-food price and world non-food price

	Maximum rank		
Null hypothesis for rank test	$r = 0$	$r \leq 1$	$r \leq 2$
Eigenvalue		0.14	0.01
Trace statistic [critical value at 5%]	44.28 [15.41]	2.84** [3.76]	
Standardized Eigenvector: $nfp - 1.29(eus + wmanp)$+5.21 [standard errors] [0.03] Normalized on world grain price: $(eus + wmanp) - 0.77nfp + 4.02$ Dickey-Fuller test: -3.06 (critical value: 2.88 at 5%)			

Note: 2 lags are included in the VAR model. The results indicate one cointegrating vector.
World non-food price is proxied by the U.S. manufacturing producer price index.

A3.d: Fiscal sector

	Maximum rank		
Null hypothesis for rank test	$r = 0$	$r \leq 1$	$r \leq 2$
Eigenvalue		0.17	0.03
Trace statistic [critical value at 5%]	58.63 [29.68]	9.67** [15.41]	
Standardized Eigenvector: $(m_1 - p) - 1.02\ def - 0.36\ pubcred + 1.65$ [standard errors] [0.14] [0.05] Dickey-Fuller test: -9.31 (critical value: 2.88 at 5%)			

Note: 4 lags are included in the VAR model. The results indicate one cointegrating vector.

Table B: Robustness test results

Table B1: Baseline inflation models over 1998-2020 – including the GDP output gap

Variables	Cereals	Food	Non-food	CPI
EC-monetary sector (t-1)	0.024*	0.018**	0.002	0.014**
	(0.08)	(0.02)	(0.51)	(0.01)
EC-cereals (grains) (t-1)	0.028*	0.026**		0.020**
	(0.08)	(0.02)		(0.03)
EC-non-food (t-1)			0.041***	0.025
			(0.00)	(0.25)
GDP output gap (t-1)	-0.033	-0.025		-0.041
	(0.71)	(0.66)		(0.31)
Money growth (t-4)	0.004			
	(0.93)			
Money growth (t-3)		0.131***		
		(0.00)		
Money growth (t-12)			0.048***	0.018
			(0.00)	(0.39)
Cereal inflation (t-9)	0.071*			
	(0.08)			
Cereal inflation (t-8)				0.038*
				(0.06)
Food inflation t-3)		0.106***		
		(0.00)		
Food inflation (t-6)				0.043**
				(0.01)
Non-food inflation (t-12)			0.162***	
			(0.01)	
Non-food inflation (t-3)				0.077
				(0.28)
World grain price (t-4)	0.085**			
	(0.05)			
World grain price (t-3)		0.072**		0.046*
		(0.02)		(0.06)
Exchange rate premium (t-11)	0.005	0.007**	0.004**	0.006**
	(0.23)	(0.02)	(0.03)	(0.01)
Dummies	Meher	Meher		Meher
	cerealpeaks	foodpeaks		foodpeaks
	cerealdeeps	fooddrops		cpi_jul2000
	cerealjumps	cpi_jul2000		cpi_sep2000
		cpi_sep2000		
Constant	0.010**	0.012***	0.001	0.006
	(0.01)	(0.00)	(0.64)	(0.11)
Observations	259	259	259	259
R-squared	0.548	0.859	0.149	0.809
DW				

Robust p-values in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table B2: Inflation models including the fiscal sector, 1998-2020, including GDP output gap

Variables	Cereals	Food	Non-food	CPI
EC: Fiscal sector	-0.006*	-0.002	0.001	-0.002*
	(0.02)	(0.12)	(0.18)	(0.06)
EC: Cereals (grains)	0.056**	0.023*		0.016*
	(0.00)	(0.05)		(0.07)
EC: Non-food			0.033***	0.004
			(0.00)	(0.85)
GDP output gap (t-1)	-0.085	-0.031		-0.008
	(0.47)	(0.62)		(0.83)
Public sector credit (t-2)	0.024*	0.021**	0.009	0.014**
	(0.07)	(0.02)	(0.13)	(0.02)
Public sector credit (t-3)	0.036**	0.028***		0.019**
	(0.00)	(0.00)		(0.00)
Cereal inflation (t-4)	0.096			
	(0.12)			
Food inflation (t-10)		0.049		
		(0.10)		
Non-food inflation (t-2)			0.132**	
			(0.03)	
Non-food inflation (t-3)			0.159**	
			(0.02)	
Cereal inflation (t-8)				0.031
				(0.12)
Food inflation (t-6)				0.025
				(0.12)
Non-food inflation (t-12)				0.068
				(0.24)
World grain price (t-4)	0.085*			
	(0.07)			
World grain price (t-12)	0.124**			
	(0.00)			
World grain price (t-3)		0.069**		
		(0.03)		
Exchange rate premium (t-8)	0.007*			
	(0.07)			
Exchange rate premium (t-11)		0.008**	0.004***	0.005**
		(0.02)	(0.01)	(0.02)
US manufacturing PPI (t-7)			0.067**	
			(0.03)	
Oil price (t-11)			0.012*	0.017**
			(0.09)	(0.03)
World food price (t-3)				0.064**
				(0.03)
Dummies	Meher Cerealjumps Cerealdeeps	Foodpeaks Fooddrops cpi_jul2000 cpi_sep2000		Foodpeaks Fooddrops cpi_jul2000 cpi_sep2000
Constant	0.000	0.004	0.000	0.003
	(0.95)	(0.11)	(0.98)	(0.34)
Observations	256	257	256	256
R-squared	0.498	0.850	0.197	0.816
DW	1.96	1.98	2.07	1.98

