INFLATIONARY EXPECTATIONS IN ETHIOPIA: SOME PRELIMINARY RESULTS

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Abstract
We analyze short-run dynamics of inflation in Ethiopia, using a parsimonious error-correction model fitted with monthly observations. Our findings show that increased money supply and the nominal exchange rate significantly affect inflation in the short-run. Agricultural output shocks, proxied by a cereal-weighted agricultural production index, are also important. By providing an accommodative financial environment, our findings suggest that monetary policy in Ethiopia triggers price inertia, which has large and persistent effects. A simulation suggests that monetary policy alone may be unfeasible to control inflation effectively. To circumvent an extreme tightening with discouraging impacts on growth, additional measures are needed. These should improve the transparency and credibility of monetary policy, and reduce structural barriers that affect price formation and market efficiency.
Keywords: Ethiopia, Error-correction Model, Inflation, Inertia.
JEL Classification: E31, E37, E52, O55.

1. Introduction

Ethiopia's economy has recorded high growth rate for the past three years. While the growth rate of GDP was -3.9% in 2003 mainly due to drought, it rapidly rebounded and remained at more than 10% during 2004-2006 (Figure 1). Current growth is supported by broad sectors, including manufacturing, trade and financial sectors although agriculture made the largest contribution to the growth. Behind this economic boom, however, inflation rate has been increasing. Although inflation rate in Ethiopia was low at 3.3% in 2004, it recorded 13.6% in 2006. Most recently it is at 17.7% in June 2007 after reaching 24.0% in April 2007. Food price inflation rate is also high at 19.9% in June 2007 after increasing to 26.8% in April 2007.

High inflation can cause serious problems. It would bring a large distribution of income. Higher food price would hurt the urban poor who spend most of their income on food. Moreover, although it would have a positive effect on the rural food producers, it would have an adverse effect on the rural food buyers, which may consist of about half of population in the rural Ethiopia. Thus, higher inflation, particularly through higher food price, could worsen the economic inequality. High inflation would also increase of uncertainty about future inflation.

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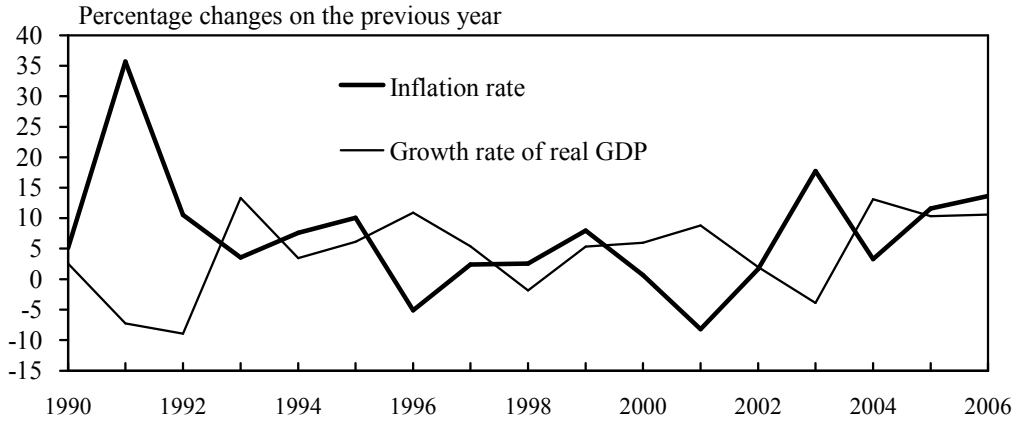
This point is raised by Friedman (1976) and many empirical studies, such as Ball (1992) and Conrad and Karanasos (2004). Increased uncertainty could be harmful to economy since it could discourage economic activities.

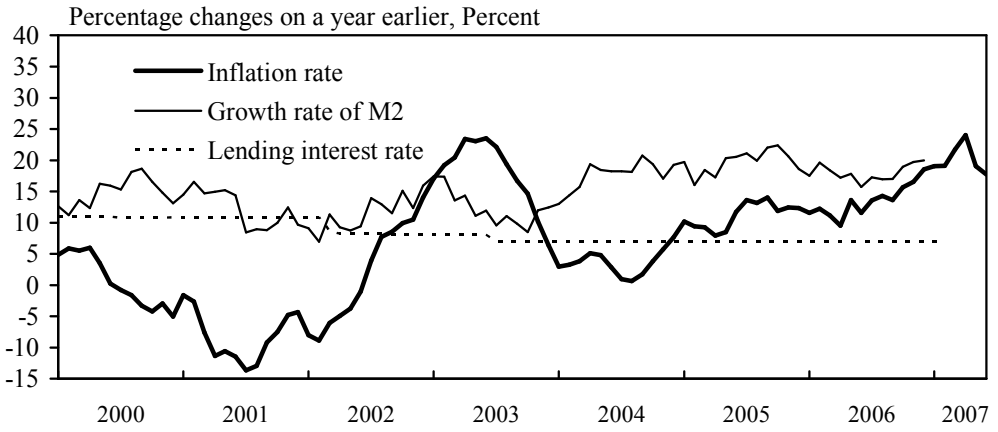
In sum, high inflation would bring serious problems because it could not only increase economic inequality but also lower economic growth.

Figure 1. Situation of Ethiopia's Economy

(1) Inflation rate and GDP growth



(2) Inflation rate, M2 growth and interest rate



Source: Central Statistical Agency, National Bank of Ethiopia

The Ethiopian government has great concern on the recent development of inflation. The reason is not only because inflation could cause serious problems to welfare and growth, but also because the inflation process shows different pattern from past inflation experiences. Since inflation, particularly food inflation, in Ethiopia was closely related to food output, inflation was often accompanied by serious drought in the past inflation experience.

Recent inflation, however, occurs during the period of bumper harvests. Because the process of recent inflation seems new to Ethiopia, inflation is of concern for its government. A clear understanding of its determinants and policy implication is needed.

This paper examines the determinants of inflation in Ethiopia. The summary of the analysis is as follows. Strong inflation inertia is observed in Ethiopia. Monetary policy also affects inflation to considerable extent in the very short-run. Accommodative monetary condition triggered the rise in inflation rate, and more importantly inflationary expectations. To contain inflation effectively, monetary policy should be tightened. But an extreme tightening would be needed if reduction of inflation rate should be achieved through monetary policy alone. Therefore, the removal of structural factors which cause inflexible price formation could also be required to contain inflation more effectively. Moreover, to enhance credibility of the central bank and increase transparency of monetary policy would make the monetary policy more effective.

This paper reviews previous studies on the inflation in Ethiopia, analyzes main determinants of the inflation and their impact on inflation, and presents policy implications of the empirical analysis. The paper is organized as follows: Section 2 looks at the sources of inflation and reviews the relevant literature in Ethiopia and selected African countries. Section 3 describes the model structure and data used. Sections 4 presents results and conducts a robustness check. Section 4 builds on these findings and conducts a dynamic multivariate analysis to help interpretation of the coefficients. Section 6 discusses policy issues and Section 7 concludes.

2. Sources of Inflation

Economic situation in Ethiopia

High inflation in Ethiopia is observed in a variety of goods. Food price shows a rapid increase while food is the largest component of CPI with 60% of weight in CPI (Table 1).[2] One can observe a high rate of inflation also in other goods with relatively large weight such as house rents. Thus, inflation in Ethiopia is caused not by a certain goods, but virtually all goods.

An orthodox explanation of inflation (observed in almost all goods) is that monetary factors cause inflation. Accommodative monetary policy is a possible explanation from an macroeconomic viewpoint. Ethiopia's monetary policy has been accommodative during the period when inflation rate was increasing. Both deposit interest rate and lending interest rate have been lower than inflation rate since 2005, which generated negative real interest rates. Negative real interest rates facilitates to borrow more money and invest in real goods, rather than holding financial assets. As a result, the domestic credit expanded at a high rate, which caused a high growth rate of money stock. Money stock has been growing at higher rate than GDP since 2002.

[2] The weightening matrix is based on the 1999-2000 Household Consumption and Expenditure Survey. According to the 2004-2005 household expenditure data, total food expenditures dropped to 50.9 percent (CSA, 2007). As food prices have increased more rapidly than other items, we find the potential for a small overestimation of the current consumer price index. However, the price index has not been revised yet and we continue to use official data.

Figure 2 shows monetary expansion is accompanied by domestic credit expansion, in particular expansion of domestic private credit. Thus, accommodative monetary policy could be a factor of current inflation, taking into consideration the fact that both money stock and domestic credit expand considerably.

