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Inflation Dynamics and Food Prices in an Agricultural Economy

The Case of Ethiopia

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Abstract

Ethiopia has experienced a historically unprecedented increase in inflation, mainly driven by cereal price inflation, which is among the highest in Sub-Saharan Africa. Using monthly data from the past decade, the authors estimate error correction models to identify the relative importance of several factors contributing to overall inflation and its three major components, cereal prices, food prices, and non-food prices. The main finding is that, in a longer perspective, over three to four years, the main factors that determine domestic food and non-food prices are the exchange rate and international food and goods prices. In the short run, agricultural supply shocks and inflation inertia strongly affect domestic inflation, causing large deviations from long-run price trends. Money supply growth does affect food price inflation in the short run, although the money stock itself does not seem to drive inflation. The results suggest the need for a multi-pronged approach to fight inflation. Forecast scenarios suggest monetary and exchange rate policies need to take into account cereal production, which is among the key determinants of inflation, assuming a decline in global commodity prices. Implementation of successful policies will be contingent on the availability of foreign exchange and the performance of agriculture.

This paper—a product of the Agricultural and Rural Development Unit, Africa Region—is part of a larger effort to understand the sources and implications of commodity price shocks in Sub-Saharan Africa. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at dick.durevall@economics.gu.se, jloening@worldbank.org, or y.a.birru@sussex.ac.uk.

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Produced by the Research Support Team

Inflation Dynamics and Food Prices in an Agricultural Economy: The Case of Ethiopia[a]

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1. Introduction

During 2004-2008, many commodity prices rose to record levels.[2] As a result, many low-income countries are still experiencing high inflation, large trade deficits, and an unstable macroeconomic environment. High commodity prices, particularly for food, also have adverse effects on poverty, above all in countries with large fractions of net food-buyers and urban population groups. Even though food and fuel prices have fallen substantially since August 2008, they continue to be high by historical standards.

Several studies have attempted to address the underlying causes of the global price rise.[3] Although there is dispute about their relative importance, the major causes are identified as: rapidly rising demand in emerging economies, poor harvests in some major commodity producing countries, increases in the costs of production due to higher fuel and fertilizer prices, higher transportation costs; and diversion of food crops to production of biofuels, and the introduction of policies to restrict food exports by some countries. Mitchell (2008) argues that one of the most important factors is the large increase in biofuels production in the United States and the European Union. Others claim that the most important factor is expansionary monetary policy in key industrial countries, which led to low interest rates and a sharp fall in the value of the US dollar (Frankel, 2006; Krichene, 2008).

We know less about how world prices are affecting domestic food prices in individual developing countries, particularly in Sub-Saharan Africa. This paper attempts to improve the understanding of the factors causing food price inflation in Ethiopia by explicitly modeling cereal, food and non-food price inflation, as well as the Consumer Price Index (CPI). Most previous studies on inflation in Africa focus only on the CPI, using traditional models based on the quantity theory or the Philips curve, yet the dynamics, its components and specific sources of inflation can differ considerably. Very few studies, if any, include international commodity markets in their analyses.

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[2] The price increases vary across commodities and data sources. The annual Commodity Food Price Index of the World Bank's Development Prospect Group rose by 13.2 percent in 2004, declined somewhat in 2005, and then rose by 10.0, 25.6 and 34.2 percent the following three years. In the middle of 2008, the indexed started to decline and by March 2009, it was at the same level as in mid 2007, which is almost twice as high as the average value 1999-2003.

[3] Some examples are von Braun (2007), ADB (2008), FAO and OECD (2008), Hebling et al. (2008), IMF (2008d) and Trostle (2008).

We use general-to-specific modeling and estimate error correction models (ECMs) where deviations from the long-run equilibrium in the money market, the external sector, and agricultural markets, as well as various short-term factors, are allowed to impact on inflation and its various components. In this framework, extending the work of Durevall and Ndung'u (2001) and Diouf (2007), inflation is allowed to be generated through changes in supply and demand in these three key sectors. In the long run, the money market, the external sector, or both should determine the price level. Agricultural markets can affect inflation both through the transmission of international food commodity prices and through changes in domestic food supply and demand. This approach may be viewed as a general (hybrid) model that embeds other models of inflation. Moreover, within this framework, we can conveniently test various hypotheses, and account for the specific circumstances of developing economies with a large agricultural sector.

In the light of global commodity price inflation, Ethiopia, Africa's second most populous country after Nigeria, is at the same time a most interesting and worrisome case. Some countries in Africa have managed to maintain relatively stable prices, while others have seen prices rising rapidly. One of the most affected countries is Ethiopia, which, with the exception of Zimbabwe and small island economies, has had the strongest acceleration in food price inflation during recent years (IMF, 2008a). Average food prices rose by more than 34 percent in 2007/08, but annual inflation reached a historical record growth of 91.7 percent in July 2008. Since August 2008, prices have continuously started to decline, though food inflation continues to be of significant concern, running at 46.7 percent in December 2008 and 26.5 percent in March 2009.

There is no consensus on why Ethiopia is experiencing such rapid prices rises. Inflation growth has recently coincided with high economic growth rates, whereas in the past inflation was traditionally associated with large agricultural supply shocks due to drought. World food price increases are traditionally believed to have rather small effects in Ethiopia because of the limited size of food imports, which amount to about 5 percent of agricultural GDP. Prices for major staple crops have been above import parity since early 2008, and though there has been an incentive to import ordinary cereals, estimates suggest that little informal or formal trade actually took place

(IFPRI, 2008).[4] Instead, the chief explanations have focused on high domestic demand, expansionary monetary policy, a shift from food aid to cash transfers, and structural factors due to reforms and investments in infrastructure (Ahmed, 2007; Dorosh and Subran, 2007; World Bank, 2007; IMF, 2008a; IMF, 2008b).

At the same time, there has been an absence of rigorous work to identify empirically the relative importance of each factor – external, domestic or structural – contributing to inflation. It is thus of vital importance to improve the understanding of the causes of inflation in Ethiopia to allow adequate policies to be put in place. The purpose of this paper is to fill this gap and thoroughly analyze the determinants of inflation in Ethiopia using monthly data for the current decade, with a focus on food prices. The use of high-frequency data allows us to measure trends in global commodity price inflation and other recent factors, and assess their respective role on domestic price developments during a relatively short period.

Our results show that inflation in Ethiopia is associated with the dominant role of agriculture and food in the economy. It is the external sector that largely determines inflation in the long run (about three to four years). Specifically, domestic food prices adjust to changes in world food prices, measured in Birr. There is also evidence that non-food prices adjust to changes in world producer prices. There are large deviations from long-run equilibrium prices, mainly due to the importance of the domestic market for agricultural products and inflation inertia. Domestic food supply shocks along with inertial factors have a strong effect on inflation in the short run (over a year or two). This finding, however, does not imply that domestic and world food prices are always close to each other. It only suggests that there are forces making sure they do not drift too far apart, which is consistent with observed price fluctuations of domestic prices between import and export parity bands. The evolution of the money stock does not seem to affect prices directly, though money supply growth significantly affects cereal price inflation in the short-run.

Before presenting our results, three caveats need to be mentioned. Even though our empirical results appear robust, they are silent on how world food prices are transmitted to domestic prices – especially surprising in the case of Ethiopia, as it does not trade much on agriculture commodities. The results are also silent on the causes of

[4] Through a survey in border towns, preliminary evidence from IFPRI (2008) shows insignificant informal trade flows. At the same time, Ulimwengu, Workneh and Paulos (2009) find significant short-term price effects between the world maize market and Ethiopian regional markets bordering Sudan.

the inertia. Moreover, our model does not take into account the widespread shortage of foreign exchange in Ethiopia, and thus one of the key transmission channels between global and domestic prices is non-existent in the current context. It is thus unclear whether the government or private sector can import food grains in large quantities even if the differences in cereal prices between domestic and foreign markets are considerable. Finally, it is important to point out that inflationary expectations, which explain a large part of Ethiopia's recent inflation, are not randomly generated. Expectations are based on fundamentals of the economy and market conditions and policymakers can influence expectations with appropriate policies. These caveats should be kept in mind when interpreting our results.

The reminder of the paper is organized as follows: Section 2 gives a short description of Ethiopia's recent macroeconomic performance and then outlines the popular hypothesis of Ethiopia's inflation trajectory. Section 3 provides the theoretical framework and the formulation of empirical models, and discusses how various hypotheses are tested. Section 4 describes and analyzes the money market, foreign sector, and agricultural market, with the purpose of formulating explanatory variables for the inflation model. Section 5 develops the final error correction models, while Section 6 illustrates how various scenarios might affect future inflation in Ethiopia. Section 7 discusses major findings and concludes.

2. Inflation in Ethiopia: Background and Hypotheses

This section first gives a brief description of the Ethiopian economy and its inflation experience. It then outlines some of the hypotheses put forward to explain the historically unprecedented inflation process.

2.1 Economic Performance and Inflation

Ethiopia is one of Africa's largest countries with an estimated 77 million people in 2008. According to government data, about 38 percent of the population lived below the official poverty line in 2005, but it is likely that a larger proportion experiences extended periods of poverty due to shocks (Bigsten and Shimeles, 2008). Evidence on the welfare impacts of high food inflation on the rural population is somewhat inconclusive, but there is evidence of a significant negative impact on the urban population (Loening and Oseni, 2008).

Ethiopia's economy has grown very rapidly during the last four years: according to official data, GDP growth averaged 11.6 percent between 2003/04 and 2007/08. Agriculture, which accounts for about 47 percent of GDP and nearly 85 percent of employment, has grown by 13 percent per year on average since 2003/04, followed closely by the service and industry sectors.

Historically, Ethiopia has not suffered from high inflation. Annual average inflation was only 5.2 percent 1980/81-2003/04, and major inflationary episodes have occurred only during conflict and drought. Annual average inflation reached a record of 18.2 percent during the 1984/85 drought, 21.1 percent in 1991/92 at the peak of war with Eritrea, and again 15.5 percent during the 2003 drought.

Figure 1: Annual CPI inflation and its major components, 1999:1-2009:3

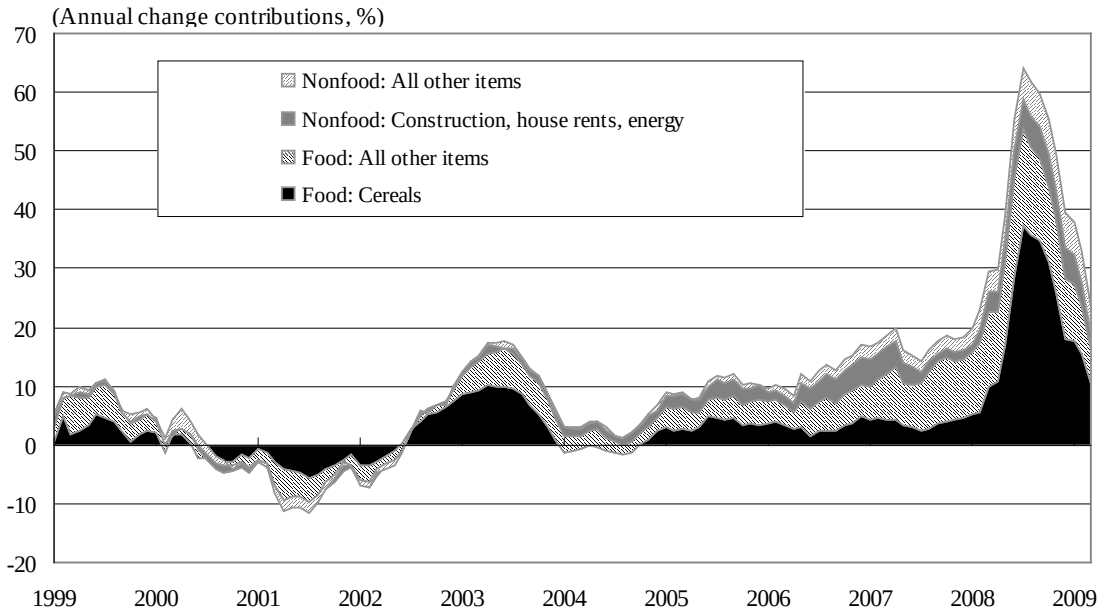
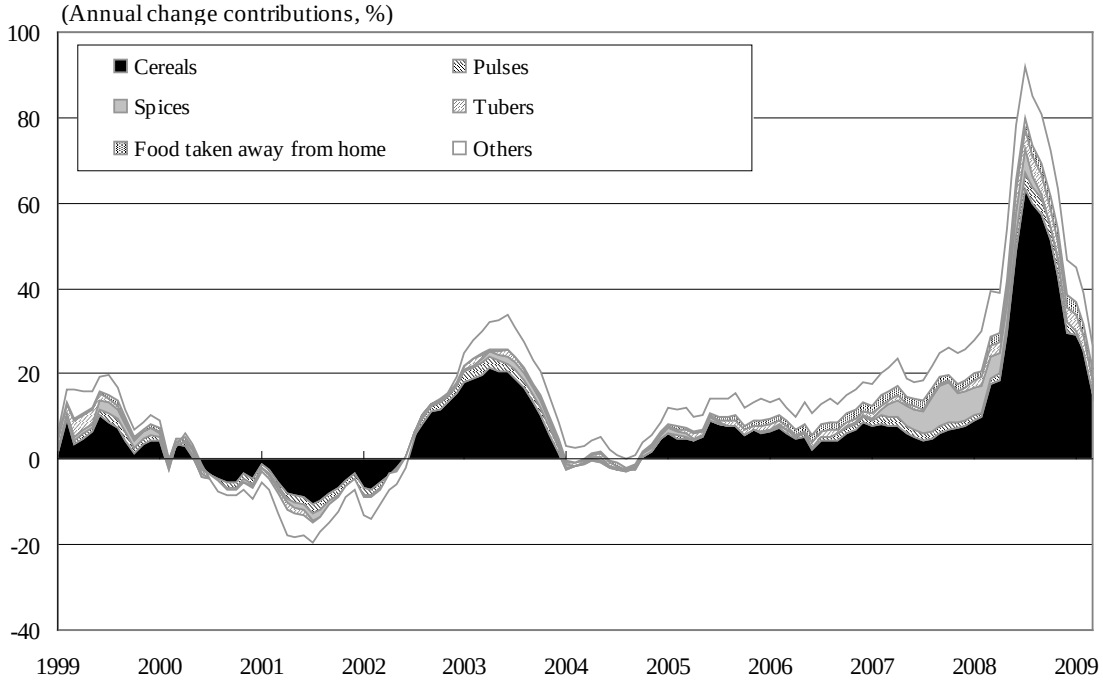


Figure 2: Annual food inflation and its major components, 1999:1-2009:3



As food accounts for 57 percent of total household consumption expenditure, adequate rainfall and good crop harvest are associated with low food and CPI inflation. This link seems to have been absent 2004/05-2007/08, since food inflation continued to accelerate despite good weather and an agricultural production boom. Annual food inflation, measured in simple growth rates, rose from 18.2 percent in June 2007 to a peak of 91.7 percent in July 2008. At the same time overall inflation rose from 15.1

percent in June 2007, to 55.3 in June 2008.[5] In March 2009, overall inflation declined to 23.7 percent. Figures 1 and 2 depict the major trends in inflation during the current decade.

Figure 1 shows the annual growth rate of CPI and its major components: food, cereals, house rents, construction, materials, energy and other non-food prices. Table A1 in the appendix gives a list of the CPI weights. The importance of fluctuations in food prices for the overall CPI is clearly visible. There is a rapid increase in inflation induced by the 2003 drought, another increase around 2005, and an almost exponential price outburst in 2008. There was also a hike in non-food inflation 2005-2007, which may be associated with the housing and construction boom in urban areas. The deflation in 2001-2002 was due to good harvests and significant amounts of food aid inflows. Overall, it is evident that food and non-food inflation behave very differently, indicating that they should be analyzed separately.

Figure 2 depicts food price inflation divided into its various components. Despite a short hike of spice inflation in 2007, it is obvious that cereal price inflation accounts for most of the fluctuations in food prices. It is also the most important component of the food-price index; its weight in the CPI is close to 23 percent. The two figures thus give an early indication of the key role played by food prices in general, and by cereal prices in particular, in Ethiopia's overall inflation dynamics.

2.2 Approximate Causes of Inflation

Ethiopia's inflation trajectory has received relatively little empirical attention. Nevertheless, a few studies have emerged in the light of Ethiopia's food price crisis, drawing mainly on logical deductions and descriptive analysis. We subsequently review the most important ones. Most of these studies take a general approach, identifying and discussing various possible factors contributing to inflation.

The Ethiopian Development Research Institute (EDRI), a government think tank, has put forward several hypotheses, summarized by Ahmed (2007). Increases in aggregated demand should a priori put pressure on demand for food, resulting in

[5] We report annual month-to-month inflation figures to trace recent developments. To account for the extreme short-run fluctuations in prices, inflation figures in Ethiopia are sometimes presented as 12-month moving average. If measured as 12-month moving average, from August 2007 to July 2008, average annual food prices rose by 40.3 percent.

acceleration of food inflation. Yet, the puzzle is that agriculture has been leading the fast growth in the economy, so crop production has seen substantial growth during the period. This seems to undermine the potential role of aggregate demand in explaining Ethiopia's recent food inflation. Changes in the structure of the economy, following a sustained rapid growth in agriculture, are viewed as a potentially better explanation for the price increases. These include behavioral changes leading to increased commercialization of crop production and reduced distress selling by peasants, which might have significant implications for aggregate demand and prices. Ahmed (2007) also lists various other domestic and external factors matter, including money supply and world commodity prices. In addition, housing shortages in urban areas and speculation have affected inflation, where a lack of regulation might have played a role in the surge in housing prices, particularly in Addis Ababa.

A macro-econometric model from the National Bank of Ethiopia (NBE), the country's central bank, supports some of these findings; Ayalew Birru (2007) developed the model using annual data from 1970 to 2006. The chief claim is that supply shocks, inertia, and the consumer prices of major trading partners appear to be among the most important determinants of inflation. Nevertheless, the use of annual data and the need to correct for major developments in Ethiopia's turbulent history limit the model's applicability. In addition, it does not cover the period of rapid inflation 2007-2008.

In an unpublished policy note, the World Bank (2007) analyzes relative price shifts for major cereals at an early stage of the food crisis. It investigates several hypotheses, drawing on a number of background papers. Gray (2007) claims that the official data from the Central Statistical Agency (CSA) is relatively better than alternative estimates, though there is need for improvements of non-sampling errors. Dorosh and Subran (2007), using these official data and partial equilibrium simulations, then find that relative price changes for major cereals are broadly consistent with changes in domestic demand and supply during 2003-2007. Loening (2007) suggests expectations can explain a large fraction of inflation dynamics in Ethiopia for 2000-2006. The World Bank (2007) also suggests that activities of cooperatives may be improving the bargaining power of farmers, thus raising food prices. However, the shift from food aid to cash transfers seems to have had very

negligible effects on market prices.[6] The analysis draws attention to fundamental long-term challenges, such as policy-induced barriers to private trade, the need for significant yield improvements for cereals, and the importance of a sound macroeconomic policy.

Similarly, the International Monetary Fund (IMF, 2008a) suggests that multiple factors account for the recent increase in inflation. Inflation is being led by rapidly rising food prices. Since inflation is higher in Ethiopia than in neighboring countries, domestic factors, including demand pressures and expectations should be important. Some supply-side factors may also explain part of the rise in food prices, such as reduced distress selling by farmers equipped with better access to credit, storage facilities, marketing information systems, and the switch from food to cash aid. The report recommends addressing macroeconomic imbalances, and forcefully tightening monetary and fiscal policies. Rising global commodity prices may be important, but the transmission mechanism is not clear because the amount of non-aid food imports is relatively small. The IMF (2008b) notes that there might be a process of convergence to world prices driven by high food prices in neighboring countries.

On a different note, Osborne (2004) analyzes the role of news in the Ethiopian grain market. Although the focus is on generalizing the neoclassical storage model, it throws light on the micro-determinants of the inflation process since the weight of cereals in CPI is 23 percent. Osborne reports that there have been several occasions of sharp rises or falls in seasonal prices. For instance, in 1983/84, 1990/91 and 1993/94 maize prices rose by over 100 percent during periods of six months. She attributes these to the role of news of future harvests and forward-looking expectations. Hence, it is possible that the almost doubling of grain prices that took place between February and September 2008 is a similar phenomenon (particularly since there are indications of a lower agricultural production level than official estimates, as suggested by IFPRI, 2008).