Robust p-values in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table B3: Empirical results from baseline models of inflation, January 2005 – September 2020

Variables	Cereals	Food	Non-food	CPI
EC-monetary sector (t-1)	0.030***	0.020***	0.002	0.011***
	(0.01)	(0.00)	(0.41)	(0.00)
EC-cereals (grains) (t-1)	0.032	0.026**		0.019**
	(0.17)	(0.05)		(0.05)
EC-non-food (t-1)			0.046**	-0.017
			(0.01)	(0.56)
Cereal output gap (t-1)	0.240*	0.241***		0.136***
	(0.06)	(0.00)		(0.01)
Money growth (t-3)	-0.007	0.115**	0.030	0.091***
	(0.91)	(0.02)	(0.25)	(0.00)
Cereal inflation (t-4)	0.043			-0.003
	(0.45)			(0.91)
Food inflation (t-3)		0.077		0.047
		(0.35)		(0.36)
Non-food inflation (t-3)			0.130	0.128
			(0.14)	(0.10)
World grain price (t-3)	0.076*	0.078**		0.054**
	(0.06)	(0.01)		(0.01)
Exchange rate premium (t-11)	0.005	0.011*	0.007***	0.006*
	(0.48)	(0.05)	(0.01)	(0.05)
U.S. manufacturing PPI (t-7)			0.066*	
			(0.05)	
Dummies	Meher Cerealpeaks Cerealdeeps Cerealjumps	Meher Foodpeaks Fooddrops		Meher Cerealdeeps Cerealjumps Foodpeaks
Constant	0.056***	0.042***	0.010**	0.024***
	(0.00)	(0.00)	(0.01)	(0.00)
Observations	178	178	179	178
R-squared	0.57	0.47	0.14	0.56
DW	2.04	1.94	2.05	1.99

Robust P-values in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Note: Estimates are corrected for autocorrelation except for non-food cpi equation where no autocorrelation was detected.

Dummies: Meher = main harvest season = 1 for September-February; foodpeaks = Food price peaks = 1 for 1999:1; 2000:7; 2008:5-9; 2011:3-10; fooddrops = Food price drops: 2000:9-12; 2008:10-12; cerealjumps = Cereal price jumps = 1 for 1999:2, 6-9; 2001:1; 2005:6; 2008:3, 5-7; 2011: 3-6; 2012:3; 2017:7-11; cerealdeeps = Cereal price deeps = 1 for 1997:12; 1998:11,12; 1999:1; 2003:12; 2008:11, 12.

Table B4: Empirical results of inflation models including the fiscal sector, January 2005 – June 2020

Variables	Cereals	Food	Non-food	CPI
EC: Fiscal sector (t-1)	-0.002***	-0.002***	-0.000	-0.001***
	(0.00)	(0.00)	(0.65)	(0.00)
EC: cereals (grains) (t-1)	0.032*	0.015		0.018*
	(0.09)	(0.16)		(0.08)
EC: non-food (t-1)			0.044***	-0.033
			(0.01)	(0.37)
Cereal output gap (t-1)	0.028	0.106*		0.056
	(0.84)	(0.09)		(0.20)
Public sector credit (t-2)	0.025*	0.020*	0.001	0.010
	(0.09)	(0.07)	(0.89)	(0.19)
Public sector credit (t-3)	0.027**	0.028**	0.011*	0.020***
	(0.04)	(0.02)	(0.06)	(0.01)
Cereal inflation (t-4)	0.046			0.016
	(0.46)			(0.70)
Food inflation (t-5)		0.047		0.015
		(0.60)		(0.82)
Non-food inflation (t-3)			0.095	0.118
			(0.28)	(0.23)
World grain price (t-3)	0.095**	0.085**		0.060**
	(0.03)	(0.01)		(0.02)
World grain price (t-12)	0.089**	-0.029		-0.024
	(0.02)	(0.30)		(0.22)
Exchange rate premium (t-8)	0.010			
	(0.12)			
Exchange rate premium (t-11)		0.009*	0.007***	0.009**
		(0.09)	(0.01)	(0.03)
Oil price (t-11)	0.000	0.032**	0.017*	0.029***
	(0.98)	(0.01)	(0.06)	(0.00)
U.S. manufacturing PPI (t-7)			0.063*	
			(0.06)	
Dummies	cerealjumps cerealdeeps	foodpeaks fooddrops		foodpeaks fooddrops
Constant	-0.005	0.004*	0.007***	0.005***
	(0.36)	(0.09)	(0.00)	(0.00)
Observations	174	174	176	174
R-squared	0.541	0.446	0.152	0.446
DW	2.07	1.94	2.05	1.97

Robust P-values in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Note: Estimates are corrected for autocorrelation except for non-food cpi equation where no autocorrelation was detected.

Dummies: foodpeaks = Food price peaks = 1 for 1999:1; 2000:7; 2008:5-9; 2011:3-10; fooddrops = Food price drops: 2000:9-12; 2008:10-12; cerealjumps = Cereal price jumps = 1 for 1999:2, 6-9; 2001:1; 2005:6; 2008:3, 5-7; 2011: 3-6; 2012:3; 2017:7-11; cerealdeeps = Cereal price deeps = 1 for 1997:12; 1998:11,12; 1999:1; 2003:12; 2008:11, 12.