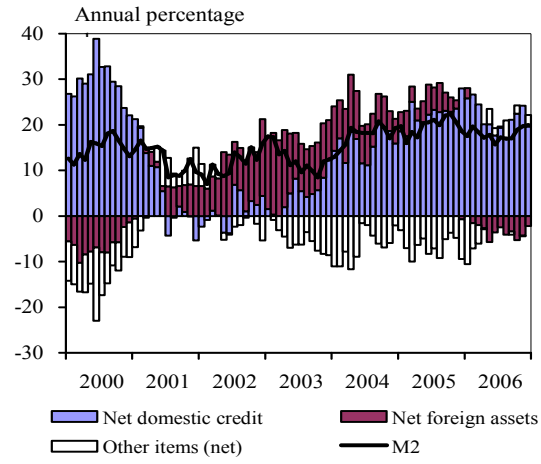
Table 1. Consumer Price Index of Ethiopia

	Weights Percent	Percentage change from April 2006 to April 2007
All items	100.0	24.0
Food	60.1	26.8
Beverages	2.0	20.0
Cigarettes and Tobacco	0.5	0.7
Clothing and Footwear	9.3	8.5
House Rent, Construction Materials, Water, and Fuel and power	15.4	23.6
Furniture, Furnishings, Household Equipment and Operation	4.9	21.0
Medical Care and Health	1.2	7.6
Transport and Communication	2.0	26.8
Recreation, Entertainment and Education	1.0	7.3
Personal Care and Effects	0.9	17.2
Miscellaneous Goods	2.6	0.0

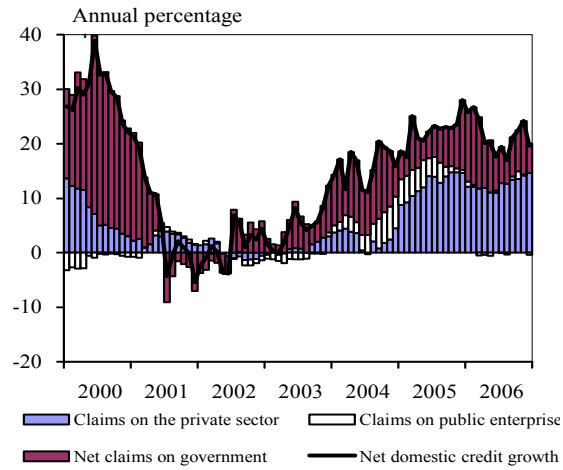
Source: Central Statistical Agency

Figure 2. Source of Growth of Money Stock

(1) Contribution to Growth of M2



(2) Contribution to Growth of Net Domestic Credit



Source: National Bank of Ethiopia

To mention the structure of Ethiopia's economy: agriculture is the largest sector with about 47% of share in its economy. So, one can easily understand that the economic performance in Ethiopia depends heavily on climatic conditions. As a matter of fact, drops in growth rate of GDP were observed in years with drought such as 2003 [to be expanded].

Literature Review

There is some literature on the determinants and situation of recent Ethiopia's inflation. Klugman (2007) examines food inflation in Ethiopia based on micro-analysis. She suggests that recent food inflation can be largely explained by overall inflation, which is related to increase of money stock. The analysis is based on accounting equation, not on an econometric estimation. It also provides some other explanations of the high inflation. For example, a shift from food aid to cash aid could affect the price of food. Activities of cooperatives would also affect the price level by improving the bargaining power of farmers. It points out the possibility that increasing marketization of agricultural production would increase demand for money without necessarily having inflationary effects. Velocity of money may have increased by 16% during the period from March 2002 to July 2006, suggesting shifts in the demand for money due to structural changes in the economy, such inflationary expectations, or other factors.

Ahmed (2007) examines the determinants of inflation in Ethiopia and concludes "structural changes" such as increasing bargaining power of farmers and monetary expansion are the main reasons of inflation in Ethiopia. He argues that monetary expansion is largely dictated by credit expansion in both the public and private sector. Credit expansion is explained, on the public side, by decline in foreign finance flow, including a reduction foreign aid. At the same time, he points out private sector credit expands substantially, which is supported by negative real interest rate and increased investment demand.

Ayalew (2007) constructs a macroeconomic model and simulates impact of various shocks on inflation. He uses annual data from 1970 to 2006 which limits the interpretation of the analysis due to significant changes of the economy. He suggests that inflation in Ethiopia is affected by real GDP, money stock, foreign prices, and the exchange rate. The coefficient of lagged inflation in the food price equation implies the existence of inflation inertia in Ethiopia.

Mamma (2004) examines the effect of monetary shocks on Ethiopia's economy. In an error-correction model, money stock explains inflation both in the long-run and in the short-run. The result of the estimate suggests that there is inflation persistence in Ethiopia. Based on simulation by using the model, a monetary shock, such as contraction of domestic credit, would decrease the price level. Similarly to Ayalew (2007), a weakness of this analysis is that the regression is based on annual data.

Sterken (2004) focuses on the determinants of real demand for money while only data up to 1994 was used in the analysis. This paper does not directly analyze the determinants of inflation but suggests that shortage of food due to drop in rainfall might have long-run monetary consequences, showing a stable relationship between real money and real income.

In the absence of significant analysis for Ethiopia, it is worthwhile to look at some of the inflation determinants in other African countries. Moser (1994) examines Nigeria's case while the model is simple OLS and the regression is based on annual data. Money stock is the main determinant of inflation in Nigeria and could have effect without lags. The exchange rate is also an important factor. Rainfall is significant in the model, and fiscal and monetary policies have large effect on inflationary process.

Durevall and Ndung'u (1999) analyze Kenya's case. Their findings suggest that inflation inertia was a significant factor of inflation in Kenya, until exchange rate regime changed from a discretionary crawl to a floating regime with removal of price controls. They also find that money stock would not explain inflation in Kenya in the long run. The exchange rate, foreign price level and terms of trade are the main determinants.

Ubide (1997) looks at inflation in Mozambique. There is a long-run relationship between prices, money stock and exchange rates. Rainfall data is used to explain inflation in Mozambique as a proxy of output. The control of monetary expansion would have significant effect on inflation, mainly by stabilizing the exchange rate. Tight monetary policy explains a reduction of Mozambique's inflation performance.

Ndaferankhande and Ndholovu (2006) on Malawi and Diouf (2006) on Mali suggest that money stock and exchange rate have significant influence on inflation. Rainfall data is used as a proxy of output data. Sowa (1994) on Ghana finds that real factor, such as shortage of goods, are more dominant than monetary factor. Money could have effect on inflation without any lag.

Some literature shows the existence of inflation inertia in African countries. Woodford (2006) present interpretations of inflation inertia, which is often expressed as lagged inflation in an econometric model. One can interpret lagged inflation as a result of indexation to the aggregate price index in the price formation. Another interpretation is that omission of lead inflation term in hybrid new Keynesian Phillips curve equation could cause spurious positive coefficient of lagged inflation term. Other possible interpretation of lagged inflation is that it is proxy for departures from rational expectation. These interpretations hardly exclude each other.

In sum, the inflation literature for Africa finds existence of inflation inertia, and inertia often explains a large fraction of inflation. Money stock is an important factor of inflation though it has sometimes insignificant effect on inflation. Rainfall data is be used as a proxy of output in some countries.

3. Model and Data

Concept of model

Like most empirical researches regarding inflation, this paper employs an error correction model to analyze inflation dynamics. An error correction model allow us to analyze both the medium-run[3] and short-run dynamics of inflation. The estimation of inflation is based on the assumption that inflation is subject to the equation of exchange so that we can understand the situation simply. The medium-run equation is specified as,

(1) $\log(P) = \alpha_1 \cdot \log(M) + \alpha_2 \cdot \log(Y)$

where P is the price level, M is money stock and Y is real output level. One approach to construct an error correction model is to combine medium-run information as an error correction term with the short-run adjustment mechanism.

[3] We discuss only medium-run dynamics in this paper because we use seven years of data.

The error correction model can be estimated in different ways. The generalized one-step error correction model is a transformation of an autoregressive distributed lag model. Based on this approach, the structure of the error correction model in this paper is specified as follows.

$$(2)\quad \Delta\log(P_t) = \alpha_0 + \sum_{i=0}^{k}\alpha_1 \cdot \Delta\log(M_{t-i}) + \sum_{i=0}^{k}\alpha_2 \cdot \Delta\log(Y_{t-i}) + \sum_{j=1}^{k}\alpha_3 \cdot \Delta\log(P_{t-j})$$
$$-\alpha_4 \cdot [\log(P_{t-h}) - \alpha_5 \cdot \log(M_{t-l}) - \alpha_6 \cdot \log(Y_{t-m})] + \varepsilon_t$$

The equation in the parenthesis expresses the medium-run relationship. If the equation of exchange strictly holds, both α_5 and α_6 should be equal to one. However, we loosen this assumption. An advantage of this one step error correction model is that one can estimate the re-parameterized form, even if there is no information of α_5 and α_6. The re-parameterized form is as follows,

$$(3)\quad \Delta\log(P_t) = \beta_0 + \sum_{i=0}^{k}\beta_1 \cdot \Delta\log(M_{t-i}) + \sum_{i=0}^{k}\beta_2 \cdot \Delta\log(Y_{t-i}) + \sum_{j=1}^{k}\beta_3 \cdot \Delta\log(P_{t-j})$$
$$+\beta_4 \cdot \log(P_{t-h}) + \beta_5 \cdot \log(M_{t-l}) + \beta_6 \cdot \log(Y_{t-m}) + \varepsilon_t .$$

If β_3 is significantly positive, it means that there is inflation inertia in Ethiopia like other African countries and the value of β_3 indicates the degree of the inflation inertia. The estimate of the parameter β_4 can be used to calculate the explanatory powers of money stock and real income in the medium-run relationship, α_5 and α_6, as $\alpha_5 = -\beta_5/\beta_4$ and $\alpha_6 = -\beta_6/\beta_4$. The estimate of the parameter β_4 is also useful because it can be interpreted as a measure of speed of adjustment in which the system moves toward its equilibrium on the average.