In sum, the major hypothesis can broadly be categorized into three groups: domestic, structural, and external factors. However, there is little evidence of the relative importance of their possible contribution to inflation in Ethiopia.

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[6] The Productive Safety Net Program (PSNP) was launched in 2005 and is providing labor-intensive public works and direct financial support to about 7.4 million beneficiaries. The size of the program in relation to GDP is small and food subsidies were provided with an estimated cost of 0.1 percent of GDP in 2007/08.

3. Modeling Inflation in an Agricultural Economy

In this section, we present an empirical inflation model that embeds different models of inflation. Within this framework, we can test various hypotheses rather than imposing restrictions on the models and account for the specific circumstances of developing economies with a large agricultural sector. The Phillips curve and the quantity theory are the two traditional approaches used to modeling inflation, which we first review briefly.

The Phillips curve stipulates that high aggregate demand generates employment, which first leads to wage increases and later to rising prices. Although sometimes applied to Sub-Saharan Africa, as in Barnichon and Peiris (2007), it may not be an adequate approach. Extensive self- and underemployment, large informal markets, and a low degree of labor-market organization all make the link between aggregate demand, unemployment and wage increases very weak or even non-existent. Moreover, there is usually a strong negative correlation between business cycles and inflation, since positive agricultural supply shocks increase GDP growth and lower inflation, and vice versa.

The quantity theory focuses on the role of money supply and demand, assuming that inflation is due to excess money supply. It has been used in numerous studies of inflation in developing countries, nowadays often with foreign prices added to account for imports or internationally traded goods. Two examples are Blavy (2004) on Guinea, and Moriyama (2008) on Sudan. Studies in this tradition usually neglect agricultural markets and food supply, even though food makes up more than half of the consumer basket in many developing countries. In countries where food has a large weight in CPI, such as Ethiopia, food supply is bound to impact strongly on domestic inflation. This seems to be the case in Kenya (Durevall and Ndung'u, 2001), Pakistan (Khan and Schimmelpfennig, 2006) and Mali (Diouf, 2007).

In this paper, we take the view that inflation originates either from price adjustments in markets with excess demand or supply or from price adjustments due to import costs. The focus is on markets in three main sectors: the monetary sector; the external sector, including the markets for tradable food and non-food products; and the domestic market for agricultural goods. Specifically, we postulate that changes in the domestic price level are affected by deviations from the long-run equilibrium in the

money market and the external sector, represented by food and non-food products, giving three long-run relationships,

$$m - p = \gamma_0 + \gamma_1 y + \gamma_2 R \quad (1)$$

$$pnf = e + wp - \tau_1 \quad (2)$$

$$pf = e + wfp - \tau_2 \quad (3)$$

where *m* is the log of the money stock, *p* is the log of the domestic price level, composed of *pnf* and *pf*, the log of domestic non-food and food prices, *y* is the log of real output, *R* is a vector of rates of returns on various assets and other sources of money demand, *e* is the log of the exchange rate, *wp* and *wfp* are the log of foreign non-food and food prices, and τ_1 and τ_2 are potential trends in the relative prices.

Equilibrium in the monetary sector is spelled out in (1). Demand for real money is assumed to be increasing in *y*, where $\gamma_1 = 1$ for the quantity theory. In economies with liberalized and competitive financial markets, the relevant rates of returns are usually the interest rate paid on deposits and Treasury bills discount rates. However, in Ethiopia interest rates are unlikely to influence money demand due to heavy market distortions (Ayalew Birru, 2007). Earlier studies have also mentioned inflation, returns to holdings of foreign currency and certain goods, such as coffee, international trade, and food shortages, as potential sources of demand (Sterken, 2004; Ayalew Birru, 2007; IMF, 2008b). We test these factors later in the paper.

Equations (2) and (3) can be viewed as the long-run equilibrium in the external markets for non-food and food products. For Ethiopia, they are probably best described as relationships between prices of domestic goods and imported intermediate goods. This is because strictly speaking all imports, except capital goods, can be treated as intermediate products, since value is added in the domestic market to final products by wholesalers and retailers.

As Figure 1 shows, there is a substantial difference in the behavior of the two prices of the goods, explaining the use of price-specific formulations of the external sector. In the empirical analysis, domestic non-food prices and international producer prices are used when modeling non-food prices, and domestic and international food prices are used when modeling food prices. The trend terms in (2) and (3) are included because there might be trends in relative prices. We denote $pnf = e + wp$ and

$pf = e + wfp$ as either, the real exchange rate for non-food and food or the relative price of non-food or food.

The domestic market for agricultural goods affects food inflation in the short to medium run through supply shocks. To model the agricultural market we estimate a measure of the agricultural output gap (*ag*). The output gap is obtained by calculating the stochastic trend in agricultural production with the Hodrick-Prescott filter, and then removing the trend. There are other methods to estimate the gap, but the swings in agricultural production are so large that the choice probably does not matter much.

In the short run, several other factors might affect inflation as well. Hence, we also consider money growth, exchange rate changes, imported inflation, oil-price inflation and world fertilizer-price inflation, but shocks in the domestic agricultural market are likely to be the most important.

Ideally, we would analyze all the variables in a single system. However, because of the small sample, 119 monthly observations (January 1999 to November 2008), we adopt an alternative strategy. We first estimate the equations above separately to establish whether there is cointegration. Then, to examine the relative importance of these relationships in determining prices, we develop single-equation ECMs for each of the four price series. The specifications vary but a representative ECM is of the form:

$$\begin{aligned}\Delta p_t = &\sum_{i-1}^{k-1}\pi_{1i}\Delta p_{t-i} + \sum_{i=0}^{k-1}\pi_{2i}\Delta m_{t-i} + \sum_{i=0}^{k-1}\pi_{3i}\Delta R_{t-i} + \sum_{i=0}^{k-1}\pi_{4i}\Delta e_{t-i} + \sum_{i=0}^{k-1}\pi_{5i}\Delta wfp_{t-i} \\ &+ \sum_{i=0}^{k-1}\pi_{6i}\Delta wp_{t-i} + \pi_7 ag_{t-1} + \alpha_1(m - p - \gamma_1 y - \gamma_2 R)_{t-1} \\ &+ \alpha_2(e + wp - pnf - \tau_1)_{t-1} + \alpha_3\left(e + wfp - pf - \tau_2\right)_{t-1} + \pi_7 D_t + \nu_t,\end{aligned} \tag{4}$$

where all variables are in logs, Δ is the first difference operator, ν_t is a white noise process, D_t is a vector of deterministic variables such as constant, seasonal dummies, and impulse dummies. To anticipate some of the findings: only one lag of agricultural output gap, *ag*, enters the model because the series is highly persistent, and output only enters in log-levels since monthly observations for the short run are not available.[7]

[7] We interpolate annual GDP and cereal production to obtain the monthly observations for *y* and *ag*. The data measures nicely the long-run trend in GDP, which is of primary interest for the analysis of the monetary sector, and deviation from trend, used to measure the agricultural output gap. However, the interpolation does not capture the monthly rates of change, so we do not include the monthly growth rates in our regressions.

The long-run part of (4) consists of the three error correction terms, which allow for discrepancies between the log-level of the price and its determinants to impact on inflation the following period. Their coefficients, α_1, α_2 and α_3, show the amount of disequilibrium (or strength of adjustment) transmitted in each period into the rate of inflation. The inclusion of variables in first differences and the agricultural output gap variable accounts for the short-run part of the model. Since (3) can be solved to get p_t on the left-hand side, it determines both the log-level of the price, as well as the rate of inflation.

It is possible to view (4) as a general model that embeds other models of inflation within which we can test some of the hypotheses discussed in Section 2. A fundamental one is that excess money supply drives inflation. In the pure monetarist version, only variables entering the money-demand relationship should be significant. Since this implies assuming a closed economy, or a floating exchange rate and no imported intermediate goods, it is reasonable to allow imported inflation to influence domestic inflation or assume that the law of one price holds for tradable goods (Ubide, 1997; Jonsson, 2001). In the open economy version, a truly fixed exchange rate would make money supply endogenous. However, this case does not seem relevant for Ethiopia, which can be described as having a managed float during our study period.

An alternative interpretation is that inflation occurs when world prices rise or the exchange rate depreciates, while money supply is partly endogenous, as in Nell (2004), or that the monetary transmission mechanism mainly operates through the exchange rate channel, as Al-Mashat and Billmeier (2007) find to be the case in Egypt. The mechanism at work in the latter case would be through the impact of credit supply on imports, and not the traditional exchange rate channel described by Mishkin (1995) where interest rates affect capital flows, which in turn affect the nominal exchange rate.

Another possibility is that domestic goods are made up of nontradables, exportables and importables, and that relative prices change due to an increase in export prices, for example. This leads to an improvement in terms of trade and disequilibrium in the external sector. As a result, either the nominal exchange rate has to appreciate, or the prices of nontradables have to increase, for equilibrium to be restored. Decreases in terms of trade, on the other hand, require a depreciation of the nominal exchange rate or a decline in domestic prices. It is quite possible that the consumer price rise in both cases. This occurs if the nominal exchange rate is not

allowed to appreciate enough when terms of trade improve, and 'devaluations' push up prices through feedback effects when terms of trade deteriorate. Money supply would in this case be demand determined, or solely influence domestic prices through its effects on their proximate determinants (Dornbusch, 1980, Chapter 6; Kamin, 1996).

Our specification also allows us to evaluate the importance of food prices for inflation in two ways. First, the specification of (3) makes it possible to estimate the impact of world food inflation on both Ethiopian food prices, as well as overall inflation. Second, the inclusion of the agricultural output gap allows domestic food supply to have an effect on inflation.

It is also possible to shed some light on the importance of the structural changes in the agricultural markets, although a microeconomic analysis would be preferable. If the reforms have had a substantial influence on prices, we should observe them in our models, particularly when modeling cereal prices. The change in the relationship between agricultural output and inflation, noted above, can be expected to show up in the form of unstable coefficients and a structural break.

Another issue of interest is the degree of inflation inertia, measured by the coefficient on lagged inflation. It is usually interpreted as measuring the effects of indexation or inflation expectations. When there is no inertia, the parameters on lagged inflation should be zero. In the other extreme, when the level of inflation is only determined by inertia, the parameters on lagged inflation should sum to unity and all others should be zero. In Ethiopia, indexation has not been common and government-administered price setting, which was widespread before, has almost been abolished (IMF, 2008b). Therefore, inertia would capture expectations, which are believed to be particularly important in agricultural markets (Ng and Ruge-Murcia, 2000).

4. The Monetary, External, and Agricultural Sectors

In this section we formulate the error correction terms for the monetary and external sectors and calculate the agricultural market output gap, which are later included in the ECMs. We use cointegration analysis to test for the presence of long-run relationships in the monetary and external sectors.

In addition, as a robustness check, we follow the literature on the P-Star model of inflation and use de-trending to obtain estimates of equilibrium and deviations from equilibrium (Belke and Polliet, 2006). This approach is common when analyzing money markets, and can be viewed as an alternative to the cointegration analysis. The

Appendix outlines the P-Star model and develops the alternative measures of deviations from money market equilibrium.

The analysis focuses on the period January 1999 to November 2008, including the lags. A nationally representative CPI is available from 1997 but extending the sample further back in time is challenging: there were significant data revisions of the National Accounts and the CPI methodology in 2000. Data on the Euro exchange rate, which we prefer to use, is available from January 1999. The Ethiopia and Eritrea war during 1998-2000 created economic instability. The appendix describes the data sources, methods, and definitions of the variables used.

4.1 The Monetary Sector

Modeling money demand in Ethiopia is less straightforward than in many other countries because of its small financial sector and heavy government regulation. The sector consists of 10 commercial banks and one development bank. The Commercial Bank of Ethiopia, a state-owned bank, dominates the market (IMF, 2007). It had a market share of over 70 percent in both deposits and loans in 2002, and these have only declined moderately since then (IMF, 2002; IMF, 2007). Moreover, the capital account of the Balance of Payments is closed, so domestic investors are not allowed to issue debt in international capital markets. Thus, the market structure is concentrated and there is limited competition.

Interest rates are partially liberalized: the National Bank of Ethiopia sets the minimum bank deposit rate while banks are free to set all lending rates and deposit rates beyond the minimum. The minimum interest rate was adjusted only twice between January 1999 and July 2008, and the averaged deposit rate only changed a few more times.

The banking system is characterized by excess liquidity and banks hold about twice as much reserves in the National Bank of Ethiopia as required (Saxegaard, 2006; IMF, 2008c). No interest is paid on excess reserves. As the capital account is closed, treasury bills may become attractive for banks, buying over 80 percent of the ones issued. Subsequently the Treasury bill rate is low, and it has been negative in real terms since mid-2002. In 2007/08, the real Treasury bill rate was -24 percent, and the

nominal rate was even been below one percent recently.[8] It is thus clear that interest rates are not good measures of the costs or returns of holding money, and standard formulations of money demand are unlikely to work well.[9]

Another challenge to estimating money demand is the lack of monthly observations on income: only annual data on GDP are available. The annual GDP series, measured in millions of Birr at 1999/2000 prices, thus had to be interpolated.[10] Although the interpolation does not create any useful information about short-run fluctuations in income, it produces a monthly series that measures the trend in GDP, which is the relevant variable for long-run money demand analysis.

One way of highlighting the long-run relationship between income, the price level and the money stock, measured as broad money,[11] is to graph the log of velocity $y-(m-p)$. Figure 3 shows that velocity had an inverse U-shape over the period 1999:1-2008:11 with a sharp increase during 2007. Thus, it is not a stationary series.[12] Furthermore, adjusting the coefficient on y, which is unity in the velocity formulation, to other economically realistic values does not make the combination of $m-p$ and y stationary. This means that to develop a long-run money demand model, we need to look for non-stationary variables that together with m, p and y form a stationary vector.

Since the interest rates are not useful, the only standard candidates are inflation, which measures the cost of holding money instead of goods, and the rate of change of the value of foreign currency, which measures the cost of holding domestic currency instead of foreign currency. Even though there are restrictions on capital flows in Ethiopia, some people hold foreign currency as an alternative to broad money. It could

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[8] The real interest rate was calculated with current annual inflation using CPI data from the Central Statistical Agency. The Treasury bill rates are those reported in the IFS database. It is important to mention that the reason for excess liquidity is not clear. A lack of investment opportunities for the banks and mal-functioning of Ethiopia's financial sector is likely to be one explanation. The capital account is closed, and when banks lend to firms the money ends up in bank accounts, increasing their liquidity. In other words, even low yields of treasury bill may be better than nothing.

[9] Tadessea and Guttormsen (2008) find that the interest rate change in formal financial markets appears to have no effect on cereal price dynamics, suggesting that speculative decisions are not correlated with interest rates in formal financial markets.

[10] The interpolation was done with RATS assuming a random walk. The Denton method, which combines annual data with other high frequency data, would be preferable. However, the by far the most important variable causing short-run fluctuations is agricultural output, but it is only available at an annual frequency.

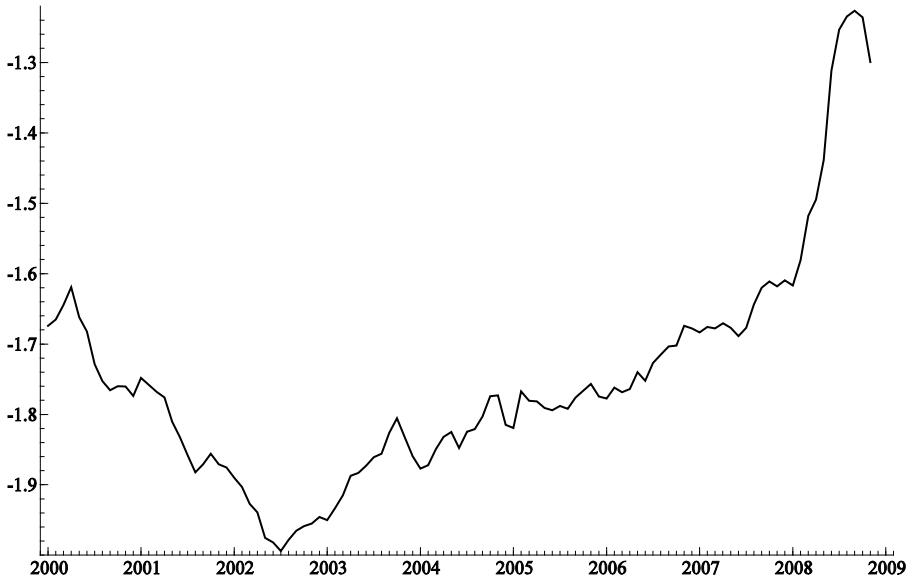
[11] Money demand was modeled using both M1 and broad money. The results were very similar so only the results for broad money are reported.

[12] A non-stationary series for velocity is not an uncommon finding, see for example Hendry and Erisson (2002) for the UK. Another reason for finding an I(1) process maybe related to sample size.

easily be purchased in a semi-official parallel foreign exchange rate market until the authorities closed it in February 2008.

A few unconventional variables have been shown to influence money demand in earlier studies. Sterken (2004) finds that shortages induce increases in money holdings during 1966-1994. The shortages, which are attributed to drought, are measured as the price of food items relative to non-food items. Sterken also finds that coffee prices affect money demand. He suggests that there are illegal exports of coffee, and when real coffee export prices increase, money demand declines. Yet another potentially important explanatory variable is international trade. Ayalew Birru (2007) argues that it influences demand for deposits, and finds that real imports enter demand for deposits in Ethiopia during 1970-2006.

Figure 3: The log of monthly velocity, *y-(m-p)*



To test for cointegration, we use the Johansen procedure.[13] The tests show that only income, *y*, and the annual change in the parallel-market US dollar exchange rate[14], $\Delta_{12}eus$, measuring currency substitution effects, cointegrate with $m-p$. None of the other unconventional variables is significant. Table 1 shows the results with *m-*

[13] See Juselius (2006) for a detailed description of the Johansen approach. Table A2 in the appendix reports Augmented Dickey-Fuller unit roots tests.

[14] The Birr-US$ exchange rate is measured by the parallel rate up to February 2008. Due to the closure of the official parallel market in February 2008, the official rate is used from March to November. The parallel market rate was re-scaled when linked with the official exchange rate.

p, y, and $\Delta_{12}eus$, the cointegration tests with the other variables are not reported.[15] There is strong evidence for one cointegrating vector, $(m-p)-0.65y+2.38\Delta_{12}eus$, since the null of one cointegrating vector (rank = 0) is rejected. The long-run relationship is also evident in Figure 4, which shows $0.65y-(m-p)$ and $\Delta_{12}eus$ (with $\Delta_{12}eus$ mean and variance adjusted to highlight the long-run relationship), as well as in Figure 5, which depicts the cointegrating vector. Since the real money stock is clearly endogenous, as indicated by the significant adjustment parameter, α_1, reported in Table 1, we consider the cointegrating vector as representing long-run money demand. This is a valid interpretation even if the adjustment parameter for the annual change in the exchange rate is significant at the 10 percent level, indicating a possible feedback effect.

Table 1: Cointegration analysis of the monetary sector, 1999:4-2008:11

Rank test			
Null hypothesis	r=0	r≤1	R=≤2
Eigenvalues	0.184	0.109	0.002
Trace statistic	37.27	13.69	0.207
Probability-value	0.005	0.091	0.649
Standardized eigenvector β_i			
	m-p	y	$\Delta_{12}eus$
	1.00	-0.65	2.38
	[0.00]	[0.07]	[0.31]
Standardized adjustment coefficients α_i			
	-0.107	Assumed weakly	-0.029
	[0.026]	exogenous	[0.016]

Note: The VAR includes three lags on each variable, an impulse dummy for 2008:6 and centered seasonal dummy variables. Standard errors are in brackets. Income is assumed weakly exogenous when estimating the standardized eigenvector and adjustment coefficients.