The expected signs of coefficients are positive for coefficients, β_1, β_3, and β_5, and negative for other coefficients. An increase in money stock would increase the inflation rate by providing more excess money and an increase in output would decrease inflation by reducing excess money due to increase of demand for money. Inflation in the previous periods would positively affect the inflation of this period if there is inflation inertia. The price level of past periods would negatively affect since higher price level tends to result in higher positive deviation from the medium-run equilibrium which should be corrected toward the equilibrium level in the following periods.

The model above can be understood to be based on closed economy model as, for simplicity, it omits the variable such as exchange rate, which is supposed to affect price level in an open economy. As in other empirical studies, we can augment the model by including other explanatory variables. Following Ubide (1997), we can specify the equations as follows,

$$(4)\quad \Delta p_t = \alpha + \sum_{i=0}^{k}\beta_{ij} \cdot X_{t-j} + \sum_{h=1}^{k}\gamma_h \cdot \Delta p_{t-h}$$
$$+\delta \cdot (p_{t-l} - \mu_1 \cdot m_{t-m} - \mu_2 \cdot y_{t-n} - \mu_3 \cdot e_{t-o} - \mu_4 \cdot p^f{}_{t-p} - \mu_5 \cdot R_{t-q}) + \eta \cdot D + \varepsilon_t$$

and $X_t = X(\Delta m_t, \Delta y_t, \Delta e_t, \Delta p^f_t, \Delta R_t)$

where η expresses a vector of coefficients, D expresses a vector of dummy variables, e is exchange rate, p^f is foreign price level and R is interest rates. All variables in small letters are in the logarithm form. We include interest rates in the model based on past empirical studies such as Durevall and Ndung'u (1998). The expected signs are positive for e, p^f and R.

The basic concept of this inflation model under an open economy is the idea that the overall price level is weighted average of the price of tradable goods (P^T) and of non-tradable goods (P^N) as follows,

(5) $\log(P) = \gamma \cdot \log(P^T) + (1 - \gamma) \cdot \log(P^N)$.

The price of tradable goods depends on the exchange rate and foreign price since it is assumed to be determined in the world market as follows,

(6) $\log(P^T) = \log(E) + \log(P^f)$.

The price of non-tradable goods is determined by real excess supply of money which is defined by the difference between real money supply (M^s) and real demand for money (M^d) as follows,

(7) $\log(P^N) = \mu \cdot [\log(M^s) - \log(M^d)]$.

Real money supply is defined by the nominal money stock divided by price level and real money supply depends on output level, interest rates and expected inflation rate ($E(\pi)$).

(8) $\log(M^s) = \log(M/P)$. and

(9) $\log(M^d) = g(y, R, E(\pi))$.

Expected inflation rate can be modeled in some ways. For instance, one can include learning process in the model or assume price level moves toward long-run equilibrium level. In this paper, however, we assume that expected inflation depends only on past inflation rates to keep the procedure simple. Based on these concepts with adding dummy variables, we can derive the equation (4). By using this model, we will test the regression in the following sections.

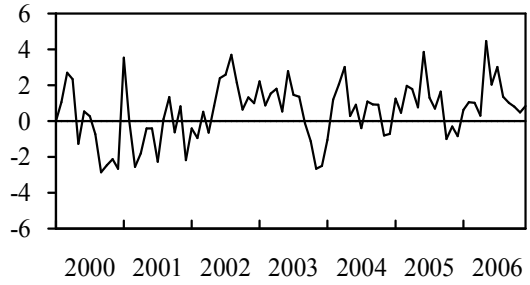
Data Description

The data used in this paper are as follows. The price index is consumer price index (CPI) provided by the Central Statistical Agency of Ethiopia. Money stock is provided by the IMF. For real income, since Ethiopia only has annual GDP data, we need another variable to have enough size of sample to rely on. We generate a monthly agricultural production index from a high-quality rainfall data set provided by the National Oceanic and Atmospheric Administration (see Appendix 1). After careful examination, we decide to use it as a proxy of real output like other empirical studies. Exchange rates used in this paper are inter-bank rates against US dollar and against the Euro, which are the currencies of the major trade partners of Ethiopia. Foreign prices are CPI of the US and Euro area. Deposit interest rate for the term less than one year is used as interest rate partly due to the problem of availability of other indicators. Foreign prices and deposit interest rate are provided by IMF. All data are monthly data.

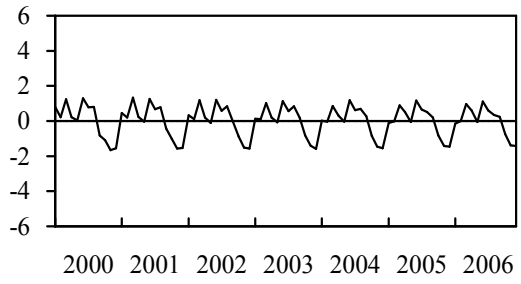
Figure 3. Decomposition of Monthly Inflation and Growth of M2

1. Monthly Inflation Rate

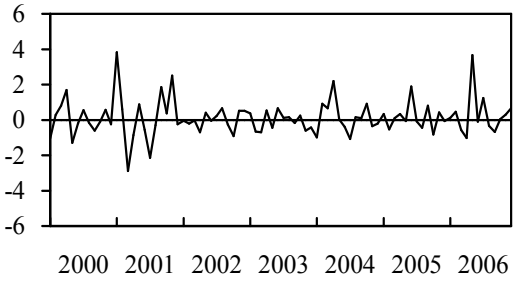
(1) Original Data



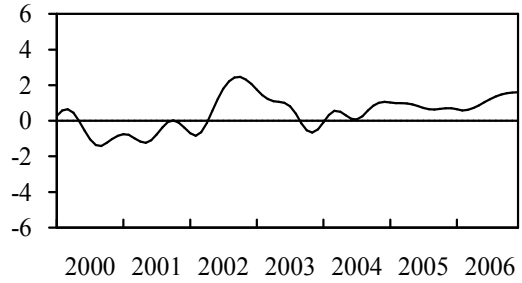
(2) Seasonal Component



(3) Irregular Component

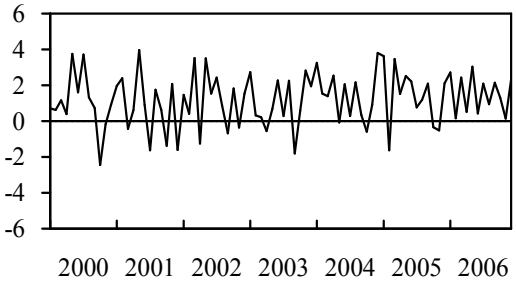


(4) Trend Component

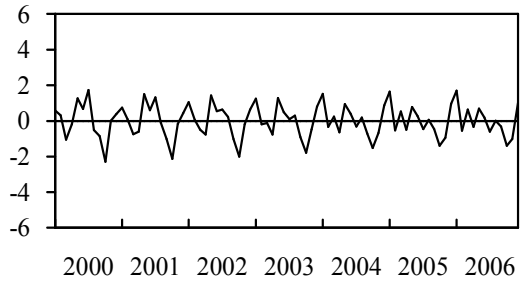


2. Monthly Growth Rate of M2

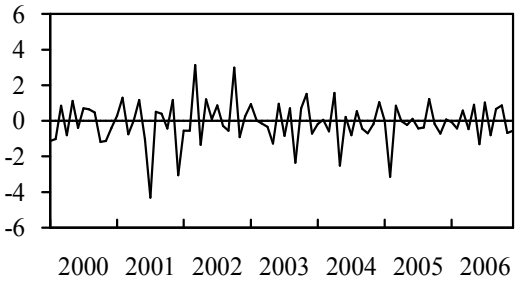
(1) Original Data



(2) Seasonal Component



(3) Irregular Component



(4) Trend Component

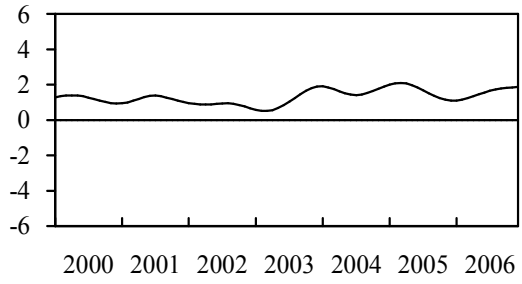


Figure 3 presents the decomposition of the data of CPI and M2 based on the X-12 monthly seasonal adjustment method developed by the U.S. Census Bureau. Each of CPI and M2 has large fluctuation of irregular component. The monthly inflation rate has no apparent trend prevalent during the period from 2000 to 2006 while trend component has slightly increased for recent a few years. The trend component of monthly growth rate of M2 also shows increase at 2003, which is consistent with the slight increase of trend component of monthly inflation rate.

We examine if there is a structural change during the period of the estimate. Chow's breakpoint test presented in Table 2 suggests the existence of breakpoint at around January 2000. The break is likely due to substantive revisions of the national accounts system around 2000. With the data before year 2000, the model shows a lower fit and some explanatory variables are les significant. The overall findings still hold.

Table 2. Chow Breakpoint Test for 2000.01

	Statistics	Prob-value
F-statistic	2.23	0.009
Log likelihood ratio	44.73	0.000

4. The Inflation Equation and It's Robustness

Result of estimation

We first carry out unit root test of variables in the equations. We used the Augmented Dickey-Fuller test (ADF test). Table 3 shows the results. We proceed under the assumption that the first order differences of all variables are stationary. Results from Johansen cointegration test are presented in Table 4. It shows that the null hypothesis that there is no cointegration is rejected. The test contains intercept but no trend. Therefore, there could be a cointegration relationship among the variables and an error correction model can be conducted.

Table 3. ADF Test for Unit-Root, 2000.01-2006.12

Variables	t-ADF			
	In log-levels	Lags	In first difference of log-levels	Lags
CPI	0.65	1	-5.40 **	0
M2	0.97	1	-6.68 **	1
Agricultural Production Index	-2.28	9	-3.16 *	8
M1	0.74	1	-10.63 **	0
M0	-1.24	0	-9.22 **	0
Exchange rate (US$)	-1.73	0	-9.16 **	0
Exchange rate (Euro)	-0.26	2	-7.20 **	1
Foreign price (US price)	-0.17	2	-7.82 **	1
Foreign price (EuroPrice)	0.49	11	-3.92 **	11
Interest rate	-1.67	1	-6.11 **	1

** Significant at 1% level, * significant at 5% level. All variables in logarithm except the interest rate. Lags are chosen so that AIC would be the smallest.

To specify the model, we first estimate a general model presented in Table A2-1 in Appendix 2, and then based on the general-to specific modeling concept, we specify a parsimonious model. The general model contains lagged variables up to 12 months ago so that we can examine the effect of variables of up to one year ago. Seasonal dummies and dummies for two months when CPI showed an extreme jump are included in the model. Then, by repeatedly removing explanatory variable which is the most insignificant, we obtained the estimated equation presented in Table A2-2 in Appendix 2. Then, by removing coefficients of agricultural production index with wrong sign, we finally obtained the parsimonious model, which is presented in Table 5 and Figure 4. The model shows a good fit to the data.

Table 4. Result of Johansen Cointegration Test

Hypothesized Number of Cointegration Equation	Likelihood Ratio	5% Critical Value
0	35.17 *	29.68
1	11.71	15.41

* Significant at 5% level.

The coefficient of lagged inflation is 0.35, indicating that there is inflation inertia. The degree of inertia is considerably large and is similar to the result in Ayalew (2007) and Mamma (2004) for Ethiopia. We will discuss the implication later.

Growth of money stock (M2) has the most significant effect on inflation without any lag while the coefficient is 0.44. In empirical researches on economies of developed countries such as Batini and Nelson (2001), it is commonly accepted that there is a lagged relationship between money growth and inflation. In contrast to that, an immediate impact of money on inflation in Ethiopia is not necessarily strange since, looking at empirical studies on inflation in African countries, money stock can have immediate effect on inflation in, for example, Nigeria and Ghana. It can be also pointed out that large fluctuation of inflation and monthly growth of M2 could make the *real* lag structure obscure, based on the result that the cross-correlogram between changes of three month moving averages of CPI and M2 would be maximized with two months lag. Money stock could have significant effect in the short-run inflation dynamics within very short time. Taking the effect of money stock into account, monetary policy would be effective to control inflation in Ethiopia in the short run.

The agricultural production index is also significant in both change and level while their coefficients are small (however the proper interpretation requires to take into account that there are significant peaks over time). A weakness could be derived from possible discrepancy between the index and real GDP. The discrepancy could be caused not only by the ability of rainfall to describe the development of agricultural output, but also by the fact that agriculture's weight in real GDP is about 50%.

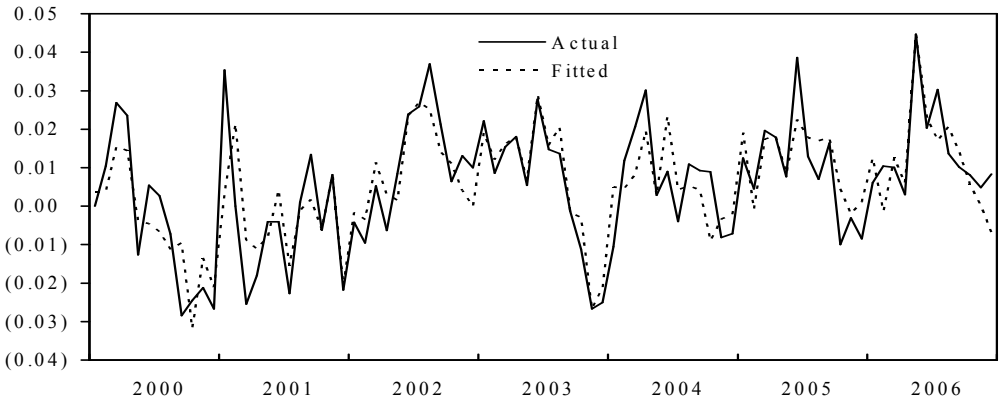
The monthly adjustment process towards equilibrium is 7%, showing that it would take about 7 years in order for the adjustment to be half-done. Taking this outcome into account together with the suggested existence of inflation inertia, we can conclude that the speed of adjustment of inflation to its medium-run equilibrium is very slow in Ethiopia.

Table 5. Parsimonious Error Correction Model
2000:01 – 2006:12

Variable	**Coefficient**	**t-statistic**
Constant	0.002	0.034
Percentage change of CPI(-1)	0.347 **	3.831
Percentage change of M2	0.437 **	4.534
Percentage change of Agricultural Production Index(-2)	-0-036 **	-3.340
Log CPI(-12)	-0-067 **	-3.79
Log M2(-12)	0.033 **	4.107
Log Agricultural Production Index(-9)	-0.009 *	-2.006
Adjusted R^2 = 0.608, standard error =0.010, DW = 1.98 AR 2: F-statistic = 1.36 (0.265); ARCH 2 : F-statistic = 2.25 (0.112) Normality: χ^2 = 5.66 (0.059); RESET: F-statistic = 0.48 (0.621) Number of observations = 84		

Note: ** significant at 1%, ** significant at 5%. Seasonal dummies and dummies for November 2003 and May 2006 are included in the model.

Figure 4. Actual and Fitted inflation, 2000:01-2006:12
(First difference Log (CPI))



This slow speed of adjustment could bring long period of adjustment and thus increase of cost of the adjustment of inflation when price starts to deviate the equilibrium.

The elasticity of M2 on inflation in the medium-run relationship is about 0.5 and that of output is about 0.15, based on the method explained in the previous section.

M2 explains only half of inflation in the medium-run, which would indicate other factors also have considerable explanatory power.

Robustness check

We assess the model's empirical constancy by estimating the model recursively. Figure 5 shows the result. All coefficients are stable for recent three years with exception of the one for percentage change of agricultural production index [-2] of which absolute value is slightly decreasing.

Although the development of the coefficient might be affected by possible discrepancy between income and rainfall, it can be pointed out that explanatory power of income might be somewhat reduced by the increasing marketization in Ethiopia, which is supposed to similar effect to income in the respect that both would positively affect the demand for money.

In the following, we show the results of sensitivity analysis, replacing M2 with other money stock indicators. We also develop the model to the one based on open economy. Results are presented in the Table A2-3 in Appendix 2.

Equation 1 and Equation 2 present the case when M2 is replaced with M1 and M0. The coefficients of lagged CPI are more or less the same as the one in the original model. M1 and M0 are, like M2, significant without any lag, which is natural because they have more liquidity than M2 and is supposed to have more immediate effect on inflation than M2. Although their coefficients are smaller than the original one, reflecting their larger fluctuation than M2, the medium-run effects of money stock and output on inflation are similar to those in the original model except M0. The percentage change in agricultural production index is insignificant in the regression with M0. This could be partly because M0 includes banks' deposit at the central bank which can be affected by some factors such as banks' attitude to have excess reserve and such irregular factors could affect the most fragile explanatory variable, the production index.

Equation 3 presents the estimates based on the concept of determination of inflation under open economy. Exchange rate against US dollar, US price and deposit interest rate are included in addition to the original estimate. The coefficients of lagged CPI, M2 and agricultural production and the speed of adjustment toward equilibrium are virtually the same as the original model. The exchange rate is significant only in the form of percentage change. The US price and deposit interest rate are insignificant.