The coefficient on income is 0.65. Although consistent with economic theory, it is lower than expected since there is a belief that Ethiopia is going through a process of monetization, which would imply a coefficient greater than unity.[16] However, no formulation of the money demand model generated such a large value. It is also surprising that inflation does not enter money demand. However, widespread poverty might make the population so dependent on non-durable goods, such as food, that buying durables as a protection against inflation is uncommon. Thus, as mentioned

[15] In order not to overburden the reader with tables, we do not report all results. The cointegration tests with the other variables are available on request.

[16] This finding could also be due to overestimation of GDP. Another reason could be that currency substitution matters.

earlier, we derive an alternative measure of excess money supply in the appendix to check for the robustness of our money-demand cointegrating vector.

Figure 4: Income and real money stock, $0.65y-(m-p)$, (left Y-axis) and the annual change in Birr-$US exchange rate (right Y-axis)

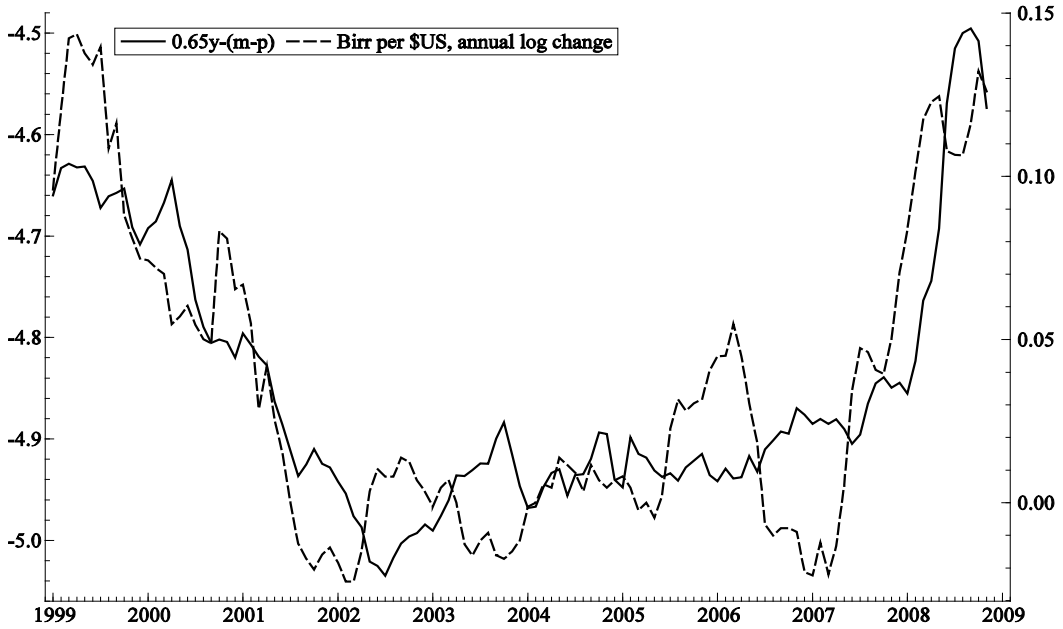
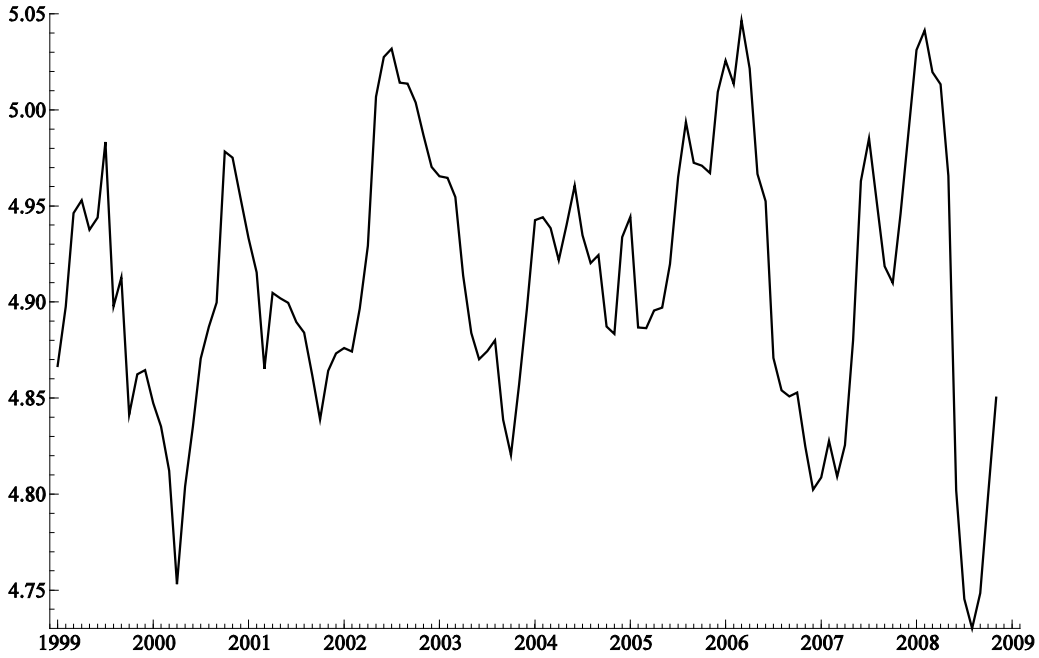


Figure 5: Money demand cointegrating vector, $(m-p)-0.65y+2.4\Delta_{12}eus$.



4.2 The External Sector

As shown above, the behavior of the price series analyzed differs markedly over the period studied, so it is likely that the relevant world market prices also differ. We therefore use different specifications to estimate equilibrium in the external sector based on equations (2) and (3).

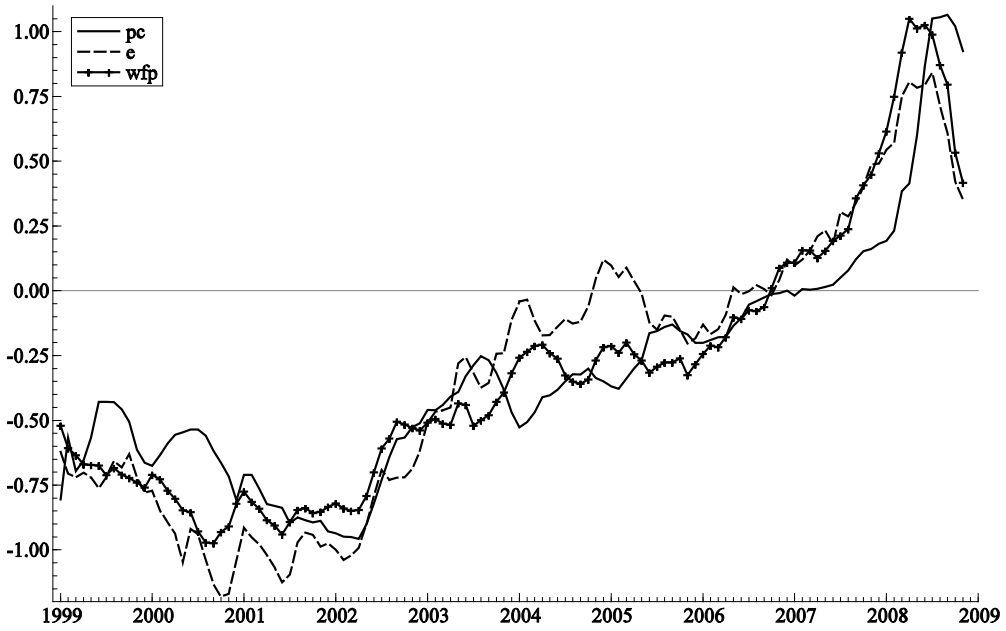
We begin by estimating the long-run relationship for food, equation (3), using the CPI for cereal prices, *pc*, and the World Bank grain commodity price index *wfp*.[17] The choice of cereal prices instead of food prices is made to get a reasonably good match between domestic and world food prices, although the differences between the CPI index for food and cereals are small as evident from Figure 2. The world market prices were converted to local currency using the Birr-Euro exchange rate. We also tested the US dollar, but it was unambiguous that the Euro works better in the models of inflation, both for food and none-food prices. The US dollar is the intervention currency used by the National Bank of Ethiopia, so the official Birr-US$ rate is constant for extended periods. The official parallel exchange rate worked better than the official rate, but it was abolished in early 2008. Moreover, it is not used for most trade.

Figure 6 depicts the log of the three variables for 1999:1-2008:11, where the mean and variance of the series for the exchange rate and world food have been adjusted to highlight the long-run relationship, and Figure 7 shows the relative food price (and the relative price of non-food prices). The three series follow each other over time, and the relative price appears to be a stationary series, although the swings around the mean are very large. The Johansen approach is thus used to test if this is the case, i.e., if *e, wfp* and *pc,* are cointegrated with coefficients 1,1,-1. The trace test and the estimated Eigenvalues, reported in Table 2, indicate that there is one cointegrating vector. Moreover, domestic cereal prices seem to be adjusting while the exchange rate and world food prices are weakly exogenous, as shown by the estimates of the α_i and their standard errors. Finally, the likelihood ratio test for imposing the restrictions 1, -

[17] The components of the index are wheat (25%), maize (41%), rice (30%), barley and sorghum (4%). The index does not cover teff, a local grain only produced and consumed in Ethiopia and Eritrea, though major cereals prices closely mirror movements in the teff price. Although it would have been better to have indexes with very similar weights, we preferred to use world grain prices for transparency reasons.

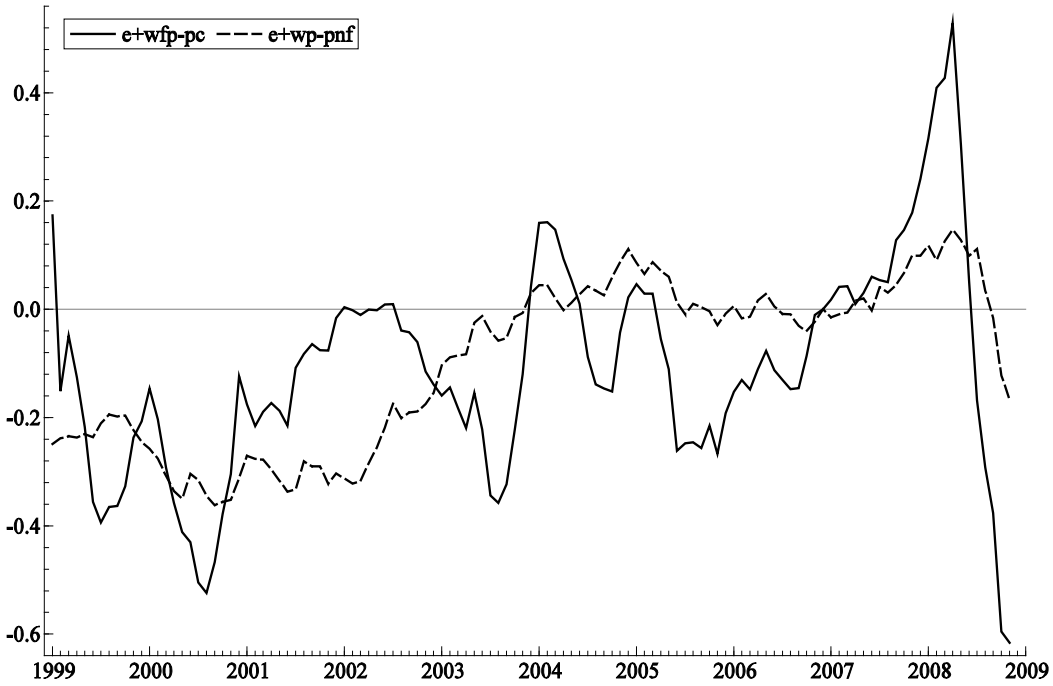
1, -1 on the β vector is insignificant. Hence, we conclude that $e + wfp - pc$ is stationary.

Figure 6: Log of cereal prices, *pc*, exchange rate, *e*, and world food prices *wfp* (indexes 2006:12=1)



Note: The exchange rate and world food price series have been mean and variance adjusted to highlight long-run relationships.

Figure 7: Log of relative price indexes for food, $e + wfp - pc$ and non-food $e + wp - pnf$



It is important to keep in mind that the relative price series is calculated with price indexes, set to unity in 2006:12, and that it does not say anything about the actual price levels. Moreover, the stationarity of the relative price series does not imply that world and domestic prices will converge, only that domestic food prices adjust when relative prices drift apart.

Table 2: Cointegration analysis of the external sector, 1999:3-2008:11

Rank test			
Null hypothesis	r=0	r≤1	R=≤2
Eigenvalues	0.204	0.082	0.014
Trace statistic	38.51	11.76	1.67
Probability-value	0.003	0.17	0.196
Standardized eigenvector β_i			
	p	Wfp	pc
	1.00	-0.66	-1.28
	[0.00]	[0.22]	[0.33]
Standardized adjustment coefficients α_i			
	-0.125	-0.018	-0.007
	[0.025]	[0.024]	[0.016]
Likelihood ratio test for restricted cointegrated vector ; $\beta_1 - \beta_2 - \beta_3 = 0$ $\chi^2(2) = 1.11\,[0.57]$			

Note: The VAR includes two lags on each variable and centered seasonal dummy variables. Standard errors are in brackets.

The log of the non-food relative price is also depicted in Figure 7. It is measured with non-food CPI, *pnf*, the Birr-Euro exchange rate, *e*, and the EU producer prices, *wp*. The reason is that the EU is Ethiopia's largest trading partner: in 2007 roughly 40 percent of total exports went to the EU. Moreover, this relative price is easy to calculate, transparent, and works well empirically. We also tested alternative specifications, the Birr-US$ exchange rate, US wholesale prices and the real trade weighted (effective) exchange rate, calculated with weights for the ten largest trading partners. The real effective exchange rate is in principle the most adequate one, but it works very much like the Birr-Euro exchange rate. Although there are some differences in the series, they nonetheless provide the same information for our purposes.[18]

As the figure shows, $e + wp - pnf$ is clearly non-stationary, which is also shown by the Johansen cointegration test (not reported). We thus tested for

[18] The use of the official Birr-US$ exchange rate weakens the results in the sense that the t-values are lower. This is probably partly due to Ethiopia's trade pattern, but also partly due to the management of the Birr, since the exchange rate changed very slowly between 2002 and 2007. The effective real exchange rate was used in an earlier version of the paper, but it has not been updated. The real effective exchange rate and the real Birr-Euro exchange rate produce similar results.

cointegration between $e + wp - pnf$ and terms of trade, but failed to find a stationary vector (not reported). Because of this, and because the measurement of monthly terms of trade is surrounded with some uncertainty, we follow Kool and Tatom (1994) and Garcia-Herrero and Pradhan (1998) and use the Hodrick-Prescott filter to remove the non-stationary component of the real exchange rate (see Appendix for details). We thus assume that the trend obtained is the long-run real equilibrium exchange rate, or that it at least captures the long-run level that is relevant for the adjustment of prices in the goods market.

4.3 The Agricultural Sector

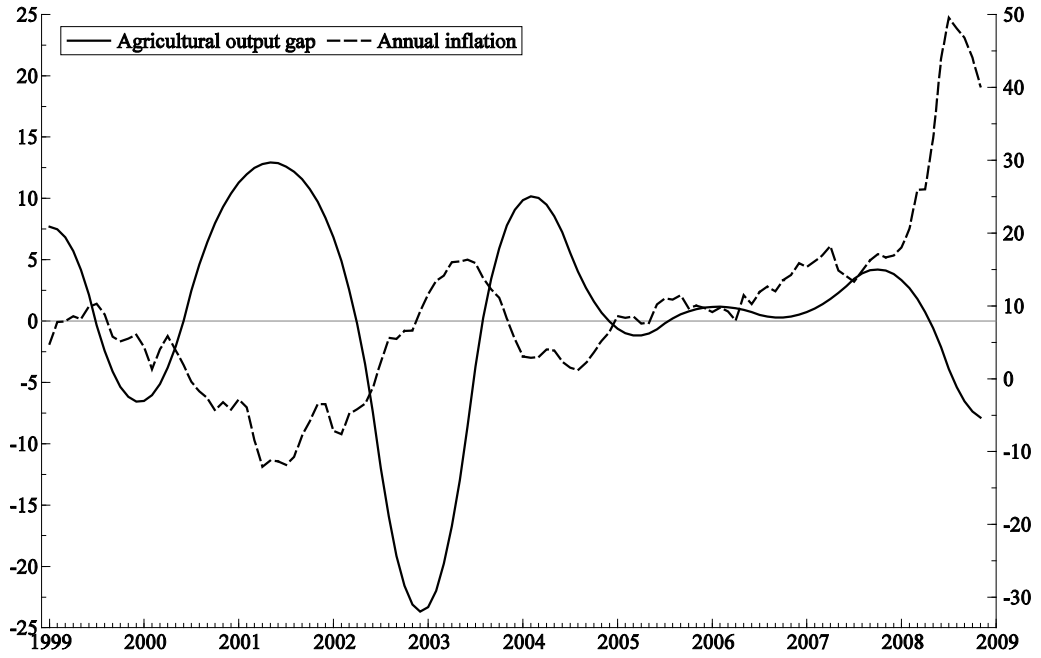
It is not as straightforward to find variables for agricultural output, since only annual data are available. One option is to use the amount of rainfall, as Diouf (2007) does, and another one is to use wholesale prices of agricultural commodities, following Durevall and Ndung'u (2001) and Khan and Schimmelpfennig (2006). We use the annual series for the volume of cereal production, interpolated to monthly observations.[19]

Including the growth rate of agricultural production in the models is not a good idea, since it affects income, which in turn affects demand for food. Therefore, the Hodrick-Prescott filter is used to obtain the deviations from the long-run trend in agricultural production. The resulting series can be viewed as a measure of the output gap. It is assumed that demand grows with average agricultural production, and that deviations from this level result in price changes.

Figure 8 shows the output gap and annual inflation from January 1999 to November 2008. The countercyclical pattern is clearly visible, and there is little doubt that variations in agricultural production affected inflation during the study period. It is also evident that other factors influence inflation, particularly since early 2005 when prices continued increasing while output gap remained positive. Moreover, the rapid rise in inflation in 2008 is not fully explained by the output gap. However, our data for 2008 and 2009 might overestimate agricultural production.

[19] As a robustness check, we experimented with different series, and the choice of series for agricultural output does not matter much. For instance, value added in agriculture gives virtually the same results. Note that the observation for 2007/8 is an official estimate, and the one for 2008/09 is based on satellite information provided by EARS (2008).

Figure 8: The agricultural output gap (left axis) and annual inflation (right axis) (in %)



5. Determinants of Inflation in Ethiopia

In this section, we develop single equation ECMs for cereal, food, non-food and overall CPI inflation. The models are estimated with OLS for the period January 1999 (including lags) to November 2008. We use general-to-specific modeling, starting with general models that include the money market and foreign sector error correction terms and the agricultural production output gap, and variables in first differences. The reduction of the general model is carried out with Autometrics, a computer-automated general-to-specific modeling approach. In principle, Autometrics tests all possible reduction paths and eliminate insignificant variables while keeping the chosen significance level constant. A great advantage of Autometrics is that it can handle models with many variables and few observations.[20]

We reports results based on models with eight lags in the general models.[21] Since the general models contain many parameters, we use the 1 percent significance level, rejecting the null hypothesis and including variables erroneously (Type I error)

[20] The methodology is based on Hoover and Perez (1999) and Hendry and Krolzig (2001). See Doornik and Hendry (2007) for a description of Autometrics. Castle and Hendry (2009) and Ericsson and Kamin (2008) are two applications of automated general-to-specific modeling.

[21] We first estimated models with 13 lags, implying they had over 100 parameters, but 8 lags seemed sufficient.

increases substantially with a 5 percent significant level in models with many lags. Since misspecification tests of the general models, as well as Figure 1 and 2, indicate the presence of some extreme values, we start by using dummy saturation, a procedure in Autometrics that tests for outliers and unknown structural breaks by including a dummy for each observation (Castle and Hendry, 2009; Santos, 2008). Then, by applying the standard options in Autometrics, the well-specified general models, including the dummy variables, are reduced to specific models.