Equation 4 shows the estimates with exchange rate against Euro and Euro CPI instead of US dollar and US price in Equation 3. The coefficients of lagged CPI and M2 are a slightly smaller than ones in the original model while they are robustly significant. The exchange rate is insignificant and log of M2 and agricultural production index are also insignificant. Equation 5 presents the model in which the dependent variable is the inflation rate of food price. Inflation inertia is observed and its degree is similar to the original model. Other coefficients are also similar to those in the original model except that of percentage change in M2 which is much larger than original one. We also test the robustness by including oil price and commodity price such as wheat in the model. Since these variables are not significant, the results are omitted from the table.

In sum, sensitivity analysis shows the degree of inflation inertia is stable in the various models. The relationship between money stock and inflation is also stable. The relationship between agricultural production index and inflation is weaker than that between money stock and inflation. Among other variables, only the exchange rate against US dollar is significant. We conclude that inflation in our model is mainly driven by domestic factors, despite the fact that the foreign price level coefficients are very similar to Ayalew's (2007) analysis with annual data.

Further research may be needed to come to conclusive answers of whether foreign factors are important determinants of inflation in Ethiopia.

5. Dynamic Multivariate Analysis

Impact in the short-run and medium-run

Table 6 presents the variance decomposition based on the equation 3 of Table A2-3 although US price and interest rates are excluded from the model. The values in the table show the fractions of the forecast error variance for each variable which is attributable to the innovation in inflation rate. In constructing the model, the lags are chosen so that AIC would be the smallest.

Table 6. Variance Decomposition

		Forecast Variance Decomposition (Percentage Points)			
Forecast Horizon /Months	Forecast Standard Error	Inflation	M2	Agricultural Production Inex	Exchnage rate (Birr/US$)
1	0.012	72	16	7	5
3	0.013	60	16	7	18
6	0.013	59	14	10	17
12	0.014	54	12	18	16
36	0.014	54	12	18	16

Inflation itself explains the largest part of inflation. It explains 54% of inflation even three years after a shock. This indicates inflation inertia in Ethiopia is extremely strong, which is consistent with the results of estimates with the error-correction model. This strong inflation inertia suggests inflation in Ethiopia may be affected by structural factors. Taking Ethiopia's economic situation into consideration, possible structural factors are price regulation and market inefficiency, which would make price formation inflexible. Under inefficient market, price would be inflexible due to, for example, lack of competition and information. Regarding this point, Klugman (2007) argues that agricultural markets in Ethiopia are underdeveloped and lack transparency, liquidity, competition, integration with world markets, price risk management mechanism, accessibility, price discovery mechanisms, quality standards contract enforcement mechanisms. Strong inflation inertia in Ethiopia would be caused by structural factors, which make price formation inflexible. M2 has the second largest effect in the very short-run, while it only explains at most 16% of inflation after three years. After three months or twelve months, exchange rate and production index have larger effect than M2. These results indicate the effect of monetary factors shows up immediately, but it is very small over longer periods. In the medium-run, exchange rate and output would a have larger effect than money, although their effects are also relatively small.

Figure 6 shows the results of accumulated impulse response based on the same model as one used in the variance decomposition. The inflation shock has persistent effect on inflation itself. Its accumulated effect remains even after 36 months while the effect is maximized three months after the shock. This is consistent with the existence of strong inflation inertia.

The accumulated response to an M2 shock is maximized four month after the shock and dies out in the medium-run. The maximized effect is 0.5% to 1% shock of M2, which indicates the effect of money on inflation is significant but is not as large as monetarists expect. The effect of production index is confirmed to be small and also dies out in the medium-run. The accumulated response to exchange rate shock is weaker than that to M2 shock in the very short-run but is long lasting unlike the case of M2 shock. To see the effect of M2 shock on price level (as opposed to monthly CPI growth): a 1% increase in M2 would increase the price level by 0.5% in the medium-run, consistent with the medium-run coefficients of the error-correction model. To reduce price level only by tightening monetary policy, a considerable reduction of the money stock would be needed.

6. Implications for Policy

Our analysis suggests that the existence of strong inflation inertia in Ethiopia. Inflation expectation is considerably affected by past inflation rates. Reflecting the situation where inflation rates are increasing, inflation expectation in Ethiopia has stayed at high rate. Our analysis indicates increase in money stock significantly affects inflation at least in the very short-run and also affects inflation expectations via an increased inflation rate. Taking into consideration the fact that the central bank has kept the financial environment accommodative, recent accommodative monetary policy in Ethiopia is supposed to have triggered increase in inflation rate and in expected inflation. Therefore, to reduce the inflation expectation and inflation rate, the central bank, first of all, should tighten its monetary policy. Monetary policy tightening, however, could have to be conducted on too large scale under the current structure of Ethiopia's economy. The simulation results presented in Table 7 shows the growth rate of M2 during 2006 which realizes a certain inflation rate in December 2006. By changing the growth rate of M2 during 2006 while keeping other things unchanged from the actual values, we calculated the inflation rates corresponding with virtual growth rates of M2 from 2005-2006. A reduction of M2 growth to either 10% or 5% is not sufficient to realize 7% inflation rate which is the policy target. To achieve the target, the growth rate of M2 from the previous year should be only 2.7% during 2006. Taking into consideration the fact that real GDP has been growing at more than 10%, 2.7% growth of M2 is extremely low rate. This result suggests that it would be unrealistic to deal with the inflation problem only by monetary policy. A more realistic way to reduce inflation rate is to reduce inflation inertia while tightening monetary policy. Some empirical studies point out that monetary policy alone would not be effective to reduce inflation if there is inflation inertia and the inertia is caused mainly by structural factors.

Table 7. Simulation of inflation rate under reduced M2 growth

	Actual	Case 1	Case 2	Case 3
Growth rate of M2 during 2006	18.0%	10.0%	5.0%	2.7%
Inflation rate from Dec 2005 to Dec 2006	18.5%	12.0%	8.6%	7.0%

With regard to this point, Kaseeram, Nichola and Mainardi (2004)'s analysis on inflation in South Africa suggests inflation targeting alone could not solve the problem of inflation expectations and inflation inertia because of structural factors such as the exchange controls, budget deficits, administrative pricing and trade barriers.

This situation would also apply to Ethiopia. As we cited above, Klugman (2007) points out inefficiency of markets in Ethiopia. Although Ethiopia has undergone reforms which would provide a foundation of private sector-led economic growth, further reforms are needed. Under such economic situation where structural factors strongly affect price formation, the effect of monetary policy would be reduced. For instance, Dexter, Levi and Nault (2001)'s study presents regulation would make prices sticky and thus could delay the response of inflation to change of monetary policy. Therefore, removal of structural factors such as price regulation and improvement of market efficiency are necessary to effectively reduce inflation rate in Ethiopia.

Moreover, the credibility of a central bank and the transparency of its monetary policy are important factors for effective monetary policy. A tight monetary policy would be less effective in containing inflation expectation if people expect the policy would be replaced soon, for instance, for a political reason. It also would be less effective if people find large uncertainty about the future monetary policy due to lack of information of the central bank's way of thinking on the decision making of its monetary policy. In addition to the effectiveness of monetary policy, Westelius (2004) presents that persistency of inflation could be influenced by the credibility and transparency of a central bank. Inflation targeting is sometimes viewed as a possible solution to enhance the credibility of central bank and transparency of monetary policy. By showing a target or a target range and conducting monetary policy along with the target, people would recognize the central bank intends to reduce inflation rate and would set prices along with their forecast of future conduct of monetary policy, which would reduce inflation expectation effectively. Inflation targeting, however, is not the only solution. Kaseeram, Nichola and Mainardi (2004) argues that inflation targeting would not be effective under low credibility of a central bank. A monetary policy framework would not be effective if people do not trust the central bank and do not change their price setting behavior. The important issue is not so much the type of the monetary policy framework, but to the central bank's credibility. And it is also important to enhance transparency of monetary policy conduct which allows people to foresee future monetary policy and future inflation (for example, through analysis, forecasting and information sharing). A transparent central bank could affect inflation expectation and thus reduce inflation rate more effectively.

Some argue that reduced foreign aid is a factor of recent inflation since reduction of foreign aid results in increase of public credit expansion and expansion of money stock. The evidence is mixed. First, money triggers inflation but is not the largest factor of inflation in Ethiopia. Second, and more importantly, the positive impact of public credit expansion on money stock would be offset by the negative effect of reduced foreign aid if the government expenditure is unchanged. Expanded credit to government would increase the receipt of money by firms and households if the government expenditure increases in accordance with the increase of public credit. On the other hand, reduced foreign aid would decrease the receipt of money by firms or households if the government expenditure is reduced due to decrease of foreign aid.

If both events happen at the same time (and the same amount), government's expenditures and the receipt of money by firms and households will not change much. In this sense, reduction of foreign aid would not increase the money stock. Therefore, a reduction of foreign aid may not be the key factor of recent inflation in Ethiopia.

In sum, a tightening of monetary policy is necessary for a reduction of the inflation rate. Since it would be difficult to realize sufficient reduction of inflation only by monetary policy, without impacting on economic growth, a reduction of inflation inertia through removal of structural factors is needed. To enhance the central bank's credibility and transparency of monetary policy, it is important to reduce inflationary expectation more effectively.