Simultaneity bias is often not a major issue when estimating macro models with monthly data, since correlations between contemporaneous variables are low. However, in some of our specifications, contemporaneous variables are significant, and in some cases, this seems to be due to reverse causality or a coincidence. The specific models reported are obtained from general models without contemporaneous variables, but we comment on the consequences of including them.

When reporting the results, only significant seasonal dummies are kept, but variables of interest are included in the specific models for illustrative purposes, even though their coefficients are not significant. As a robustness check, we report some omitted variables tests in Sub-Section 5.5.

5.1 Cereal Prices

The general model for *pc* includes the money market and foreign sector error correction terms $(m-p)-0.65y+2.38\Delta_{12}eus.$ and $e+wfp-pc,$ and the agricultural production output gap, *ag*, lagged one period. The variables in first differences, entered with eight lags, are broad money, $\Delta m,$ the exchange rate, $\Delta e,$ world food prices, $\Delta wfp,$ energy prices, $\Delta energy,$ international fertilizer prices, $\Delta fert,$ non-food prices, $\Delta pnf,$ and cereal price inflation, $\Delta pc.$ Moreover, a constant and seasonal dummies are included. Since the dummy saturation procedure found outliers in 2001:1 and 2008:3-2008:7, these are also added to the general model. The 2001:1 outlier is due to a jump in the food consumer price index, which appeared after the revision in 2006. The 2008:3-2008:7 outliers are due to the almost explosive rise in cereal prices before harvest, probably related to forward looking expectations as in the model of Osborn (2004), although it could also be due to misreporting of the data used in constructing our variable for agricultural output gap. The 2008:3-2008:7 outliers are combined into

Table 3: Parsimonious inflation models for Ethiopia, 2000:1-2008:11

Explanatory variables		Model 1: Cereals Δpc	Model 2: Food Δpf	Model 3: Nonfood Δpnf	Model 4: CPI Δp
EC-Monetary overhang	$[(m-p)-0.65y+2.38\Delta_{12}eus]_{t-1}$	0.037 1.14	0.023 1.20	0.020 1.46	0.023 1.64
EC-External sector food	$[e+wfp-pc]_{t-1}$	0.091 6.88**	0.064 8.05**		0.044 7.34**
EC-External sector non- food	$[e+wp-pnf]_{t-1}$			0.074 3.29**	
Agricultural output gap	ag_{t-1}	-0.181 -6.13**	-0.092 -5.43**		-0.043 -3.67**
Lagged money growth	Δm_{t-2}	0.640 4.46**	0.295 3.57**	0.009 0.144	0.179 2.86*
Lagged endogenous variable	$\Delta pc_{t-1}, \Delta pf_{t-1}, \Delta p_{t-1}$	0.295 6.27**	0.287 5.70**		0.211 3.69**
Lagged cereal inflation	Δpc_{t-5}	-0.220 -4.90**			
Lagged food inflation	Δpf_{t-3}			0.114 3.28**	
Lagged food inflation	Δpf_{t-4}		-0.131 -2.84**		
Lagged imported inflation	Δip_{t-3}				0.695 2.80*
Lagged imported inflation	Δip_{t-4}			0.809 3.02**	
Data revision dummy	2001:1 = 1	0.147 6.49**	0.071 5.49**		0.035 3.66**
Volatility dummy[a)]		0.040 9.21**	0.046 9.22**		0.036 9.93**
Constant[b)]		-0.173 -1.07	-0.105 -1.10	-0.097 -1.43	0.110 -1.56
Seasonal dummy[b)]		Yes	Yes	Yes	Yes

Note: t-values in parenthesis. * indicates significance at 5 percent level and ** significance at 1 percent level.
[a)] The volatility dummy has the values 1, -1, 1, 2, 1 for 2008:3-2008:7 and zero otherwise. It is based on the values obtained by the dummy saturation test in Autometrics.
[b)] The constant remains in the models by force, but only significant seasonal dummies are kept.

one dummy variable, denoted the volatility dummy.[22] Misspecification tests of the general model for serial autocorrelation, autoregressive heteroscedasticity, heteroscedasticity, normality and non-linearity are all insignificant.

Table 3 reports the specific model as Model 1. The external sector error correction term is highly significant (t-value = 6.88), while the money market error correction term is insignificant. This means that world food prices, measured in domestic currency, determine the evolution of domestic cereal prices: a 1 percent

[22] The general models are not reported. They can be obtained from the authors on request.

Table 4: Diagnostic tests for parsimonious inflation models, 1999:10-2008:11

	AR 1-7	ARCH 1-7	Heterosced.	Normality	RESET	DW	R^2
Model 1: Cereals	F(7,90) = 1.80 [0.10]	F(7,83) = 1.70 [0.12]	F(17,79) = 1.31 [0.21]	$\chi2$ (2) = 4.76 [0.09]	F(1,100) = 1.81 [0.18]	2.24	0.85
						2.04	0.85
Model 2: Food	F(7,91) = 0.45 [0.87]	F(7,84) = 0.92 [0.49]	F(15,82) = 0.83 [0.64]	$\chi2$ (2) = 2.82 [0.24]	F(1,97) = 0.04 [0.84]		
Model 3: Non-food	F(7,95) = 1.11 [0.36]	F(7,88) = 0.57 [0.77]	F(12,89) = 1.41 [0.17]	$\chi2$ (2) = 1.42 [0.49]	F(1,101) = 1.27 [0.26]	1.96	0.33
Model 4: CPI	F(7,90) = 1.01 [0.42]	F(7,83) = 0.48 [0.84]	F(16,80) = 0.50 [0.93]	$\chi2$ (2)= 7.59 [0.02]*	F(1,96) = 3.90 [0.05]	1.76	0.81

Note: * indicates significance at 95% level. AR is a test for serial autocorrelation for up to seven lags, ARCH is a test autoregressive heteroscedasticity, RESET is a test for non-linearity and DW is the Durbin-Watson test. Probability values in brackets. See Doornik and Hendry (2007) for details.

increase in world prices raises the domestic price level by 1 percent in the long run, given the exchange rate. When there is disequilibrium in the external sector for food, about 9 percent of the disequilibrium is removed every month by changes domestic prices, again assuming the exchange rate is constant.

The agricultural output gap is also important. Its coefficient is -0.18 (t-value = -6.13). It explains most of the swings in cereal prices away from long-run equilibrium. The impact is quite large. A hypothetical shift from no output gap to a serious drought, such as in 2003, would raise cereal price inflation by up to 3.5 percentage points per month, calculated as the coefficient on *ag*, -0.18, times the minimum value of *ag* during the drought, -0.20. This implies that such a drought would increase annual inflation from zero to up to 40 percent within a year if all the other explanatory variables have zero impact. Since the impact of the drought is temporary, inflation would then decline.

For illustrative purposes, Model 1 is reported with the error correction term for the monetary sector, which was removed by Autometrics. It is clearly insignificant (t-value 1.14). This strengthens the evidence in favor the external sector as the main determinant of cereal prices in the long run. However, money seems to matter in the short run: money growth lagged two months enters significantly with a coefficient of 0.64. As mentioned earlier, conditioning inflation on contemporaneous growth rates can affect the results. In this case, money growth at time *t* would replace lagged money growth. Yet, it seems unlikely that changes in money supply growth would have an almost instantaneous effect on cereal price inflation. On the other hand, an increase in prices might increase demand for nominal money quickly, making it reasonable to

assume that causation runs from inflation to money growth. This interpretation is supported by the fact that changes in deposits are correlated with inflation; the coefficient is 0.26, while the correlation coefficient for currency is only -0.03.

Lagged cereal price inflation enters at the first lag with a positive coefficient (0.30) and the fifth lag with a negative coefficient (-0.22). This shows there is substantial inflation inertia, as roughly 30 percent of past inflation is carried over into the next month during for about four months. It is common to find inertia in analyses of cereal markets. Although this is not well understood, the most likely explanation is that lagged inflation terms capture inflation expectations related to news, generated by shocks to food supply (Osborne, 2004). Note also that the presence of inertia and an error correction term implies that there is price overshooting, which means that an exogenous shock initially increases the price level above its long-run equilibrium level.

We fail to find that international fertilizer and energy price inflation affect cereal inflation. In the case of fertilizer, this is probably because of the small use by the majority of rural households. Alternatively, an index specified for Ethiopia might provide more information, but unfortunately the monthly data on the value and volume of fertilizer imports are not detailed enough to allow sensible calculations of unit values. The lack of significance of energy price inflation might be because the cost of fuel is small in Ethiopian agriculture, but it could also be due to government control of fuel prices.

One issue raised in the discussion of Ethiopia's inflation is that structural reforms might be a major cause of the surge in food prices, at least between 2004 and 2008. Indirect evidence for an impact of reforms on the formation of cereal prices can be obtained with Chow tests, a structural change should induce a break in the model. Figure 9 accordingly reports one-step, break point and forecast Chow tests for the period 2001:1-2008:11. The Chow tests are far from significant at the 1 percent level, indicated by the straight line at 1.0. Thus, although structural changes in the grain market would need to be assessed more formally with microeconomic surveys, we fail to find evidence of a structural break in our model.

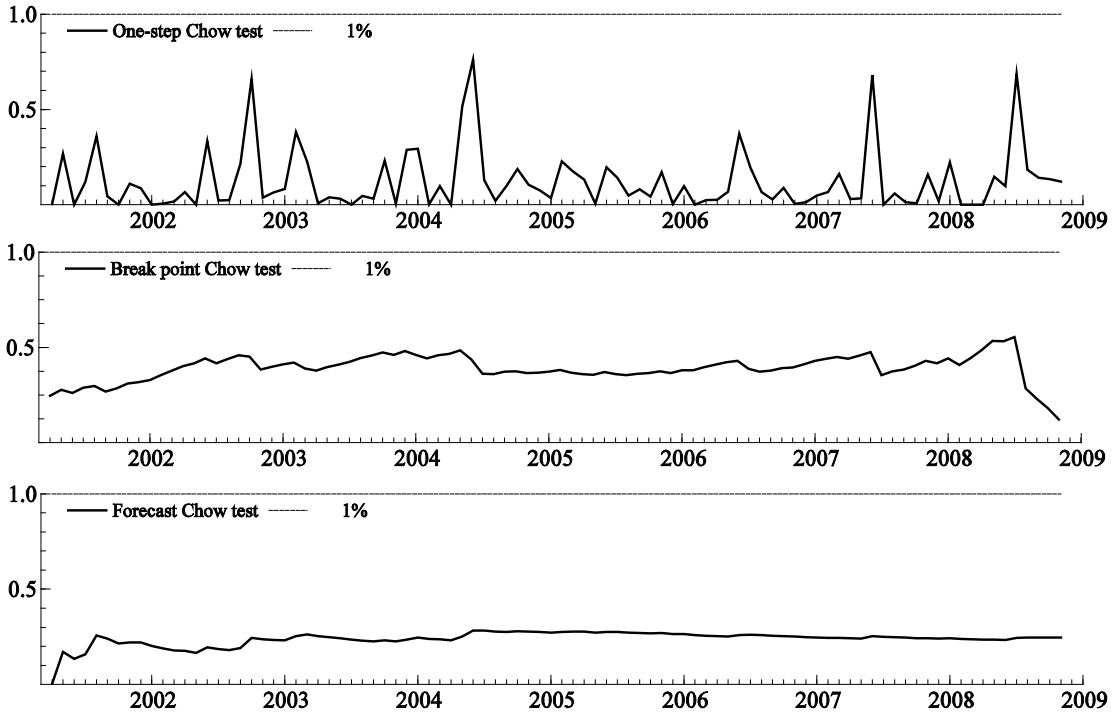
Table 4 reports various diagnostic tests. All diagnostic tests are insignificant at the 5 percent level, indicating that the model is reasonably well specified. Moreover, as the Chow tests in Figure 9 show, it is empirically stable, albeit with some dummy variables. The model explains 85 percent of the variation in cereal inflation as measured by the R^2, which is quite good given that we use noisy monthly data.

5.2 Food Prices

The general model for food inflation is specified in the same way as the one for cereal price inflation, and the results are similar (Model 2, Table 3). The most notable difference is that most coefficients in the food price model are smaller. This is because the cereal price index is a large component of the food price index, and it fluctuates more than the other components (see Figure 2). The adjustment process towards the long-run equilibrium is 6 percent instead of 9 percent per month, so it takes roughly a year to return after a shock. Moreover, the coefficient of the agricultural output gap is -0.9, instead of -0.18. Inertia, however, appears to be somewhat higher, since food inflation lagged one month has the same coefficient (0.29) while the negative value of the fourth lag is smaller (-0.13).

The coefficient on money growth is about half the size of the one in the cereal price model, indicating that it might not influence non-cereal food price inflation. The error correction term for money is clearly insignificant, as in the model for cereal prices.

Figure 9: Chow tests for the cereal price model, 2001:1-2008:11

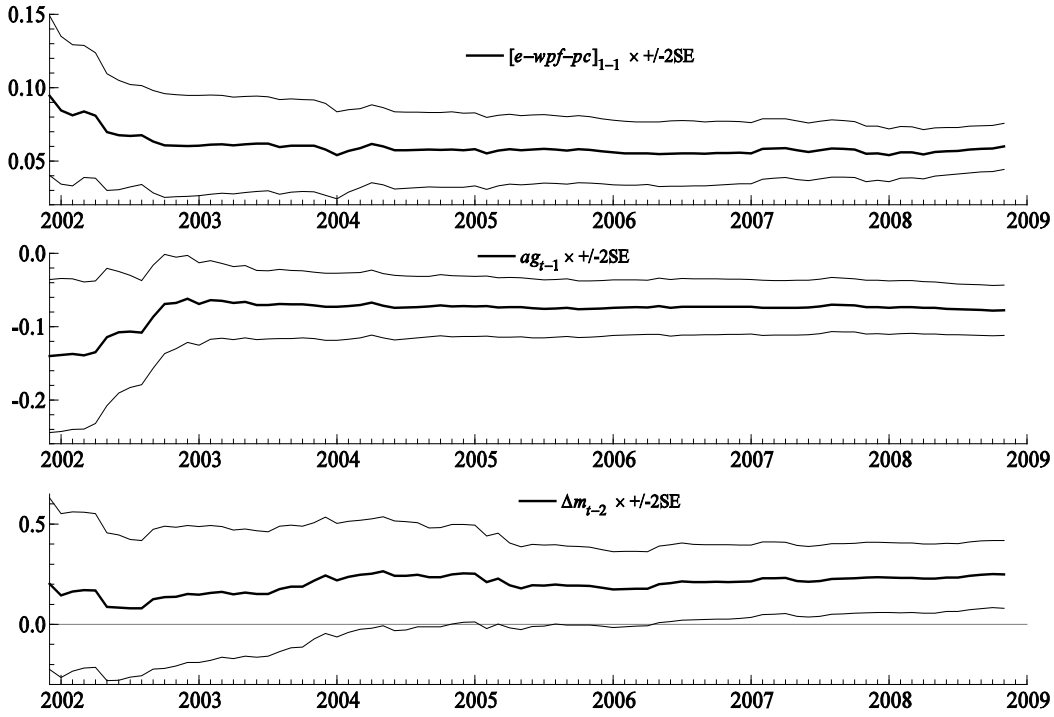


Note: The straight line at 1.0 is the 1 percent significance level. The null hypothesis in the One-step Chow is that the last observation comes from the same model as the others. The Break point and Prediction Chows are sequences of tests where the number of observations added are decreasing and increasing, respectively. See Hendry and Nielsen, 2007, Chapter 13, for details.

The model is well specified, as indicated by the diagnostic tests in Table 4. Moreover, recursive estimates of the coefficients for $\left[e + wfp - pc\right]_{t-1}$ ag_{t-1} and Δm_{t-2}, over 2002:1-2008:11, reported in Figure 10, show that they are empirically stable. The recursive estimates also reveal that lagged money growth only becomes clearly significantly different from zero at the 5 percent level in 2007.

We thus conclude that cereal and food prices seem to be determined by the exchange rate and foreign prices in the long run. The domestic agricultural market also plays an important role by both generating supply shocks, and possibly by creating backward and forward-looking expectations about future price changes. Money growth also affects food inflation in the short run, but the evidence is not as strong as for the other effects.

Figure 10: Recursive estimates of selected coefficients in the food inflation model, 2002:1-2008:11



5.3 Non-food Prices

The specification of the general model for non-food inflation includes the money market term $(m - p) - 0.65y + 2.48\Delta_{12}eus,$ and the foreign sector error correction term $e + wp - pnf - trend,$ where *trend* is obtained with the Hodrick-

Prescott filter. The other explanatory variables are the agricultural output gap, ag_{t-1}, and the lags of the rate of change of broad money, Δm, the exchange rate, Δe, imported inflation, Δwp, energy costs, $\Delta energy$, food price inflation, Δpf, and non-food price inflation, Δpnf.

As reported in Table 4, the parsimonious model, (Model 3), is well specified. Nevertheless, modeling non-food inflation with monthly data is a challenge, as indicated by the R^2; it is only 0.33. Because of this we report the results of the general-to-specific analysis using the 5 percent significance level.

Two clearly significant variables are lagged imported inflation and food inflation; both are significant at the 1 percent level. The coefficient for imported inflation is as high as 0.81, indicating a potentially large role for world prices, while the impact of lagged food inflation is small, 0.14. Entering contemporaneous food price inflation would show that it affects non-food inflation within a month. However, this could be because of simultaneity bias. There is also evidence for a long-run effect of foreign prices due to $e + wp - pnf - trend$. However, it is removed by Autometrics when the 1 percent level is used.

Money supply does not seem to influence non-food prices; the error correction term is insignificant and lagged money does not enter the model. Including contemporaneous money growth in the general model does not change this result.

A surprising result is that there is no detectible inflation inertia. No lags of non-food price inflation enter the model. Hence, there appears to be a substantial difference in the degree of inertia between non-food and food price inflation. The reason is probably the absence of both indexation and large supply shocks. The lack of inertia should not be interpreted as high price flexibility, however. The non-food price level adjusts slowly back to equilibrium after a shock while, food prices initially overshoots due to the lagged terms. Hence, food prices react much stronger to shocks.

5.4 CPI Inflation

We combine variables in the models for food and non-food price inflation when formulating the general model for CPI inflation, except that lagged food and non-food inflation are not included. This means we have two error correction terms for the external sector, $e + wp - pnf - trend$ and $e + wfp - pc$. Moreover, we use the information about the outliers obtained from the models of cereal and food inflation

and include them in the general model. This resulted in a well-specified specific model (see Table 4).

Table 3 shows that only $e + wfp - pc$ enters the model. The other external sector error correction term is insignificant. Moreover, as in the other models, the error correction term for the money market is insignificant at the 5 percent level. This means that inflation in Ethiopia is basically food inflation, and it is determined in the foreign sector in the long run: the t-value for $e + wfp - pc$ is 7.34, and the adjustment coefficient towards equilibrium is 4.4 percent per month.

The model also highlights the importance of the agricultural output gap for overall inflation. Its coefficient is 0.043. Using the same hypothetical example as above for cereal prices, a shift from no output gap to a serious drought indicates that it raises monthly inflation by 0.8 percentage points. However, afterwards dynamics set in and the impact accumulates to 1.3 percentage points per month. Yet, the long-run impact is limited by the fact that the agricultural output gap returns to zero and turns positive after some time, since it is a stationary variable.

Money does not seem to matter in the long run, but the second lag of money growth is significant at the 5 percent level (it was not kept by Autometrics). Its coefficient is much smaller than in the cereal and food price models, i.e. 0.18. This reflects the fact that it is the impact on cereal price inflation that is picked up, money growth does not appear to affect the other prices.

Lagged import price inflation enters the model with a coefficient of 0.69, although it is only significant at the 5 percent level. It probably captures the impact import costs on non-food prices.

Inflation inertia is 0.21, which is in correspondence with other models. Since there is no inertia in the model for non-food inflation, it is due to the food-price component of the CPI, particularly cereal prices.

5.5 Omitted Variables Tests

We finally carry out omitted variables tests to check the robustness of the results, showing that the models reported in Section 5.1-5.4 are valid. The results are reported in Table 5 for the cereal, food and CPI inflation (Models 1, 2 and 4).