7. Conclusions

Ethiopia's inflation has significantly increased since the midst of 2004. The results of this analysis confirms that inflation in Ethiopia is strongly affected by past inflation. This inflation inertia has the largest effect both in the short-run and in the medium-run, as evident from the result that inflation itself explains more than 50% of inflation even three years after a shock. Other important factor of high inflation is monetary expansion, while its explanatory power is considerable only in the very short-run. To reduce inflation rate, monetary policy should be tightened as accommodative monetary policy has triggered increase in inflation and inflationary expectations in Ethiopia. To deal with reduction of inflation rate only by monetary policy, however, an extreme tightening would be unrealistic. Since structural factors, such as price regulations and market inefficiency causing inflexible price formation, would generate inflation inertia and weaken the effect of monetary policy in Ethiopia, reforms to make price formation more flexible are necessary to increase the effect of monetary policy. In addition to these, it is important to enhance credibility and transparency of the central bank and improve it's ability to curb inflationary expectations more effectively. Our results are preliminary in nature. Food prices versus nonfood prices. Desequilibria.

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On line Annex at the journal website: http://www.usc.es/economet/aeid.htm

Appendix 1: Ethiopia's Monthly Agricultural Production Index

We construct a monthly agricultural production index to since output in Ethiopia is provided only annually. Agriculture has about 50% share of GDP and we use rainfall as a proxy of agricultural production.

We are provided with rainfall data by the National Oceanic and Atmospheric Administration (NOAA) in the form of the sum of percent of normal values for all areas, or pixels, within each wereda, which is called "perc_norm", for each wereda. The data are produced with highly sophisticated methods. The input data are 24-hour accumulated data from World Meteorological Organization's Global Telecommunications System Network rain gauge observations and three-hourly data from Meteosat satellite Infrared cloud top temperatures. Essentially, infrared data determines the shape of the rainfall field while gauge observations determine the intensity. Combining the both data, the Famine Early Warning System-Network team within the NOAA Climate Prediction Center provides the percent of normal rainfall at the wereda level.

The "perc_norm" for a wereda j is expressed as rainfall data in the following equations,

$$(1) \qquad \text{perc\_norm}_j = \sum_{i=1}^{n_j} \frac{A_{ji}}{N_{ji}} * 100$$

where A_{ji} is actual rainfall and N_{ji} is normal value for each pixel i within a zone j, and n_j is the number of pixels within the wereda j.

The "perc_norm" per pixel can differ from wereda to wereda as well as from month to month since in months, for instance January, when it rarely rains "perc_norm" per pixel tends to be larger than other months. An extreme value can affect the average of national rainfall to large extent, which could distort the information of rainfall data in other weredas. Therefore, before aggregating data, we remove outliers. The outliers are determined as the data outside three standard deviations from the median for each zone and each month.

In the process of aggregation, possible weights are number of pixels and agricultural production. Since we are calculating national rainfall as a proxy of output, output of agricultural product is preferable as the weight. We, however, have agricultural production data only for zones. Therefore, we aggregate the wereda data into zone data by using number of pixels as the weight, and then aggregate the zone data into national data by using cereal production weight.

The production weight was made by using 3 years' data (2003 – 2005) except Gambela region where we only have data of 2005. Therefore, for Gambela, the weight was calculated by using only 2005 data. And, for other regions, the weight was average of the 3 years while data of Gambela in 2005 was excluded from the denominator.

There are some zones in which we have no data of cereal production. Because most people lead pastoral life in such zones according to the part II-1 of the "Report on area and production of crops" (2004), we assume the weight for the zones are zero.

The detailed procedure of the aggregation is the following. First, the perc_norm for a zone h are derived from wereda data by an equation,

$$(2) \qquad \text{perc\_norm}_z = \sum_{j=1}^{n_z}\left[\frac{perc\_norm_j}{n_j} * \frac{n_j}{\sum_{j=1}^{n_z} n_j}\right]$$

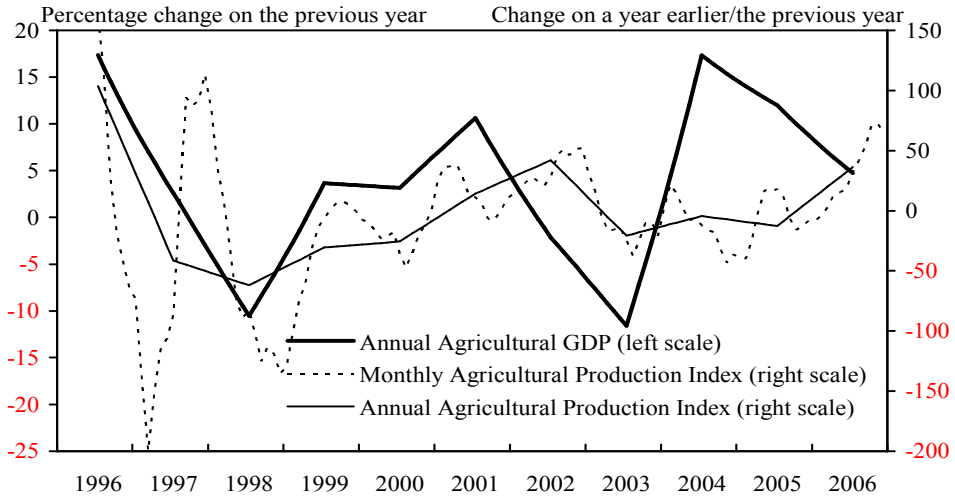
where n_z is number of weredas within a zone z. perc_norm_z is expressed in the term of per pixel for convenience of calculation. Next, we aggregate the zone data into national data by using cereal production data as the weight. The national perc_norm is as follows,

$$(3) \qquad \text{perc\_norm}_n = \sum_{z=1}^{n_n}[per\_norm_z * wgt_z]$$

where wgt_z is zone z's weight made from production data of grain and n_n is number of zones within the country. Finally, since the index shows large fluctuation, we smooth it by taking six month moving average.

We check the development of the monthly agricultural production index and confirm that it traces the development of GDP on the whole while movements toward different directions are seen in some years. We use this monthly agricultural production index in the inflation regressions and obtain the result that the lagged index has significant explanatory power on inflation in Ethiopia.

Figure A1: Agricultural Production Index and Agricultural GDP



Appendix 2: Supplementary Tables

Table A2-1. General Error Correction Model
2000:01 - 2006:12

Variables / Lags	0	1	2	3	4	5	6	7	8	9	10	11	12
Constant	-0.048												
	(-0.561)												
Percentage change of CPI		0.411 **	0.058	-0.082	-0.062	0.096	0.061	-0.078	0.152	-0.048	0.144	-0.065	-0.257 *
		(3.016)	(0.411)	(-0.575)	(-0.441)	(0.641)	(0.422)	(-0.591)	(1.088)	(-0.334)	(1.017)	(-0.454)	(-1.758)
Percentage change of M2	0.252 *	-0.109	0.205	0.221	0.113	-0.024	-0.016	-0.115	0.000	0.016	-0.106	-0.193	-0.173
	(1.885)	(-0.743)	(1.376)	(1.494)	(0.785)	(-0.169)	(-0.112)	(-0.729)	(0.002)	(0.116)	(-0.771)	(-1.354)	(-1.332)
Percentage change of Agricultural	-0.022	0.043	-0.027	0.000	-0.006	-0.018	-0.044	0.049	0.031	-0.027	0.026	-0.026	0.001
Production Index	(-0.922)	(1.499)	(-0.802)	(0.003)	(-0.154)	(-0.538)	(-1.159)	(1.377)	(0.859)	(-0.750)	(0.797)	(-0.922)	(0.025)
log CPI													-0.037
													(-1.080)
log M2													0.022
													(1.351)
log Agricultural Production Index										-0.001			
										(-0.090)			

Adjusted R^2 = 0.608 standard error = 0.010 DW = 2.18 No. of obs = 84

t-statistics in parenthesis. ** Siginificant at 1%, * significant at 10%. Seasonal dummies and dummies for November 2003 and May 2006 are included in the model.

Table A2-2. Reduced Error Correction Model
2000:01 - 2006:12

Variables / Lags	0	1	2	6	7	9	12
Constant	-0.011						
	(-0.208)						
Percentage change of CPI		0.300 ***					
		(3.466)					
Percentage change of M2	0.397 ***						-0.192 **
	(4.369)						(-2.236)
Percentage change of Agricultural	-0.027 *	0.033 **	-0.037 ***	-0.040 **	0.043 ***		
Production Index	(-1.893)	(2.034)	(-2.800)	(-2.638)	(2.898)		
log CPI							-0.068 ***
							(-3.736)
log M2							0.035 ***
							(4.025)
log Agricultural Production Index						-0.008	
						(-1.322)	

Adjusted-R^2 = 0.666 standard error = 0.009 DW = 2.03 No. of obs = 84

t-statistics in parenthesis. ** Siginificant at 1%, * significant at 5%.
Seasonal dummies and dummies for November 2003 and May 2006 are included in the model.

Table A2-3. Results of Error Correction Models
2000:01 - 2006:12

Variables	Equation 1		Equation 2		Equation 3		Equation 4		Equation 5	
Dependent Variable	Inflation rate		Inflation rate		Inflation rate		Inflation rate		Food inflation	
Constant	-0.004		0.094		0.815		-0.096		-0.056	
	(-0.075)		(1.250)		(1.022)		(-0.078)		(-0.717)	
Percentage change of CPI [-1]	0.359	***	0.399	***	0.313	***	0.264	***		
	(3.814)		(3.947)		(3.306)		(2.686)			
Percentage change of food CPI [-1]									0.343	***
									(3.489)	
Percentage change of M2					0.437	***	0.384	***	0.527	***
					(4.556)		(3.838)		(3.522)	
Percentage change of M1	0.215	***								
	(3.711)									
Percentage change of M0			0.046	**						
			(2.526)							
Percentage change of agricultural production index [-2]	-0.033	***	-0.019		-0.037	***	-0.035	***	-0.057	***
	(-2.981)		(-1.533)		(-3.354)		(-3.056)		(-3.403)	
Percentage change of nominal exchange rate (Birr/US$) [-7]					0.323	**				
					(2.224)					
Percentage change of nominal exchange rate (Birr/Euro) [-7]							0.066			
							(1.262)			
Percentage change of US price [-7]					0.657					
					(1.313)					
Percentage change of Euro area price [-7]							0.885			
							(1.179)			
Change of deposit interest rate [-1]					0.007		0.006			
					(1.281)		(1.032)			
log CPI [-12]	-0.063	***	-0.049	**	-0.065	**	-0.094	***		
	(-3.285)		(-2.045)		(-2.517)		(-3.152)			
log food CPI [-12]									-0.067	***
									(-3.841)	
log M2 [-12]					0.102	*	0.045		0.039	***
					(1.685)		(0.740)		(3.782)	
log M1 [-12]	0.033	***								
	(3.644)									
log M0 [-12]			0.017	**						
			(2.392)							
log agricultural production index [-9]	-0.007		-0.006		-0.010	*	-0.008		-0.012	*
	(-1.570)		(-1.196)		(-1.911)		(-1.460)		(-1.698)	
log nominal exchange rate (Birr/US$) [-10]					0.107					
					(1.347)					
log nominal exchange rate (Birr/Euro) [-10]							0.024			
							(1.094)			
log US price [-10]					-0.381					
					(-1.290)					
log Euro price [-10]							0.004			
							(0.010)			
Deposit interest rate [-11]					0.003		0.004			
					(1.447)		(1.445)			
Adjusted R^2	0.571		0.455		0.633		0.607		0.559	
Standard error	0.011		0.012		0.010		0.010		0.016	
F-statistic	6.808		4.642		6.729		6.138		6.534	
DW	2.000		1.924		2.121		1.871		2.124	

t-statistics in parenthesis. *** Siginificant at 1%, ** significant at 5%, * significant at 10%.
Seasonal dummies and dummies for November 2003 and May 2006 are included in the models.
Source: Author's calculatuions.

Table A2-4. Ethiopia: Time Series, 1995-2006

Year and Month	CPI Total	CPI food	M2	M1	M0	Agricultural Production Index	exchange rate	exchange rate	CPI US	CPI Euro Area	Deposit interest rate
	2000.12=100		Mil. of Birr				Birr/US$	Birr/Euro			%
1995M01	92.4				7569		5.4		87.3		11.5
1995M02	96.6				7552		5.4		87.6		11.5
1995M03	99.6				7460		5.6		87.9		11.5
1995M04	103.3				7464	113.1	5.8		88.2		11.5
1995M05	104.1				7209	122.1	5.8		88.4		11.5
1995M06	102.8				7561	121.6	5.8		88.6		11.5
1995M07	102.1				8597	114.9	5.8		88.6		11.5
1995M08	104.8				8249	99.3	5.8		88.8		11.5
1995M09	101.5				8008	104.6	5.8		89.0		11.5
1995M10	94.9				7804	133.1	5.8		89.3		11.5
1995M11	95.9				8155	145.6	5.8		89.2		11.5
1995M12	96.5				7963	151.4	5.8		89.1		11.0
1996M01	96.4				8261	167.5	5.8		89.7		11.0
1996M02	96.3				8114	246.4	5.8		90.0		11.0
1996M03	97.4				7947	315.2	5.8		90.4		11.0
1996M04	97.5				7797	298.8	5.8		90.8		11.0
1996M05	96.3				7562	291.7	5.8		90.9		11.0
1996M06	93.6				7964	292.2	5.8		91.0		10.0
1996M07	96.6				8145	278.4	5.8		91.2		10.0
1996M08	96.7				7834	209.8	5.8		91.3		10.0
1996M09	93.6				7633	131.8	5.8		91.6		7.0
1996M10	88.6				7135	114.1	5.8		91.9		7.0
1996M11	89.7				7363	102.9	5.9		92.1		7.0
1996M12	91.5				6650	86.6	6.2		92.1		7.0
1997M01	95.0		16107	10056	6831	94.1	6.2		92.4		7.0
1997M02	93.6		16605	10541	6943	105.3	6.3		92.7		7.0
1997M03	92.8		16308	10201	6639	115.5	6.3		92.9		7.0
1997M04	93.5		16608	10492	6542	149.5	6.4		93.0		7.0
1997M05	94.3		16775	10475	6666	177.7	6.5		93.0		7.0
1997M06	96.7		17057	10526	6999	185.3	6.5		93.1		7.0
1997M07	99.3	101.3	17389	10711	7402	192.0	6.6		93.2		7.0
1997M08	102.6	105.4	17299	10619	7176	216.6	6.6		93.4		7.0
1997M09	100.4	102.3	17458	10720	7003	226.0	6.7		93.6		7.0
1997M10	99.4	101.6	16925	9888	6751	201.6	6.7		93.8		7.0
1997M11	98.0	99.5	17542	10423	6771	194.4	6.6		93.8		7.0
1997M12	95.8	96.7	18266	11024	7250	199.8	6.7		93.7		7.0
1998M01	95.8	97.0	17948	10805	6822	178.9	6.7		93.8	96.0	6.0
1998M02	96.6	97.8	17956	10792	6467	140.5	6.7		94.0	96.3	6.0
1998M03	96.7	98.2	17964	10763	5987	124.2	6.8		94.2	96.4	6.0
1998M04	96.6	98.6	18469	11171	6376	118.9	6.8		94.4	96.6	6.0
1998M05	97.9	101.7	18601	11171	6281	102.8	6.9		94.5	96.7	6.0
1998M06	98.7	103.8	19250	11697	7527	96.3	6.9		94.7	96.8	6.0
1998M07	99.6	105.8	18369	10763	6889	109.1	6.9		94.8	96.8	6.0
1998M08	101.5	107.9	18198	10577	6697	114.7	7.0		94.9	96.8	6.0
1998M09	104.3	111.7	18075	10420	6489	100.5	7.2		95.0	96.8	6.0
1998M10	104.2	113.1	18131	10677	5516	87.9	7.1		95.2	96.7	6.0
1998M11	99.4	104.2	18164	10762	6511	75.1	7.2		95.2	96.7	6.0
1998M12	97.4	99.6	18066	10511	6363	64.4	7.4		95.2	96.8	6.0