First, we test the alternative measure for the money market, the monetary overhang of the P-Star approach, described in Appendix. The advantage of this

measure is that it does not require a long-run money demand function, only data on money, output, and prices. The omitted variables tests for the monetary overhang are clearly insignificant in all models. Hence, the results are the same as for the error correction term from the cointegration analysis of the monetary sector.

Next, we test if the unrestricted cointegrating vector for the money market is significant. The test could be significant because of misspecification of the long-run relationship. However, it is also insignificant in all three models.

Then we test an alternative specification of the external sector, $e + wp - p - trend$, the real exchange rate calculated with the CPI inflation. It is not significant, which shows the superior performance of the error correction term with food prices. However, $e + wp - p - trend$ does become significant if the cereal-price error correction term is excluded (not reported). This is evidence of the importance of the external sector for Ethiopia's inflation.

Finally, we verify that the exchange rate has no short-run impact on inflation by including the contemporaneous value and six lags of changes in the Birr-Euro exchange rate. Again, the omitted variable test is insignificant. The absence of a short-run impact of changes in the nominal exchange rate might be because the Birr-Dollar exchange rate only adjusts slowly and importers therefore view the rate of change in the Birr-Euro exchange rate as temporary.

Table 5: Omitted variables tests

		Model 1: Cereals	Model 2: Food	Model 4: CPI
Monetary overhang	$\left[(m-p)-y^{*}+v^{*}\right]_{t-1}$	F(1,100) = 0.14 [0.70]	F(1,99) =0.47 [0.49]	F(1,99) = 1.54 [0.22]
Unrestricted EC-monetary overhang	$m-p_{t-1}, y_{t-1}, \Delta_{12} eus_{t-1}$	F(3,98) = 0.54 [0.65]	F(3,97) = 1.30 [0.28]	F(3,97) = 1.01 [0.39]
De-trended real exchange rate	$\left[e+wp-p-trend\right]_{t-1}$	N.A.	F(1,99) = 0.01 [0.94]	F(1,99) = 1.55 [0.22]
Nominal exchange rate	$\sum_{i=0}^{i=6} \Delta e_{t-i}$	F(7,94) = 0.91 [0.50]	F(7,93) = 0.58 [0.76]	F(7,93) = 0.65 [0.71]

Note: Probability values in brackets.

6. Forecasts and Policy Scenarios

The purpose of this section is to simulate some possible policy scenarios and thus predict the CPI over December 2008 to June 2010 for illustrative purposes. The empirical models used are Model 1 and Model 4; we need to estimate both models simultaneously to predict the error correction term, which is endogenous.

Making forecasts is a challenge since there are many uncertainties, so the numbers reported should not be taken at face value. As Elliot and Timmermann (2008) show, even the best of models face significant difficulties when predicting the future. The major uncertainties here are the future evolution of world food prices, exchange rate and monetary policy, and domestic agricultural production, which are the three key determinants of the CPI according to our inflation model for Ethiopia. Moreover, to evaluate the role of policies, we would need to estimate a structural model or at least ensure that the policy variables are super exogenous to avoid the Lucas critique.

We use projections from the Development Prospects Group of the World Bank (DECPG) for the annual grain index for 2009 and 2010 to forecast world food prices. The accuracy of the predications can be discussed because historical comparisons show that commodity forecasts are surrounded with a large degree of uncertainty (Deaton, 1999). This is also evident from most recent projections. Even though they were made in late 2008, the monthly grain index had a lower value in November 2008 than the projected average mean value for 2009, in spite of the fact that the projection shows a decline in grain prices. Thus, we simply assume that the monthly index is constant over the period 2008:12 – 2010:6.

We use two scenarios for the exchange rate, assuming there is no substantial change in the Dollar-Euro exchange rate during the period 2009-2010. In the first case the Birr-Euro exchange rate is constant at the November 2008 rate. In the second case, it depreciates by 20 percent in 2008:12 and then stays constant. The depreciation is a bit larger than the change in the Birr-Euro rate during last year, 2007:11-2008:11, when the Birr depreciated by 15 percent.

We also use two alternative scenarios for agricultural growth. In the first case, agricultural growth is assumed to follow a path similar to the one in 2003 from the beginning of 2009, when according to official data it grew by above 10 percent. The growth peaks in mid-2010 and then declines. In the second case, we assume an output gap is similar to the drought in 2002/03, which corresponds to a contraction in

agricultural output of about 20 percent. Note that agricultural production is not assumed to be as low as in 2002/03, but to decrease by the same percentage. In both scenarios, the negative output gap decreases to zero during the first half of 2009 so the bumper harvest and drought apply to the fiscal year 2009/10.

Money supply growth is assumed to be 10 or 20 percent, corresponding to very tight and somewhat accommodating monetary policy.

We combine the scenarios into four main cases. Case 1 is the worst outcome for consumer prices: a drought, currency depreciation, and high money growth. In Case 2 we also have a drought, currency depreciation, but tight monetary policy. Case 3 has a drought, stable exchange rate, and high money growth. Finally, Case 4 has the best options for all three variables. Table 6 summarizes the cases.

Table 6: Forecast scenarios

	Agricultural production	Exchange rate	Monetary policy
Case 1	-20% maximum decline	20 percent depreciation	+20 percent annual growth
Case 2	-20% maximum decline	20 percent depreciation	+10 percent annual growth
Case 3	-20% maximum decline	Fixed rate from 2008:11	+20 percent annual growth
Case 4	+10% maximum growth	Fixed rate from 2008:11	+10 percent annual growth

Figure 11 depicts the forecast for Case 1, the worst case, together with two times the standard error, where we have forecasted annual inflation growth to facilitate interpretation. The fan chart shows the range of uncertainty indicated by the shaded area around the central projection. Initially, inflation will continue falling down to about 15 percent, but it then rises during the drought. The reason for the rapid decline during 2009 is that world food prices are constant, and domestic prices are high due to recent past and current high inflation. As a result, the real exchange rate appreciates in spite of the 20 percent depreciation of the nominal exchange rate in 2008:12. In other words, the disequilibrium in the external sector reduces inflation through the error correction term. The forecast thus illustrates how international market integration keeps domestic prices from moving too far from world market prices, although inflation continues to be at double-digit levels through 2010 because of the drought. Of course, these results hinges on the assumed depreciation of the exchange rate, if the value of the Birr were to fall much more, possibly due to shortages of foreign reserves, inflation could actually increase.

It is worth emphasizing that although inflation growth declines, it is still positive and high, and the consumer price level keeps rising. Moreover, the model does not imply that domestic food prices eventually will decline, even if world food prices fall since the exchange rate can depreciate, nor does it show that domestic prices eventually will be equal to import parity prices, since the long-run relationship is an index set to unity in 2006:12.

Figure 12 shows the expected developments for annual inflation for all the four cases. Case 2 and 3 illustrates the role of money supply and depreciation, respectively. In the case of tight money, inflation follows a similar path to Case 1, but it is a few percentages lower during 2010. In Case 3, inflation decreases to about 10 percent, indicating the impact of a stable exchange rate. Finally, in the best Case 4, where there is a good harvest, fixed exchange rate and low money supply growth, inflation declines rapidly and reaches single-digit levels at the end of 2009. This is a highly favorable development. Nevertheless, the behavior of inflation during 2010 highlights the important role played by agricultural growth, supported by carefully designed monetary and exchange rate policies.

Figure 11: Predicted CPI inflation growth for Case 1, 2008:12-2010:12 (annual log growth rates in %)

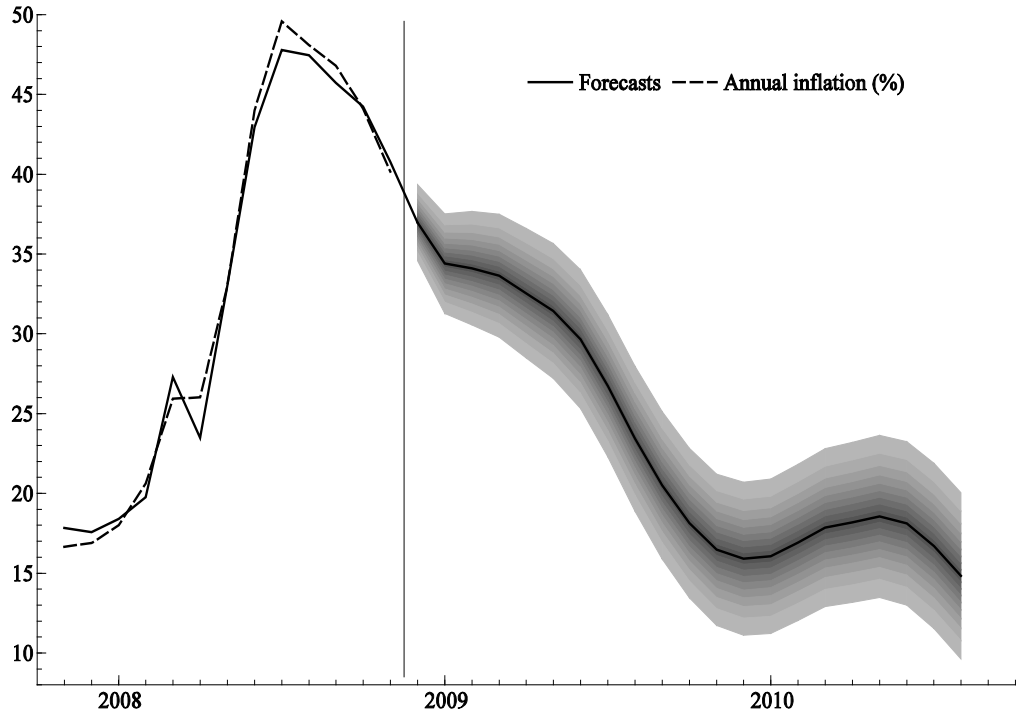
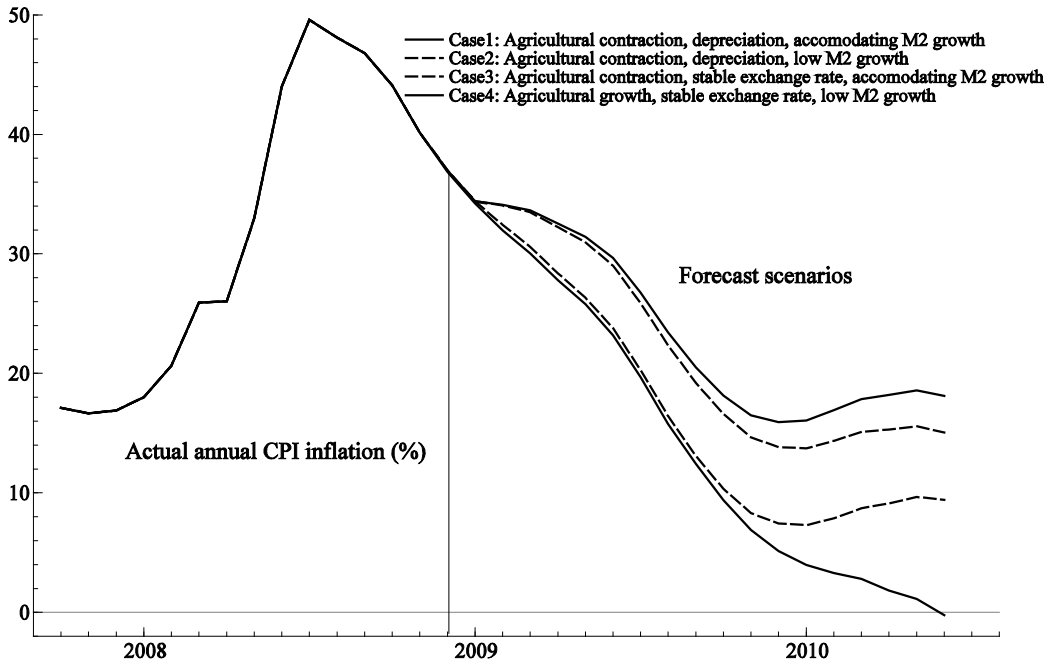


Figure 12: Illustrative forecast scenarios, 2008:12-2010:6 (annual log growth rates in %)



Although highly tentative, our four scenarios show the following. First, annual inflation *growth* in Ethiopia is likely to decrease over the coming years. This is mainly because of the strong effect of international food prices on domestic inflation. Yet, annual inflation growth is still positive, so the *level* of the overall consumer price index will continue to increase. Moreover, inflation is likely to be over 20 percent during a substantial part of 2009. Yet, it is also important to mention that if international prices would start increasing again, they would to have a strong impact on Ethiopia, and the model predictions will not be valid.

Second, inflation inertia prevents a rapid stabilization of inflation even in very good circumstances. This is because past inflation to some extent carries over to current inflation, so it takes several months for a one-time decrease in inflation to have its full impact.

Third, under the presented assumptions, the findings suggest that one of the main driving forces behind domestic inflation is agricultural output growth. While exchange rate and monetary policies can make a significant difference, it is crucial to take into consideration the development of the agricultural economy, in particular the cereal market. Our findings thus suggest that successful policies should consider supporting both exchange rate stabilization, controlling money supply growth, and most importantly, boosting and stabilizing domestic food supply.

It is important to mention, however, that the framework presented here is for illustrative purposes only, as it is based on relationships observed in historical and highly aggregated data, which should be ideally supported by microeconomic evidence, to draw stronger conclusions. Moreover, a more complete macro-model would need to incorporate the balance of payments and foreign exchange shortages.

7. Concluding Remarks

We have analyzed the determinants of inflation in Ethiopia by estimating error correction models for cereal, food and non-food consumer prices and the CPI using monthly data from January 1999 to November 2008. The resulting models are highly parsimonious and appear reasonably well specified.

Our results show that inflation in Ethiopia is heavily associated with the dominant role of agriculture and food in the economy. In fact, Ethiopia's inflation is practically synonymous with food price inflation, and prices for major cereals, such as wheat, maize, teff, sorghum and barley matter most. However, contrary to the prevailing view, we find that the growth of food prices is determined in the external sector. In other words, the exchange rate and international prices explain a large fraction of Ethiopia's inflation: a one percent increase in world food prices eventually increases domestic food prices by one percent, unless the exchange rate changes. A realistic time span is about three years. Similarly, non-food price inflation appears to be determined in the external sector, but the evidence for the long run is not as strong.

There are large periodic deviations from the equilibrium relationship between domestic and foreign prices. These are mainly due to domestic agricultural supply shocks, but also to inter-seasonal fluctuations, which probably are induced by expectations about future harvests. Therefore, the influence of world market prices explains the presence of both food price inflation and high growth rates in agricultural production after 2004. On the other hand, the mid-2008 rapid food price increases are most likely due to pessimistic expectations about the harvest of cereals. Osborne (2004) documents several similar episodes in Ethiopia.

The key role played by world food prices is surprising, given the limited role of the private sector in formal grain imports. It was not the purpose of this study to evaluate the transmission mechanism from world to domestic food prices, but we highlight a few issues.

- First, the finding of a strong link between domestic food and world food prices is consistent with the observed large fluctuations of prices above or below import or export parity bands. Domestic food supply shocks along with inertial factors have a very strong effect on food inflation in the short to medium run, causing large deviations from long-run equilibrium. Another reason is the existence of market distortions. For instance, although domestic cereal prices were below import parity for quite some time, the private sector did not export significant amounts of cereals. Nor did it import much after the price rise in early 2008, when domestic prices were well above import parity. Restricted access to foreign exchange, a distorted financial sector, and more general uncertainty from the private sector about government interventions may have inhibited traders from taking advantage of significant business opportunities.

- Second, the food price error correction term measures excess supply and demand in the market for cereals, where not only the private sector, but also the government and donors are important actors. Since both the government and donors have responded to variations in harvests, at least since the mid-1990s, by increasing or decreasing exports and imports of grain and food aid, they might have limited the impact of local supply shocks on food prices and prevented them from moving far away from world market prices. Hence, private sector arbitrage as typically understood might not be the only mechanism behind the price transmission.

- Third, the authorities liberalized the domestic market for cereals in the beginning of the 1990s, so domestic prices are market determined. An important feature in this regard is the centralized wholesale grain market structure and improved information flows due to public investments in infrastructure. For example, Getnet, Verbeke and Viaene (2004) find that the wholesale market exhibits large concentration power and transmits price signals into the local producer markets. Furthermore, their results show – taking the example of white teff – that wholesale prices in Addis Ababa not only seem to determine long run but also the short-run prices in local supply markets. To this should be added that brokers in Addis Ababa

handle a very large fraction of the grain trade in Ethiopia, making the city a de facto clearinghouse for the country. These brokers are typically well informed and have information about both domestic and international food prices. As shown by Stephens et al. (2008) for Zimbabwe, there can be price transmission even without trade.

- Fourth, although Ethiopia's international trade in food items is very tiny relative to total agricultural production, it is not that small when compared to the total volume of marketed products. In quantity terms, the share of marketed crops from total agricultural production is about one third, and the share of agricultural exports from total marketed agricultural production, which includes coffee, may reach up to 30 percent. In other words, prices may matter at the margin, and a few internationally marketed products may transmit price signals into the subsistence sectors.

We do find a short-run impact from lagged money growth on cereal price inflation. In the long run, however, excess money supply does not seem to have been an important direct source of inflation, since it is insignificant at conventional significance levels in our specifications. The lack of significance of excess money could be due to the use of a small sample (10 years of monthly data). However, as many other variables are highly significant, insignificance could in this case still be an indication of a relatively weak impact.

In our view, the main reason for our failure to find that excess money causes long-run inflation is that monetary policy may have been ineffective due to excess liquidity in the banking system. Ethiopia has very large excess reserve ratios even by Sub-Saharan African standards. According to Saxegaard (2006), only Equatorial Guinea had a higher ratio in 2004. In an environment with large holdings of excess reserves, the monetary transmission mechanism is likely to be weakened or even interrupted completely (O'Connell, 2005). This is because banks can easily adjust excess reserve ratios when money demand changes, making the link between base money, which the central bank controls, and the money stock unstable. Moreover, banks can themselves generate money supply shocks. Another reason is that money demand could be unstable as a large part of the Ethiopian economy is not monetized, particularly the rural areas, so there is a great deal of barter trade. Movements of trade

in and out of the monetized sector could affect the coefficients in the money demand function. Moreover, most Ethiopians have very limited options when they wish to shift out of money to other assets.

We find considerable inflation inertia in the cereal price models but none in the non-food price models. The inflation inertia found in the model for CPI is thus due to the grain markets. Inertia is usually attributed to various factors: official and unofficial price indexation and expectations are the usual culprits. However, agricultural prices in Ethiopia are market determined and there is no indexation. Hence, the inertia is likely to be due to expectations about changes in prices after large agricultural shocks, such as drought or large increases in world food prices, or related to foreign exchange shortages and supply of imports.

The price dynamics between the food and non-food prices also indicate a difference in price flexibility. Since the error correction models determine the price level, as well as inflation, we can see that a permanent exogenous price increase leads to some overshooting of food prices, due to the inflation inertia, while non-food prices only increase slowly. This means that food prices are more flexible than non-food prices.

We use dummy variables to capture the explosive price increases in the cereal market in mid-2008. Our interpretation is that once it passed a certain threshold, the current food-price hike also raised forward-looking expectations. News about prices, future harvests and rainfall expectations can set a self-enforcing cycle in motion where farmers withhold supply in expectation of higher prices, thus causing prices to rise until harvesting begins (Ng and Ruge-Murcia, 2000; Osborne, 2004).

We failed to find direct evidence that world energy price inflation has a direct effect on domestic inflation. This is probably because we indirectly capture oil price inflation through its effect on world food and non-food prices. Another explanation is that the authorities subsidized fuel until October 2008, keeping domestic prices low.[23]

There is little evidence that structural changes in the agricultural sector have had a substantial impact on food price inflation. This finding is based on the stability of the empirical models and their coefficients. The test is very indirect, but microeconomic survey data support our result (IFPRI, 2008). In our view, this finding

[23] In October 2008, Ethiopia fully removed fuel subsidies to relieve growing pressure on the balance of payments.

is also plausible because structural change is gradual so the reforms are unlikely to generate high inflation by themselves.

We also produced forecasts of the future development of the CPI under four different scenarios from December 2008 to June 2010. Although highly tentative, the forecasts illustrate that annual inflation is likely to decrease even in the worst case where agricultural production decreases and the exchange rate depreciates. The reason is that world food prices are assumed to remain constant over the period. Although the forecasts should not be taken at face value because of many uncertainties, they stress the dominant role of domestic food supply and exchange rate policy, which combined with carefully designed monetary policies, could reduce inflation substantially. In all scenarios, inflation growth is likely to be at double-digit levels during 2009. Our results thus highlight a challenging time ahead and the need for a multi-pronged approach to fight inflation in Ethiopia.

In the short term, an option for the authorities is to ensure the stability of the Birr. However, stabilizing the nominal exchange rate vis-à-vis the Euro or the US dollar requires large foreign exchange reserves for interventions in the foreign exchange market. The challenge is that the National Bank of Ethiopia does not have sufficient reserves. Growing trade imbalances due to high fuel and fertilizer prices have brought the minimum reserve level down to a risky low level of only 5 weeks in December 2008. Therefore, there is a need for significant increases in capital inflows, including increased aid inflows. The authorities may thus be forced to address trade imbalances through increased export competitiveness by gradually devaluating the exchange rate, to reflect real developments in the foreign exchange market.

In the medium term, measures to boost and stabilize domestic agricultural supply and productivity, in particular for major food staples, are of cardinal importance. Moreover, monetary policy has to become more effective. Improved functioning of the financial sector and a more effective control of money supply could lead to a better management of price shocks.

There are several areas for future work. An analysis of the price transmission mechanisms in Ethiopia and its links to world markets would be of much interest. It would also be of interest to study the role of expectations and inertia in the price-formation process for cereals. Moreover, there is a need to understand better the transmission mechanisms of monetary policy.

The analysis could be improved in several ways. It would be useful to update and expand the sample: international food price indexes with weights corresponding to Ethiopia's consumer basket could be used instead of standard indexes. Moreover, wholesale prices or rainfall data could be used as alternative measures, or as complements, to the agricultural output gap. In addition, a small system of equations could help to capture interrelationships of the key explanatory variables, such as foreign reserves. Thus, our analysis should not be viewed as a "final product" but part of what Hendry (1995) calls a "progressive strategy" where new models improve and encompass old ones. Nevertheless, we believe that the findings of this paper do provide some interesting insights.

References

ADB. 2008. *Food Prices and Inflation in Developing Asia: Is Poverty Reduction Coming to an End?* Special Report. Manila: Asian Development Bank.

Ahmed, H.A. 2007. *Structural Analysis of Price Drivers in Ethiopia.* Addis Ababa: Ethiopian Development Research Institute. Processed.

Al-Mashat, R. and A. Billmeier. 2007. "The Monetary Transmission Mechanism in Egypt." *IMF Working Paper* WP/07/285.

Ayalew Birru, Y. 2007. *Explaining the Current Sources of Inflation in Ethiopia: A Macro-Econometric Approach.* Addis Ababa: National Bank of Ethiopia. Processed.

Bahmani-Oskooee, M. and A. Tankua. 2006. "Black market exchange rate, currency substitution and the demand for money in LDCs." *Economic Systems* 30(3): 249-263.

Barnichon, R. and S.J. Peiris. 2007. "Sources of Inflation in Sub-Saharan Africa." *IMF Working Paper* WP/07/32.

Batini, N. and E. Nelson. 2001. "The Lag from Monetary Policy Actions to Inflation: Friedman Revisited." *International Finance* 4(3): 381-400.

Belke, A. and T. Polliet. 2006. "Money and Swedish Inflation Reconsidered." *Journal of Policy Modeling* 28(8): 931-942.

Bigsten, A. and Shimeles A. 2008. "Poverty Transition and Persistence in Ethiopia: 1994-2004." *World Development* 36(9): 1559-1584.

Blavy, R. 2004. "Inflation and Monetary Pass-Through in Guinea." *IMF Working Paper* WP/04/223.

Castle, J.L. and D.F. Hendry. 2009. "The long-run determinants of UK wages, 1860–2004." *Journal of Macroeconomics* 31(1): 5-28.

Deaton, A. 1999. "Commodity Prices and Growth in Africa." *Journal of Economic Perspectives* 13(3): 23-40.

Diouf, M.A. 2007. "Modeling Inflation for Mali." *IMF Working Paper* WP/07/295.

Dornbusch, R. 1980. *Open Macroeconomics.* New York: Basic Books.

Doornik, J.A. and D.F. Hendry. 2007. Empirical *Econometric Modelling: PcGive 12*, Vol. 1, Timberlake Consultants Press, London.

Dorosh, P.A. and L. Subran. 2007. "Food Markets and Food Price Inflation in Ethiopia." *Background paper for the Food Price Inflation Policy Note.* Washington DC: World Bank. Processed.

Dridi, J. and K. Zieschang. 2002. "Compiling and Using Export and Import Price Indices" *IMF Working Paper* WP/02/230.

Durevall, D. and N. Ndung'u. 2001. "A dynamic model of inflation of Kenya, 1974-96." *Journal of African Economies* 10(1): 92-125.

EARS. 2008. "Fast Crop Yield Forecast East Africa." EARS Earth Environment Monitoring BV. http://www.ears.nl/crop_yield_forecast_east_africa.php (accessed January 2009).

Elliott, G. and A. Timmermann. 2008. "Economic Forecasting." *Journal of Economic Literature* 46(1): 3-56.

Ericsson, N.R. and Steven B. Kamin. 2008. “Constructive data mining: modeling Argentine broad money demand.” *International Finance Discussion Papers* 943. Board of Governors of the Federal Reserve System.

Ericsson, N.R., D. F. Hendry, and K.M. Prestwich. 2002. “The Demand for Broad Money in the United Kingdom, 1878–1993.” *Scandinavian Journal of Economics* 100(1): 289-324.

Getnet, K., W. Verbeke, and J. Viaene. 2005. ”Modeling spatial transmission of the grain markets of Ethiopia with and application of ARDL approach to white teff.” *Agricultural Economics* 33(3): 491-502.

FAO and OECD. 2008. *OECD-FAO Agricultural Outlook 2008-2017.* Paris: Organisation for Economic Co-operation and Development and Food and Agricultural Organization of the United Nations.

FAO. 2008. *Crop Prospects and Food Situation in Ethiopia*. Rome: Food and Agricultural Organization of the United Nations. Processed.

Frankel, J. 2006. “The Effects of Monetary Policy on Real Commodity Prices.” *NBER Working Paper* 12713.

Garcia-Herrero, A. and M.V. Pradhan. 1998. “The Domestic and Foreign Price Gaps in the P-STAR Model: Evidence from Spain.” *IMF Working Paper* WP/98/64.

Gerlach, S. and L.E. Svensson. 2003. “Money and inflation in the euro area: A case for monetary indicators?” *Journal of Monetary Economics* 50(8): 1649-1672.

Gray, G. 2007. “Estimating Production in Ethiopia.” *Background paper for the Food Price Inflation Policy Note*. Washington DC: World Bank. Processed.

Helbling, T., V. Mercer-Blackman, and K. Chang. 2008. “Riding a Wave: Soaring Commodity Prices May Have a Lasting Impact.” *Finance and Development* 45(1).

Hendry, D. F. 1995. *Dynamic Econometrics*. Oxford: Oxford University Press.

Hendry, D. F. and H.-M Krolzig. 2001. *Automatic Econometric Model Selection*, Timberlake Consultants Press, London.

Hendry, D. F. and B. Nielsen. 2007. *Econometric modeling: a likelihood approach.* Princeton: Princeton University Press.

Hoover, K. D., and S. J. Perez. 1999. “Data mining reconsidered: Encompassing and general-to-specific approach to specification search.” *Econometrics Journal* 2(3): 167-191.

IMF. 2002. **“**Federal Democratic Republic of Ethiopia: 2002 Article IV Consultation and Third Review Under the Poverty Reduction and Growth Facility Arrangement Staff Report.” *IMF Country Report* 02/220. Washington DC: International Monetary Fund.

IMF. 2007. “Federal Democratic Republic of Ethiopia: 2007 Article IV Consultation Staff Report.” *IMF Country Report* 07/247. Washington DC: International Monetary Fund.

IMF. 2008a. “Federal Democratic Republic of Ethiopia: 2008 Article IV Consultation Staff Report.” *IMF Country Report* 08/264. Washington DC: International Monetary Fund.

IMF. 2008b. “Federal Democratic Republic of Ethiopia: Selected Issues.” *IMF Country Report* 08/259. Washington DC: International Monetary Fund.

IMF. 2008c. **"**Federal Democratic Republic of Ethiopia: Statistical Appendix." *IMF Country Report* 08/260. Washington DC: International Monetary Fund.

IMF. 2008d. *Food and Fuel Prices: Recent Developments, Macroeconomics Impact, and Policy Responses.* Fiscal Affairs, Policy Development and Review, and Research Departments, Washington DC: International Monetary Fund.

IFPRI. 2008. *Preliminary Findings from an EDRI-IFPRI Research Workshop on Cereal Availability in Ethiopia: Producers, Traders, and the Policies.* Addis Ababa: International Food Policy Research Institute and Ethiopian Development Research Institute. Processed policy briefs, December 2008.

Jonsson, G. 2001. "Inflation, Money Demand, and Purchasing Power Parity in South Africa." *IMF Staff Papers* 48(2): 243-265.

Juselius, K. 1991. "Domestic and Foreign effects on Prices in an Open Economy: The Case of Denmark." *Journal of Policy Modeling* (14): 401-428.

Juselius, K. 2006. *The Cointegrated VAR Model: Methodology and Applications*. Oxford: Oxford University Press.

Kamin, S. 1996. "Real Exchange Rates and Inflation in Exchange Rate-Based Stabilizations: An Empirical Examination." *International Finance Discussion Papers* 554.

Khan, M.S. and A. Schimmelpfennig. 2006. "Inflation in Pakistan: Money or Wheat?" *IMF Working Paper* WP/06/60.

Kool, C.J. and J.A. Tatom. 1994. "The P-STAR Model in Five Small Economies." *Review* 1994: 11-29.

Krichene, N. 2008. "Recent Inflationary Trends in World Commodities Markets." *IMF Working Paper* WP/08/130.

Loening, J. 2007. "Inflationary Expectations in Ethiopia." *Background paper for the Food Price Inflation Policy Note.* Washington DC: World Bank. Processed.

Loening, J. and G. Oseni. 2008. "Approximating Rural and Urban Welfare Impacts of Food Price Inflation in Ethiopia." *Background paper for the Food Price Inflation Policy Note.* Washington DC: World Bank. Processed (original 2007, updated 2008).

Mitchell, D. 2008. "A note on rising food prices." *World Bank Policy Research Working Paper* 4682.

Mishkin, F.S. 1995. "Symposium the Monetary Transmission Mechanism." *Journal of Economic Perspectives* 9(4): 3-10.

Moriyama, K. 2008. "Investigating Inflation Dynamics in Sudan." *IMF Working Paper* WP/08/189.

NBE. 2008. *The Monthly Macroeconomic Indicators for the Month of July 2008.* Addis Ababa: National Bank of Ethiopia.

Nell, K.S. 2004. "The structuralist theory of imported inflation: an application to South Africa", *Applied Economics* 36(13): 1431-1444.

Ng, S. and F.J. Ruge-Murcia. 2000. "Explaining the Persistence of Commodity Prices" *Journal of Computational Economics* 16(1-2): 149-171.

O'Connell. 2005. "Note on Excess Liquidity." International Monetary Fund. Processed.

Osborne, T. 2004. “Market News in Commodity Price Theory: Application to the Ethiopian Grain Market.” *The Review of Economic Studies* 71(1): 133-164.

Pugel, T. and K. Odell. 2006. *Study Guide to Accompany International Economics: Theory and Policy*. Boston: McGraw-Hill.

Santos, C. 2008. “Impulse saturation break tests.” *Economic Letters* 98(2) 136-143.

Saxegaard, M. 2006. “Excess Liquidity and the Effectiveness of Monetary Policy: Evidence from Sub-Saharan Africa.” *IMF Working Paper* WP/06/115.

Sterken, E. 2004. “Demand for money and shortages in Ethiopia.” *Applied Economics Letters* 11(12): 759-769.

Stephens, E., E. Mabaya, S. von Cramon-Taubadel, and C. B. Barrett. 2008. “ Spatial Price Adjustment with and without Trade.” *Department of Applied Economics and Management Working Paper*. Cornell University.

Tadesse, G. and A Guttormsen. 2008. “Commodity Price Dynamics in Ethiopia: Do speculators destabilize the market?” Paper presented at the 6th International Conference on the Ethiopian Economy, July 3 - 5, 2008, Addis Ababa. Processed.

Trostle, R. 2008. “Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices.” *USDA Outlook* WRS-080.

Ubide, A. 1997. “Determinants of Inflation in Mozambique.” *IMF Working Paper* WP/97/145.

Ulimwengu, J.M., S. Workneh, and Z. Paulos. 2009. “Impact of Soaring Food Price in Ethiopia: Does Location Matter?” *IFPRI Discussion Paper* 846.

von Braun, J. 2007. “The World Food Situation: New Driving Forces and Required Actions.” *Food Policy Report* 18. Washington DC: International Food Policy Research Institute.

World Bank. 2007. *Ethiopia: Explaining Food Price Inflation: Policy Note.* Washington DC. Processed.

World Bank. 2008. *Country Assistance Strategy for the Federal Republic of Ethiopia.* Report No. 43051-ET. Washington DC.

APPENDIX

I. Additional Tables

Table A1: Main components of the CPI

Component	Weight	Component	Weight
Non-Food	42.99	*Oils, fats*	2.39
House rent, construction, water, fuel, power	20.56	*Vegetables*	2.55
Food total	57.01	*Spices*	1.97
Cereals	22.54	*Potatoes, other tubers, stems*	4.16
Pulses	4.31	*Coffee, tea*	4.27
Bread, other prepared food	1.87	*Other food items*	1.23
Meat	2.82	*Milling charges*	1.17
Milk, cheese, eggs	1.96	*Food taken away from home*	5.76

Table A2. Augmented Dickey-Fuller tests for unit roots

Variables	t-ADF	Period	Lags	Variables	t-ADF	Period	Lags
p	-0.92	2000:1-2008:11	1	Δp	-4.53**	2000:1-2008:11	0
pnf	1.88	2000:1-2008:11	0	Δpnf	- 3.11*	2000:1-2008:11	2
pf	-1.49	2000:1-2008:11	1	Δpf	-4.54**	2000:1-2008:11	0
pc	-1.69	2000:1-2008:11	1	Δpc	-5.08**	2000:1-2008:11	0
e	-2.77	2000:1-2008:11	1	Δe	-6.76**	2000:1-2008:11	0
tot	-1.43	2000:1-2008:3	0	Δtot	-8.30**	2000:1-2008:3	0
$\Delta_{12} eus$	-1.47	2000:1-2008:11	1	$\Delta\Delta_{12} eus$	-6.78**	2000:1-2008:11	0
wfp	-2.46	2000:1-2008:11	1	Δwfp	-5.20**	2000:1-2008:11	0
wp	-1.76	2000:1-2008:11	1	Δwp	-4.57**	2000:1-2008:11	0
m	-0.33	2000:1-2008:11	0	Δm	-10.48**	2000:1-2008:11	1
$m-p$	-1.90	2000:1-2008:11	3	$\Delta(m-p)$	-5.69**	2000:1-2008:11	0
y	-1.75	2000:1-2008:11	2	Δy	-3.17*	2000:1-2008:11	1
ag	-3.15*	2000:1-2008:11	2	$\Delta fert$	-4.85**	2000:1-2008:11	0
				$\Delta energy$	-7.38**	2000:1-2008:11	1

Note: A trend was used when testing the variables in log-levels. The significance levels for the tests with constant and seasonals: 10 percent = 2.58, 5 percent =-2.89 and 1 percent =-3.50. With constant, seasonal dummies and trend: 10 percent 3.15, 5 percent =-3.45 and 1 percent =-4.05.

* Indicates significance at 5 percent, and ** at 1 percent level.

II. The P-Star Model for Ethiopia

Since our study period is only about ten years and there are many market distortions in Ethiopia, we also used the P-Star model of inflation to derive the long-run relationships in the monetary and foreign exchange sectors. Although cointegration analysis is employed in the P-Star literature, a common approach is to use the Hodrick-Prescott filter to calculate deviations from equilibrium (Belke and Polliet, 2006). This approach sidesteps the problem of not having adequate measures of own and alternative returns to holding money and the variables needed to estimate the equilibrium real exchange rate. Hence, it has potentially several advantages when analyzing inflation in Ethiopia.

The P-star model is based on the idea that excess money supply creates inflation. This means that the difference between the log of the actual real money stock and the long-run equilibrium real money stock leads to price adjustments. In the P-Star model the equilibrium real money stock, $(m - p^*)$, is determined by the quantity theory, $(m - p^*) = y^* - v^*$, where v is velocity, $v = p + y - m$, and the asterisk indicates long-run equilibrium velocity and potential output. The difference between the actual and the equilibrium real money stock, $(m - p) - y^* + v^*$, is the variable of interest. It is viewed as the monetary overhang (Gerlach and Svensson, 2003). We use the Hodrick-Prescott filter to estimate y^* and v^*.[24] Figure 1A below shows the monetary overhang calculated with broad money, roughly M2, which is very similar to a series calculated with M1. We use the series for broad money as an alternative to the error correction term for the long-run money demand to test for the influence of money on inflation.

The specification of the external sector is based on a general model of the long-run exchange rates, described for example in Pugel and Odell (2006, pp. 389-396), which differs somewhat from Equation 2. Assuming the nominal exchange rate is controlled by the authorities, the price level and the real exchange rate are related in the following way, $p^* = e + pf - q^*$, where q^* is the equilibrium real exchange rate and p^* is the equilibrium price level. When there is a deviation between the actual domestic price level and the equilibrium level, prices adjust according

[24] We set λ to 6,400 to obtain a very smooth and slowly changing trend.

Figure A1: Monetary overhang, $(m-p)-y^{*}+v^{*}$.

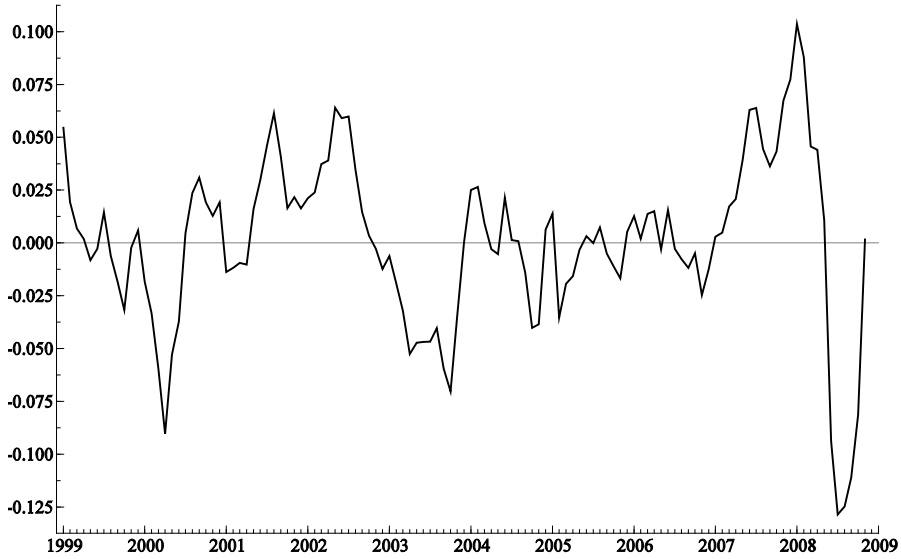
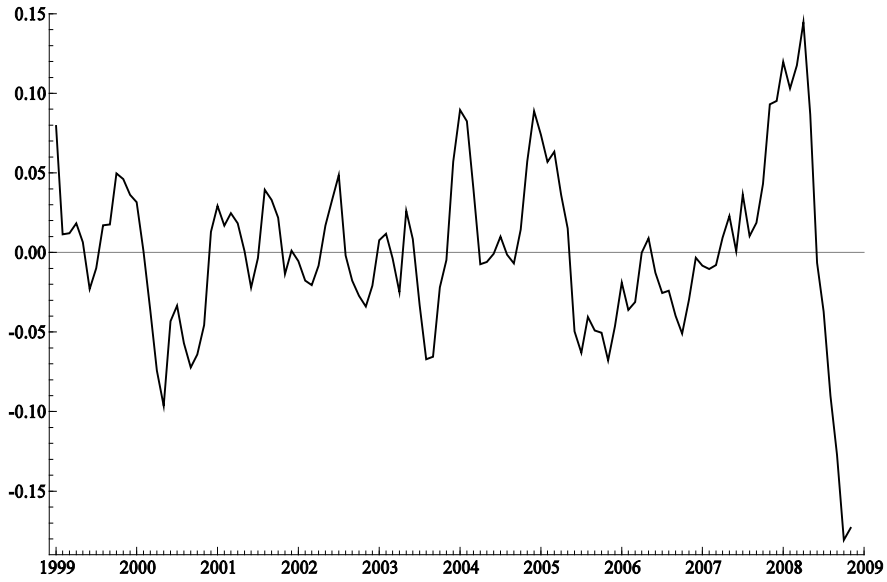


Figure A2. Deviation from long-run equilibrium real exchange rate $(e+wpp-p)-trend$.

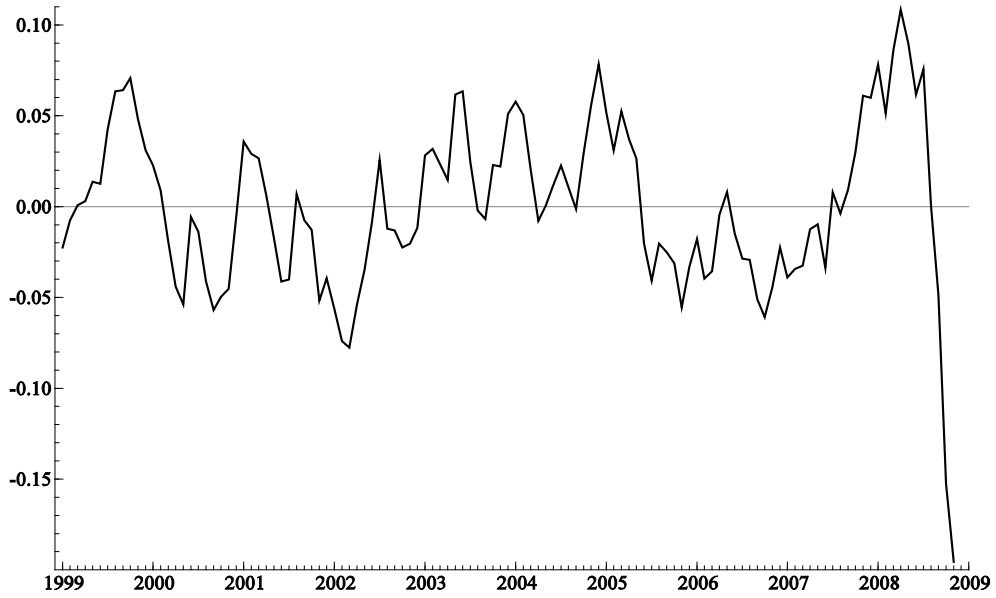


to $p-p^{*}=p-(e+pf-q^{*})$ where the left hand side shows the price gap due to pressures from the external sector.

The Hodrick-Prescott filter is used remove the non-stationary component of the real exchange rate, following Kool and Tatom (1994) and Garcia-Herrero and Pradhan (1998).[25] Hence, the trend obtained is assumed to measure the long-run real equilibrium exchange rate, which in practice is the same as τ in Equation 2, or at least

[25] To obtain a very smooth equilibrium real exchange the parameter λ was set to 6,400.

Figure A3: Deviation from long-run equilibrium real exchange rate calculated with non-food price index $(e + wp - pnf) - trend$.



to capture the level that is relevant for the adjustment of prices in the goods market. Figures 2A and 3A show the external sector price gap, calculated with CPI and the non-food price index.

We use the monetary overhang of the P-Star approach as an alternative measure for the money market, and test its significance and potential impact on CPI and cereal inflation in section 5.4.

III. The Real Exchange Rate and Terms of Trade

Purchasing power parity does not hold for $e + wp - p$, so to estimate the equilibrium real exchange rate we use the log of terms of trade (*tot*) (see Durevall and Ndung'u, 2001 and Diouf, 2007). Figure 6 depicts $e + wp - p$, and the log of the inverse of terms of trade, and they do appear to have the same stochastic trend and to be cointegrated.

Table A2 reports the cointegration test, and it indicates that there is one cointegrating vector. The test for two vectors is significant at the 10 percent level, but this implies that both series are stationary, which is unlikely (see also Figure A4). The estimated long-run relationship is thus $(e + wp - p) + 0.3tot$, and *tot* appears to be weakly exogenous since its adjustment parameter is insignificant. Nevertheless, it does not enter significantly in any the models of inflation (not reported). Figure A5 shows the cointegrating vector. We also tested for cointegration between $e + wp - pnf$ and *tot*, but failed to find a stationary vector.

Table A2: Cointegration analysis of the external sector, 2000:1-2008:7

Rank test		
Null hypothesis	r=0	r≤1
Eigenvalues	0.141	0.049
Trace statistic	21.00	5.266
Probability-value	0.006	0.22
Standardized eigenvector		
	$e + wpp - p$	tot
	1.00	0.301
	[0.00]	[0.054]
Standardized adjustment coefficients		
	-0.150	0.084
	[0.042]	[0.079]

Note: The VAR includes three lags on each variable and centered seasonal dummy variables. Standard errors are in brackets.

Figure A4: Log of real exchange rate, $e + wpp - p$, (left Y-axis) and the log of the inverse of terms of trade (right Y-axis)

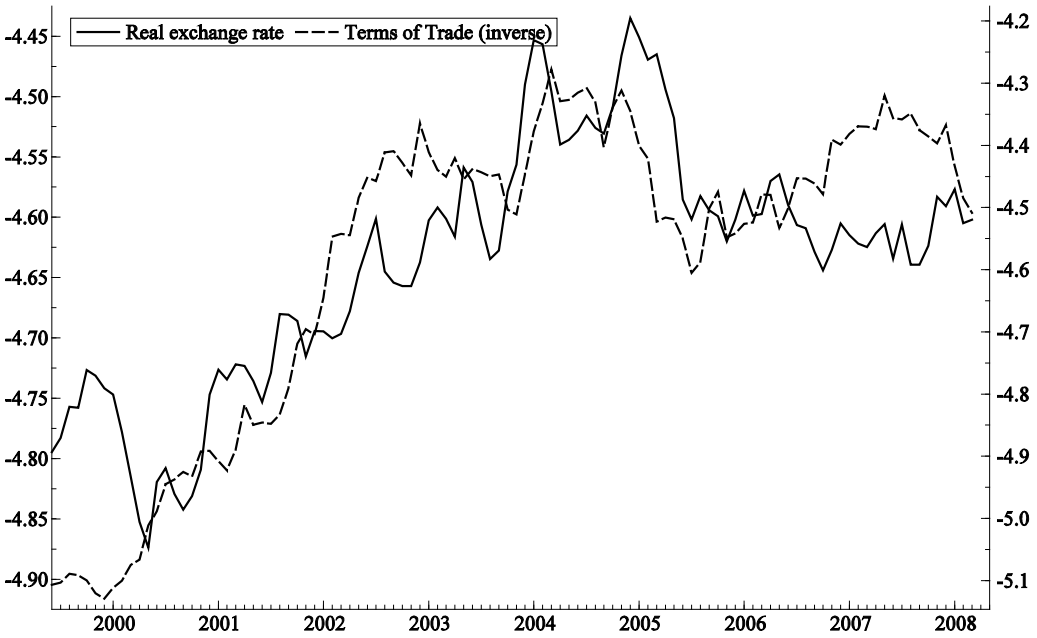
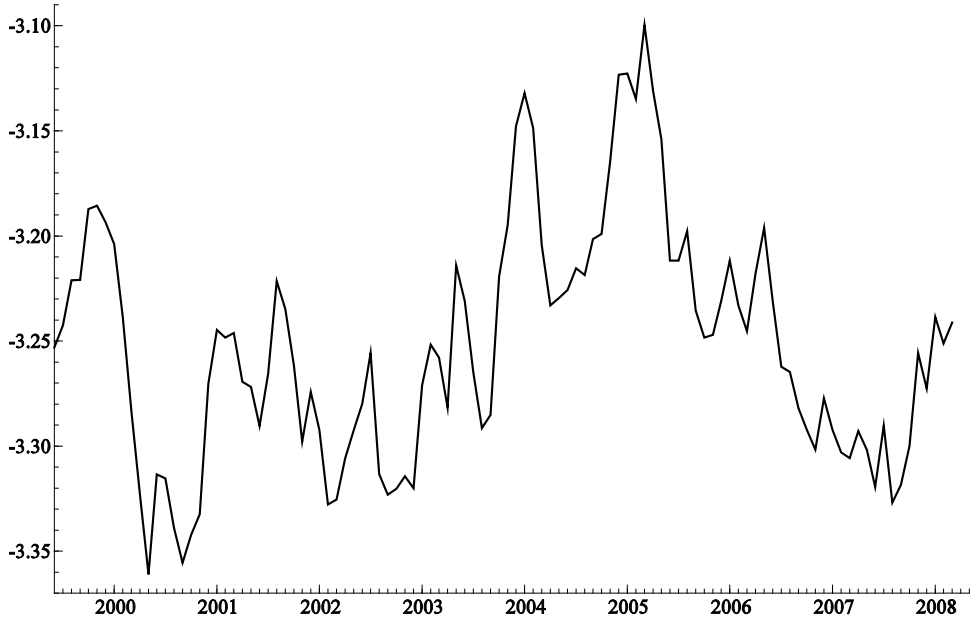


Figure A5: External sector cointegrating vector, $(e + pfor - p) + 0.3tot$.



VI. Data

Agricultural output gap: Annual agricultural production data is from the National Statistical Agency of Ethiopia. The monthly agricultural output gap was estimated by interpolating annual crop production, cereals in metric ton, to monthly observation with the procedure "Distribute" from the RATS econometrics software package. The underlying process was assumed to be a random walk. The trend in agricultural production was estimated with the Hodrick-Prescott filter assuming $\lambda = 6{,}400$. The value for 2008/09 is based on EARS (2008) satellite data, predicting 6 percent decline compared to 2007/08. The value for 2009/10 is assumed to be in line with the average growth rate since 2003/04, partly because this is the best guess we can make, and partly because it creates a gap during 2008/09. We also calculated the output gap with value added in agricultural production, but there are only small differences between the series.

Consumer prices indexes: Central Statistical Agency of Ethiopia. The base is December 2006. Observations for July and August 2000 for the Food CPI and overall CPI are interpolated, in consultation with the Central Statistical Agency.

GDP: National Bank of Ethiopia. GDP at 1999/2000 constant prices in million of Birr. Monthly GDP was estimated by interpolating annual GDP with RATS. The underlying process was assumed to be a random walk. The trend in GDP was estimated with the Hodrick-Prescott filter assuming $\lambda = 6{,}400$.

Money supply: Money and Broad Money from the National Bank of Ethiopia.

Nominal exchange rate: National Bank of Ethiopia. Until February 2008 the Birr-US dollar exchange rate is the parallel exchange rate. Since March 2008, we use the official exchange rate because of the closure of the parallel foreign exchange market. The premium in February 2008 was used to scale down the parallel market rate to merge the two series. The scale factor is 0.935. The Birr-Euro exchange rate is the official exchange rate.

Real effective exchange rate: Own calculations with weights for the 10 largest trading partners, based on data from the National Bank of Ethiopia, IFS and COMTRADE.

Terms of trade: Simple terms of trade index or $TT_t = P_{x,t} / P_{m,t}$ where $P_{x,t}$ represents the export price index, and $P_{m,t}$ represents the export price index. To construct the export and import price indexes we follow Dridi and Zieschang (2002). We use data from the Ethiopia's customs authorities on trade values and volumes, domestic prices from the Central Statistical Agency, and the IMF World Market Price Index. Units of the trade values were converted into Birr using the official Birr-US$ exchange rate. Other definitions of the terms of trade or the use of partner country statistics give very similar series.

World commodity prices: Various indexes and forecasts from the Development Prospects Group of the World Bank as of July 2008. The Grain price index is a weighted average of rice, maize, wheat, barley and sorghum. The energy price index is a weighted average of natural gas and crude oil. The fertilizer index is a weighted average of phosphate rock, phosphate, potassium and nitrogenous.

World non-food producer prices: Eurostat and IFS. Producer price indexes are from the Euro area only. US producer prices are from the wholesale price index. Dataset name: Short-Term Statistics.

Table A3: Variable definitions

Variables (in logs)	
p	CPI
pnf	Non-food CPI
pf	Food CPI
pc	Cereal CPI
e	Birr-Euro exchange rate
$\Delta_{12} eus$	Annual change in Birr-US$ exchange rate
wfp	International grain price index
wp	International producer prices
tot	Terms of trade
y	GDP
m	Money stock, M2
$m-p$	Real money stock, M2
ag	Agricultural output gap
$e-wp-p$	Real effective exchange rate
$e-wp-pnf$	Relative non-food prices / real exchange rate, non-food
$e-wfp-pc$	Relative cereal price / real exchange rate, food
$\Delta fert$	Growth rate in international fertilizer price index
$\Delta energy$	Growth rate in international energy price index

Table A4: Time Series, 1997:1-2008:11

	Euro-Dollar exchange rate	Bitrr-Dollar Exange rate	Bitrr-Euro exchange rate	Bitrr-Dollar parallel exchange rate	TOT	Food CPI	Cereals CPI	No food CPI	CPI	World Bank grain index	World Bank fertilizer index	World Bank energy index	Broad money	Money	Currency	EU PPI	EU CPI	GDP	Agricultural production
1997-1	#N/A	6.466	#N/A	6.639	#N/A	#N/A	#N/A	#N/A	#N/A	151.4	128.8	84.1	#N/A	#N/A	#N/A	#N/A	#N/A	4986.8	2731.1
1997-2	#N/A	6.627	#N/A	6.676	#N/A	#N/A	#N/A	#N/A	#N/A	150.7	123.3	74.0	#N/A	#N/A	#N/A	#N/A	#N/A	4984.7	2709.3
1997-3	#N/A	6.648	#N/A	6.704	#N/A	#N/A	#N/A	#N/A	#N/A	151.0	119.6	70.2	#N/A	#N/A	#N/A	#N/A	#N/A	4981.1	2683.1
1997-4	#N/A	6.603	#N/A	6.676	#N/A	#N/A	#N/A	#N/A	#N/A	148.1	114.4	66.1	#N/A	#N/A	#N/A	#N/A	#N/A	4976.2	2652.7
1997-5	#N/A	6.634	#N/A	6.695	#N/A	#N/A	#N/A	#N/A	#N/A	146.2	109.1	70.9	#N/A	#N/A	#N/A	#N/A	#N/A	4969.8	2618.1
1997-6	#N/A	6.773	#N/A	6.723	#N/A	#N/A	#N/A	#N/A	#N/A	137.3	108.1	66.3	#N/A	#N/A	#N/A	#N/A	#N/A	4962.1	2579.2
1997-7	#N/A	6.742	#N/A	6.732	#N/A	59.7	47.1	77.2	64.9	131.2	104.8	67.5	#N/A	#N/A	#N/A	#N/A	#N/A	4952.9	2536.1
1997-8	#N/A	6.768	#N/A	6.742	#N/A	59.2	50.1	79.5	67.3	132.3	101.2	69.4	#N/A	#N/A	#N/A	#N/A	#N/A	4947.0	2498.3
1997-9	#N/A	6.803	#N/A	6.760	#N/A	56.4	50.5	77.3	64.8	130.2	96.7	69.8	#N/A	#N/A	#N/A	#N/A	#N/A	4944.2	2466.1
1997-10	#N/A	6.812	#N/A	6.816	#N/A	56.3	49.4	76.8	64.5	133.7	97.6	74.2	#N/A	#N/A	#N/A	#N/A	#N/A	4944.7	2439.2
1997-11	#N/A	6.804	#N/A	6.807	#N/A	55.4	47.3	76.8	63.9	129.8	98.2	76.7	#N/A	#N/A	#N/A	#N/A	#N/A	4948.4	2417.7
1997-12	#N/A	6.834	#N/A	6.811	#N/A	54.5	43.5	75.3	62.8	129.2	101.5	63.3	#N/A	#N/A	#N/A	#N/A	#N/A	4955.2	2401.7
1998-1	#N/A	6.874	#N/A	6.499	#N/A	54.5	42.8	75.1	62.7	130.8	98.2	56.7	#N/A	#N/A	#N/A	96.2	96.1	4965.3	2391.1
1998-2	#N/A	6.914	#N/A	6.442	#N/A	55.2	43.3	75.2	63.2	132.0	98.2	54.5	#N/A	#N/A	#N/A	96.1	96.4	4978.6	2386.0
1998-3	#N/A	6.941	#N/A	6.480	#N/A	55.0	45.1	74.8	62.9	132.1	102.1	51.3	#N/A	#N/A	#N/A	96.0	96.5	4995.2	2386.2
1998-4	#N/A	6.984	#N/A	6.480	#N/A	55.3	44.9	74.2	62.9	129.1	102.1	52.5	#N/A	#N/A	#N/A	95.9	96.7	5014.9	2391.9
1998-5	#N/A	7.052	#N/A	6.527	#N/A	56.5	47.4	74.1	63.5	129.4	100.1	53.5	#N/A	#N/A	#N/A	95.8	96.9	5037.8	2403.9
1998-6	#N/A	7.059	#N/A	6.573	#N/A	57.0	50.3	73.4	63.5	127.7	97.8	48.8	#N/A	#N/A	#N/A	95.6	97.0	5064.0	2419.6
1998-7	#N/A	7.109	#N/A	6.676	#N/A	57.9	52.5	72.9	63.9	125.2	98.8	49.3	#N/A	#N/A	#N/A	95.4	97.9	5093.3	2441.5
1998-8	#N/A	7.202	#N/A	7.013	#N/A	58.9	53.9	73.7	64.8	115.9	98.4	47.5	#N/A	#N/A	#N/A	95.2	97.8	5121.9	2461.3
1998-9	#N/A	7.145	#N/A	6.975	#N/A	61.2	56.2	74.6	66.5	115.1	96.6	51.8	#N/A	#N/A	#N/A	95.0	97.9	5149.7	2479.9
1998-10	#N/A	7.270	#N/A	7.003	#N/A	62.6	59.4	73.2	66.5	120.2	91.2	49.9	#N/A	#N/A	#N/A	94.7	96.9	5176.7	2494.4
1998-11	#N/A	7.342	#N/A	7.062	#N/A	58.5	49.2	73.5	64.5	118.2	90.8	45.8	#N/A	#N/A	#N/A	94.4	96.9	5202.9	2507.7
1998-12	#N/A	7.502	#N/A	7.184	#N/A	56.6	44.9	74.3	63.7	117.3	89.4	40.9	#N/A	#N/A	#N/A	94.2	97.0	5228.3	2518.9
1999-1	0.861	7.512	8.725	7.153	#N/A	57.8	44.7	78.0	65.8	121.1	88.4	44.0	18215.6	10645.7	5065.0	93.9	96.9	5252.9	2527.9
1999-2	0.892	7.539	8.452	7.265	#N/A	64.1	56.8	74.7	68.3	114.7	88.9	41.8	18453.9	10875.0	5168.4	93.8	97.1	5276.8	2534.7
1999-3	0.919	7.727	8.408	7.471	#N/A	64.1	49.8	74.1	68.1	112.2	92.7	49.0	18370.5	10740.3	5190.3	93.9	97.5	5299.9	2539.3
1999-4	0.934	7.907	8.466	7.480	#N/A	64.1	52.0	75.1	68.5	107.6	89.2	57.5	18607.6	10916.6	5171.6	94.3	97.7	5322.2	2541.8
1999-5	0.941	7.909	8.405	7.490	#N/A	65.5	56.8	74.1	68.9	108.0	89.7	58.3	18749.3	10986.2	5166.1	94.3	97.8	5343.7	2542.1
1999-6	0.964	7.975	8.273	7.518	165.2	67.9	65.1	73.5	70.1	109.6	88.4	59.4	19399.3	11378.9	5196.4	94.5	97.8	5364.4	2540.3
1999-7	0.966	8.121	8.407	7.677	164.5	69.2	65.1	73.2	70.8	103.9	87.3	67.3	20164.6	11974.6	5151.1	95.9	97.9	5384.4	2536.3
1999-8	0.943	8.119	8.610	7.817	162.1	68.8	65.1	73.9	70.8	104.2	88.7	71.9	19992.5	11796.0	5037.4	95.2	98.1	5404.8	2535.3
1999-9	0.952	8.119	8.528	7.836	162.6	68.3	63.3	73.8	70.5	102.6	87.6	79.0	19890.1	11602.0	4888.0	95.6	98.2	5431.8	2537.5
1999-10	0.934	8.122	8.696	7.649	164.0	66.4	60.3	75.4	70.0	99.4	87.0	77.2	19721.4	11417.1	4845.8	96.0	98.2	5459.3	2542.7
1999-11	0.967	8.126	8.403	7.658	167.4	63.5	54.1	75.1	68.1	101.0	86.2	83.3	20021.0	11655.6	5035.9	96.3	98.4	5489.3	2556.9
1999-12	0.989	8.132	8.222	7.742	168.9	62.5	51.5	75.4	67.7	101.2	86.9	86.3	20295.5	11853.5	5540.0	96.7	98.7	5521.8	2562.3
2000-1	0.987	8.138	8.245	7.705	165.1	63.1	52.2	75.2	68.0	106.0	91.4	87.9	20383.7	11967.4	5643.5	97.5	98.9	5547.4	2574.7
2000-2	1.017	8.148	8.012	7.808	164.0	64.2	53.0	76.7	69.2	107.3	96.2	94.0	20469.6	12002.1	5732.5	97.9	99.1	5594.4	2594.2
2000-3	1.037	8.161	7.870	8.013	160.0	66.0	55.4	78.2	70.9	104.5	93.3	95.1	20686.6	12100.6	5724.9	98.4	99.4	5634.5	2614.8
2000-4	1.056	8.178	7.744	7.901	158.6	68.2	57.4	79.4	72.6	102.9	92.3	83.5	20827.2	12190.9	5884.5	98.7	99.5	5677.1	2638.4
2000-5	1.104	8.198	7.426	7.929	159.1	67.7	57.9	77.7	71.7	102.7	96.9	95.4	21610.9	12730.4	5738.1	99.4	99.6	5722.2	2665.1
2000-6	1.054	8.216	7.795	7.985	146.7	67.6	58.2	77.5	71.5	97.0	103.8	103.8	22177.8	13050.2	5914.3	99.7	100.0	5769.8	2694.9
2000-7	1.064	8.230	7.735	8.107	140.4	64.8	58.6	78.9	70.5	90.8	110.7	99.4	23123.7	13714.9	5862.7	100.3	100.1	5820.0	2727.8
2000-8	1.106	8.240	7.450	8.219	139.4	62.7	57.1	78.5	69.6	90.3	113.0	103.3	23566.5	13942.0	5842.1	100.6	100.2	5866.7	2757.7
2000-9	1.147	8.248	7.191	8.228	137.7	62.6	53.9	77.8	68.7	93.3	102.6	113.0	23725.2	14003.7	5696.4	101.5	100.6	5910.1	2784.7
2000-10	1.170	8.262	7.062	8.313	138.7	60.8	51.5	76.3	67.0	99.2	104.6	111.2	23180.6	13378.2	5482.2	102.0	100.7	5950.1	2800.8
2000-11	1.168	8.283	7.092	8.393	133.2	59.0	48.8	76.5	66.0	101.0	97.2	114.8	22969.3	13288.7	5474.0	102.2	100.9	5986.7	2829.9
2000-12	1.115	8.306	7.449	8.266	133.1	56.9	44.5	76.9	64.9	105.0	98.1	98.9	23010.9	13014.5	5624.0	101.8	101.2	6019.9	2848.1
2001-1	1.066	8.328	7.812	8.238	135.4	59.7	49.2	77.6	66.8	104.9	106.0	100.4	23229.1	13159.0	5666.8	102.1	100.8	6049.8	2863.4
2001-2	1.085	8.356	7.701	8.247	137.4	59.5	49.2	77.1	66.6	102.3	99.3	100.7	23456.5	13290.7	5872.4	102.3	101.0	6076.2	2875.7
2001-3	1.100	8.389	7.626	8.247	132.8	57.6	46.6	76.5	65.1	100.6	96.2	93.5	23289.3	13059.6	5896.1	102.4	101.6	6099.3	2885.1
2001-4	1.121	8.412	7.504	8.238	123.8	56.1	45.9	76.9	64.4	97.8	91.0	95.6	23261.8	12952.7	5819.8	102.7	102.3	6119.0	2894.6
2001-5	1.144	8.431	7.370	8.135	127.6	55.4	43.6	77.2	64.1	97.5	89.1	99.7	24032.9	13419.6	5839.8	102.8	102.7	6135.9	2895.1
2001-6	1.172	8.451	7.211	8.107	127.2	55.0	43.3	77.1	63.8	96.2	89.3	97.3	24516.2	13745.8	5911.8	102.8	102.9	6148.2	2895.7
2001-7	1.162	8.473	7.292	8.107	127.4	53.0	40.8	77.2	62.7	99.9	91.0	89.3	24737.7	13825.3	5920.0	102.3	102.6	6157.7	2893.4
2001-8	1.111	8.493	7.644	8.116	125.6	53.0	41.7	76.8	62.5	99.8	91.7	92.2	25306.2	14232.7	5925.5	102.2	102.5	6162.9	2887.1
2001-9	1.098	8.513	7.753	8.088	120.3	53.4	41.2	78.7	63.5	99.2	92.0	89.1	25416.8	14238.6	5769.5	102.3	102.8	6163.7	2878.7
2001-10	1.104	8.533	7.729	8.144	112.0	53.4	40.9	77.9	63.2	97.6	93.9	75.7	24906.4	13671.1	5665.7	101.6	102.9	6160.1	2862.4
2001-11	1.126	8.555	7.598	8.172	109.5	53.7	41.1	78.8	63.7	99.8	94.9	68.8	25455.1	13989.7	5808.7	101.2	102.8	6152.2	2844.1
2001-12	1.121	8.558	7.634	8.154	110.4	52.7	39.5	77.6	62.6	101.2	99.0	68.0	25083.5	13532.0	5903.5	101.1	103.3	6139.9	2821.8
2002-1	1.132	8.559	7.561	8.088	104.1	51.9	39.2	77.8	62.2	103.6	98.7	69.2	25223.8	13601.3	6185.8	101.4	103.5	6123.3	2795.5
2002-2	1.149	8.560	7.450	8.051	94.3	51.2	38.7	77.4	61.7	103.1	95.5	71.9	25239.9	13522.4	6102.1	101.4	103.6	6102.3	2765.3
2002-3	1.142	8.562	7.497	8.051	91.3	51.7	37.7	77.8	62.1	101.4	92.4	83.7	25510.0	13798.4	6193.5	101.9	104.2	6077.2	2733.9
2002-4	1.129	8.563	7.585	8.116	94.1	52.1	38.4	76.3	61.7	100.6	89.7	89.3	25969.7	14150.4	6411.6	102.0	104.7	6047.3	2692.7
2002-5	1.091	8.564	7.850	8.163	89.6	52.1	40.6	76.7	61.9	102.7	91.9	90.1	26839.1	14780.5	6353.9	102.0	104.9	6013.2	2650.5
2002-6	1.047	8.565	8.181	8.191	85.8	53.8	44.0	77.0	63.0	107.9	92.1	85.9	27322.0	15182.4	6491.8	101.9	104.8	5974.8	2604.2
2002-7	1.008	8.568	8.500	8.172	86.2	55.8	48.2	76.6	64.1	113.9	93.8	89.2	27929.9	15579.5	6508.1	102.0	104.7	5932.0	2553.9
2002-8	1.023	8.569	8.376	8.182	82.4	58.5	52.7	77.7	66.1	120.2	96.4	92.3	28297.6	15679.4	6438.8	102.2	104.8	5900.1	2512.8
2002-9	1.020	8.571	8.403	8.200	82.2	60.3	56.4	77.3	67.1	127.8	92.5	97.6	28152.5	15543.2	6358.5	102.4	105.1	5881.4	2480.6
2002-10	1.020	8.574	8.406	8.247	83.8	60.9	56.8	77.4	67.5	126.3	92.1	96.7	28108.1	15361.8	6345.7	102.7	105.3	5873.5	2457.5
2002-11	1.008	8.577	8.509	8.228	85.5	62.1	59.1	77.0	68.1	123.2	94.4	87.7	28256.5	15401.8	6579.0	102.3	105.2	5877.3	2443.5
2002-12	0.982	8.580	8.737	8.182	78.6	62.8	60.0	77.7	68.7	118.8	95.0	98.7	28346.9	15468.3	6722.8	102.6	105.7	5892.8	2438.5
2003-1	0.942	8.582	9.110	8.079	82.4	64.7	63.1	77.7	69.9	117.5	101.0	108.5	29081.7	16170.3	7331.0	103.6	106.5	5919.9	2442.5
2003-2	0.928	8.585	9.251	8.088	84.8	65.6	63.1	78.1	70.5	117.4	108.8	118.2	29061.9	16005.6	7343.4	104.1	106.9	5958.6	2455.7
2003-3	0.926	8.587	9.273	8.107	85.6	67.1	64.3	78.2	71.5	115.0	112.3	108.1	29161.6	16000.5	7439.6	104.3	106.7	6009.0	2477.9
2003-4	0.922	8.587	9.313	8.116	83.1	68.9	66.5	77.9	72.5	113.9	103.5	93.0	29040.6	15740.8	7420.1	103.7	106.9	6071.0	2509.1
2003-5	0.865	8.592	9.933	8.060	86.1	69.2	67.7	78.1	72.7	116.1	109.6	95.2	29378.0	15865.0	7452.9	103.3	106.8	6144.7	2549.4
2003-6	0.858	8.597	10.020	8.060	84.6	71.9	72.7	78.8	74.2	114.3	111.1	99.3	30059.7	16447.7	7641.9	103.3	106.9	6233.3	2586.7
2003-7	0.879	8.602	9.786	8.079	85.9	73.1	75.9	78.2	75.1	108.1	113.8	101.9	30552.1	16638.5	7486.6	103.3	106.8	6327.0	2657.1
2003-8	0.898	8.606	9.584	8.107	85.6	74.4	77.7	78.1	75.9	112.7	116.4	105.2	31175.3	17102.3	7492.9	103.6	107.0	6420.8	2712.9
2003-9	0.892	8.609	9.651	8.069	85.3	74.2	76.5	78.2	75.8	114.1	118.3	96.6	30657.4	16482.3	7352.2	103.5	107.3	6511.4	2766.0
2003-10	0.855	8.613	10.074	8.107	90.3	73.3	72.8	78.6	75.4	115.1	120.6	103.0	30287.2	15994.3	7261.0	103.6	107.4	6598.9	2816.6
2003-11	0.855	8.617	10.078	8.107	91.0	71.1	69.2	78.1	73.9	119.3	122.3	101.7	30883.9	16372.2	7402.6	103.7	107.4	6683.3	2864.5
2003-12	0.814	8.619	10.588	8.088	85.3	68.3	62.5	79.0	72.6	122.4	125.7	109.1	31522.2	16945.7	7910.8	103.6	107.8	6764.5	2909.8
2004-1	0.793	8.622	10.873	8.069	79.6	66.6	59.0	80.2	72.0	126.6	124.3	113.8	32210.6	17533.7	8230.4	103.9	107.5	6842.5	2952.5
2004-2	0.791	8.624	10.903	8.088	76.1	67.3	60.3	80.6	72.6	129.1	115.9	113.5	32657.6	17847.9	8409.8	104.1	107.8	6917.4	2992.5
2004-3	0.816	8.627	10.572	8.154	72.1	69.1	62.6	80.5	73.6	136.2	115.7	121.8	32707.6	17683.2	8438.4	104.7	108.5	6989.1	3030.0
2004-4	0.834	8.629	10.347	8.154	75.9	72.0	66.3	80.7	75.5	139.8	116.4	123.2	33261.9	18061.9	8421.6	104.9	109.0	7057.7	3064.8
2004-5	0.834	8.632	10.350	8.172	75.7	72.6	66.8	80.1	75.6	135.4	119.3	136.1	33407.6	18005.6	8540.5	105.5	109.4	7123.1	3097.0
2004-6	0.824	8.635	10.479	8.154	74.8	73.5	68.3	79.8	76.0	130.8	130.0	130.6	34655.9	19065.9	8873.8	105.5	109.4	7185.3	3126.6
2004-7	0.815	8.638	10.599	8.154	74.3	73.9	70.5	79.9	76.3	121.1	147.6	137.9	34260.8	18291.9	7789.4	106.0	109.2	7244.4	3153.5
2004-8	0.821	8.641	10.525	8.135	76.0	74.4	72.5	80.3	76.8	119.2	150.3	149.4	34655.1	18358.6	7501.2	106.4	109.4	7304.3	3180.9
2004-9	0.819	8.643	10.553	8.163	81.7	74.9	72.4	81.4	77.5	117.8	159.3	147.0	34635.7	18197.1	7314.3	106.6	109.6	7364.8	3208.6
2004-10	0.801	8.646	10.794	8.163	76.6	76.3	74.1	81.2	78.2	117.1	166.4	165.3	34244.3	17476.5	7244.2	107.5	110.0	7426.1	3235.7
2004-11	0.770	8.648	11.231	8.144	74.6	75.1	71.5	82.0	77.8	121.2	155.3	150.1	34315.7	17232.2	7380.8	107.3	109.9	7488.2	3265.1
2004-12	0.748	8.641	11.552	8.144	77.1	74.3	70.5	82.1	77.4	124.0	147.4	141.5	35882.0	18662.9	8274.5	107.0	110.4	7551.0	3294.0
2005-1	0.755	8.653	11.461	8.135	81.5	74.8	69.1	84.1	78.5	125.6	149.7	153.3	36884.0	19575.6	8374.6	107.7	109.6	7614.5	3323.2
2005-2	0.768	8.655	11.270	8.126	83.2	75.1	68.5	84.7	78.9	124.4	147.8	158.3	35493.2	18037.0	8120.7	108.1	110.1	7678.7	3352.7
2005-3	0.759	8.658	11.425	8.135	92.1	77.3	71.3	84.6	80.2	127.7	161.4	177.9	36854.0	19122.5	8541.6	108.9	110.8	7743.7	3382.7
2005-4	0.773	8.660	11.203	8.154	91.5	79.2	74.1	84.7	81.4	124.4	172.9	177.7	37744.6	19545.2	9300.3	109.4	111.3	7809.4	3413.0
2005-5	0.788	8.663	10.994	8.135	91.7	80.1	76.5	83.9	81.6	123.8	177.7	168.5	38550.3	20568.6	9416.3	109.2	111.6	7875.9	3443.7
2005-6	0.822	8.665	10.541	8.172	94.7	83.7	84.9	84.8	84.2	123.2	164.3	187.5	40212.1	21289.8	10021.4	109.7	111.7	7943.1	3474.8
2005-7	0.831	8.668	10.431	8.341	109.9	84.4	85.7	86.2	85.1	127.4	162.2	196.1	40757.6	21002.8	9953.3	110.3	111.6	8011.0	3506.2
2005-8	0.814	8.670	10.794	8.397	90.2	84.9	86.7	85.6	85.3	129.9	160.1	215.2	41111.1	21041.9	9750.0	110.8	111.9	8078.2	3536.4
2005-9	0.816	8.673	10.629	8.397	90.1	86.5	87.8	87.5	86.9	127.1	161.6	218.2	41833.2	21406.7	9552.7	111.3	112.4	8149.9	3568.2
2005-10	0.832	8.675	10.427	8.415	87.7	85.6	85.6	87.0	86.2	131.6	168.0	208.9	41434.3	20968.5	9246.5	112.0	112.7	8220.9	3598.7
2005-11	0.849	8.678	10.221	8.406	94.4	85.3	84.5	87.3	86.1	125.8	170.9	194.9	41342.7	20733.8	9440.0	111.8	112.4	8292.9	3628.9
2005-12	0.843	8.680	10.297	8.481	93.8	84.7	81.8	86.3	85.3	130.3	164.0	202.2	42098.9	21205.8	9623.3	112.9	112.8	8366.0	3658.9
2006-1	0.862	8.681	10.509	8.424	94.8	87.9	86.1	87.6	86.7	132.8	167.1	207.3	42960.2	21978.7	10474.0	113.3	113.2	8440.1	3688.3
2006-2	0.838	8.685	10.364	8.500	92.2	85.7	82.7	89.1	87.0	139.1	164.0	207.3	43169.4	22013.1	10579.0	113.9	112.6	8515.2	3717.8
2006-3	0.832	8.687	10.441	8.593	88.1	86.7	83.6	89.9	88.0	137.3	176.4	210.6	44311.8	22919.6	11086.8	114.4	113.3	8591.3	3746.8
2006-4	0.815	8.689	10.661	8.528	88.2	87.0	83.7	89.8	88.1	139.6	179.3	232.8	44596.9	22929.1	10889.0	115.4	114.0	8668.5	3775.5
2006-5	0.783	8.691	11.100	8.387	93.0	90.8	87.4	92.7	91.6	144.9	179.8	233.7	45643.7	23528.7	11258.7	115.8	114.4	8746.7	3803.9
2006-6	0.791	8.694	10.991	8.322	90.1	89.7	86.0	94.2	93.3	145.4	181.1	233.7	47441.2	24766.5	11660.4	116.1	114.4	8825.2	3832.0
2006-7	0.788	8.696	11.036	8.285	85.9	95.4	94.8	96.6	95.9	149.8	160.6	245.4	48029.8	24912.1	11124.0	116.9	114.3	8906.2	3859.7
2006-8	0.781	8.699	11.138	8.313	85.9	96.8	96.1	97.7	97.2	148.0	165.5	244.4	48522.7	25042.2	11316.5	117.1	114.4	8986.3	3887.8
2006-9	0.786	8.701	11.070	8.331	86.6	97.5	97.4	98.7	98.0	151.2	166.1	212.0	48799.6	24946.3	10916.9	116.5	114.4	9066.4	3916.1
2006-10	0.793	8.703	10.975	8.350	88.1	98.6	98.7	98.8	98.7	164.0	164.7	200.5	49526.9	25679.9	10967.1	116.5	114.5	9146.5	3944.7
2006-11	0.778	8.706	11.178	8.294	88.7	99.3	99.3	99.2	99.2	174.2	328.4	224.9	64390.7	33357.8	15133.1	123.6	118.5	9539.2	4421.6
2006-12	0.757	8.750	11.559	8.303	81.3	100.0	100.0	100.0	100.0	172.0	182.8	211.5	49811.3	25592.7	11606.4	116.6	115.9	9306.3	4092.6
2007-1	0.769	8.811	11.458	8.322	79.9	99.9	98.2	100.9	100.3	173.4	189.3	189.0	50721.3	26183.9	12153.8	116.9	114.4	9386.1	4032.0
2007-2	0.765	8.841	11.557	8.397	79.0	102.9	100.6	101.5	102.3	180.3	204.5	203.1	51723.2	26780.8	12505.7	117.2	114.7	9465.8	4061.6
2007-3	0.755	8.843	11.713	8.406	79.0	105.4	100.4	102.9	104.3	177.8	216.7	211.3	53307.8	27909.5	12775.0	117.7	115.5	9545.5	4091.5
2007-4	0.740	8.879	11.958	8.415	79.3	107.6	100.4	103.3	105.8	169.1	211.9	215.0	54896.3	28269.1	12843.8	118.2	116.1	9625.1	4121.6
2007-5	0.740	8.925	12.061	8.434	75.2	107.9	101.5	104.1	106.3	172.4	224.8	225.3	55173.4	28818.1	12992.3	118.6	116.5	9704.6	4152.9
2007-6	0.745	8.812	11.828	8.612	78.0