Table A2-4. Ethiopia: Time Series, 1995-2006 -continued

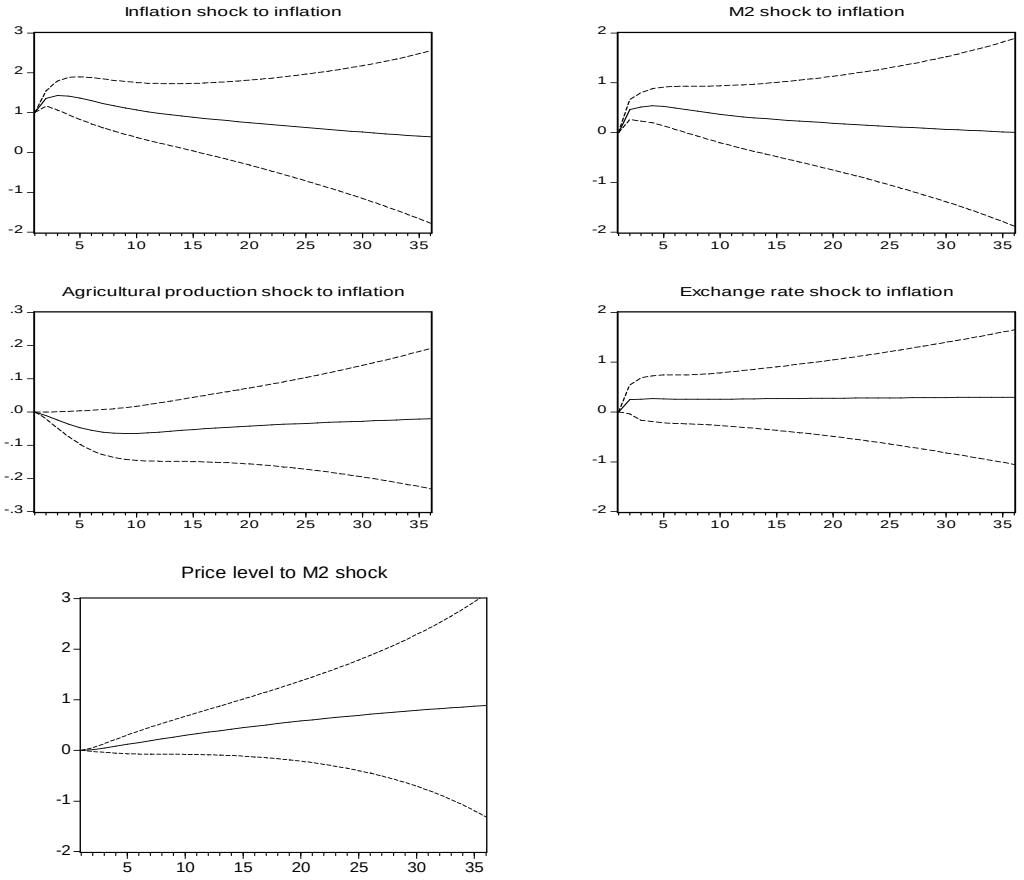
Year and Month	CPI Total	CPI food	M2	M1	M0	Agricultural Production Index	exchange rate	exchange rate	CPI US	CPI Euro Area	Deposit interest rate
	2000.12=100		Mil. of Birr				Birr/US$	Birr/Euro			%
1999M01	100.4	100.9	18367	10803	6406	49.0	7.4	8.6	95.4	96.7	6.0
1999M02	100.5	104.5	18715	11143	6506	39.7	7.5	8.3	95.5	97.0	6.0
1999M03	103.6	110.9	18532	10860	6636	49.5	7.6	8.3	95.8	97.3	6.0
1999M04	105.6	112.2	18825	11084	6689	59.4	7.8	8.4	96.5	97.6	6.0
1999M05	106.7	116.4	18883	11073	6813	71.0	7.8	8.3	96.5	97.7	6.0
1999M06	110.8	125.1	19242	11169	7197	82.0	7.8	8.1	96.5	97.7	6.0
1999M07	112.3	127.5	20072	11844	6749	102.8	7.8	8.0	96.8	97.9	6.0
1999M08	112.4	126.9	19859	11584	7015	116.0	8.0	8.5	97.0	98.0	6.0
1999M09	111.2	124.9	19911	11593	6979	107.3	8.0	8.4	97.5	98.0	6.0
1999M10	109.5	120.3	19787	11461	6230	95.7	8.0	8.6	97.7	98.1	6.0
1999M11	105.8	113.7	20055	11658	6040	79.7	8.0	8.3	97.7	98.2	6.0
1999M12	105.3	110.5	20542	12067	6051	63.8	8.0	8.1	97.7	98.5	6.0
2000M01	105.3	110.1	20690	12254	6525	41.5	8.0	8.1	98.0	98.6	6.0
2000M02	106.4	113.1	20818	12328	7519	29.9	8.0	7.9	98.6	99.0	6.0
2000M03	109.3	116.9	21060	12435	8356	33.5	8.0	7.8	99.4	99.4	6.0
2000M04	111.9	120.7	21143	12484	8423	36.0	7.9	7.4	99.5	99.5	6.0
2000M05	110.5	120.2	21952	13024	9494	49.8	8.1	7.3	99.6	99.6	6.0
2000M06	111.1	120.5	22308	13144	10120	64.1	8.1	7.7	100.1	100.0	6.0
2000M07	111.4	119.7	23150	13693	11655	66.6	8.1	7.6	100.3	100.2	6.0
2000M08	110.6	118.7	23456	13787	11644	68.6	8.1	7.4	100.3	100.2	6.0
2000M09	107.5	113.6	23625	13901	11924	72.5	8.2	7.1	100.9	100.7	6.0
2000M10	104.9	109.7	23055	13200	11711	74.8	8.1	7.0	101.0	100.7	6.0
2000M11	102.7	105.5	23016	13038	8281	68.1	8.2	7.0	101.1	101.0	6.0
2000M12	100.0	100.0	23228	13226	8395	63.1	8.2	7.4	101.0	101.1	6.0
2001M01	103.6	105.7	23689	13611	8597	65.4	8.1	7.6	101.7	100.5	6.0
2001M02	103.6	105.8	24260	14083	9007	66.4	8.2	7.6	102.1	100.8	6.0
2001M03	101.0	102.2	24155	13891	8359	70.3	8.2	7.5	102.3	101.4	6.0
2001M04	99.2	98.9	24302	13975	8389	74.4	8.3	7.4	102.7	102.0	6.0
2001M05	98.8	97.8	25283	14670	8473	77.0	8.3	7.3	103.2	102.5	6.0
2001M06	98.4	97.2	25517	14704	8363	76.9	8.3	7.1	103.4	102.6	6.0
2001M07	96.2	93.3	25107	14176	7723	77.9	8.3	7.1	103.1	102.4	6.0
2001M08	96.3	93.7	25549	14421	8581	74.3	8.3	7.5	103.1	102.3	6.0
2001M09	97.6	94.1	25709	14510	8739	65.9	8.5	7.5	103.5	102.6	6.0
2001M10	97.0	93.9	25356	14069	7721	66.9	8.8	7.3	103.2	102.7	6.0
2001M11	97.8	94.3	25886	14350	7364	67.5	8.8	7.2	103.0	102.6	6.0
2001M12	95.7	92.5	25475	13865	7640	72.6	8.8	7.2	102.6	103.1	6.0
2002M01	95.3	91.2	25848	14166	8098	79.4	8.8	7.1	102.8	103.1	6.0
2002M02	94.4	90.1	25953	14154	8085	79.4	8.8	7.0	103.3	103.3	6.0
2002M03	94.9	90.7	26883	15117	8837	93.8	8.8	7.0	103.8	103.9	4.0
2002M04	94.3	91.2	26548	14642	8705	102.4	8.8	7.1	104.4	104.4	3.2
2002M05	95.1	92.0	27495	15335	8780	101.1	8.8	7.4	104.4	104.6	3.3
2002M06	97.4	95.5	27919	15672	9393	97.9	8.8	7.7	104.5	104.6	3.3
2002M07	100.0	99.8	28604	16141	10485	105.9	8.7	7.9	104.6	104.5	3.3
2002M08	103.7	104.9	28856	16245	10602	120.1	8.7	7.8	104.9	104.5	3.3
2002M09	106.0	108.8	28662	15949	9849	116.8	8.8	7.9	105.1	104.7	3.3
2002M10	106.6	109.8	29186	16357	9980	113.0	8.8	8.0	105.3	105.0	3.3
2002M11	108.0	112.3	29082	16108	9413	118.7	8.9	8.2	105.3	104.9	3.3
2002M12	109.1	113.6	29534	16558	10302	124.5	8.8	8.2	105.1	105.4	3.3

Table A2-4. Ethiopia: Time Series, 1995-2006 -continued

Year and Month	CPI Total	CPI food	M2	M1	M0	Agricultural Production Index	exchange rate	exchange rate	CPI US	CPI Euro Area	Deposit interest rate
	2000.12=100		Mil. of Birr				Birr/US$	Birr/Euro			%
2003M01	111.6	117.4	30354	17396	10971	110.4	8.7	8.5	105.5	105.3	3.3
2003M02	112.5	118.6	30453	17294	11120	96.3	8.8	8.8	106.3	105.8	3.3
2003M03	114.3	121.4	30521	17300	11286	90.4	8.7	8.7	107.0	106.4	3.4
2003M04	116.4	124.9	30351	17005	11334	86.2	8.7	8.8	106.7	106.5	3.3
2003M05	117.0	125.9	30561	16966	11432	85.4	8.8	9.5	106.6	106.4	3.3
2003M06	120.3	131.2	31260	17538	11250	84.2	8.7	9.5	106.7	106.5	3.3
2003M07	122.1	133.8	31346	17521	12116	81.2	8.8	9.3	106.8	106.4	3.4
2003M08	123.8	136.7	32058	17941	12461	82.4	8.9	9.2	107.2	106.6	3.4
2003M09	123.6	136.2	31482	17235	11207	90.9	8.9	9.3	107.5	107.0	3.4
2003M10	122.3	133.6	31663	17467	8671	102.6	8.8	9.7	107.4	107.1	3.4
2003M11	119.0	128.9	32567	18032	11426	109.0	8.8	9.7	107.1	107.2	3.4
2003M12	116.1	123.1	33208	18595	11859	103.7	8.8	10.2	107.0	107.5	3.4
2004M01	114.9	119.8	34303	19611	12664	112.8	8.8	10.4	107.5	107.3	3.4
2004M02	116.2	121.2	34835	19991	12549	118.2	8.9	10.5	108.1	107.5	3.4
2004M03	118.7	124.7	35321	20293	11651	104.5	8.8	10.2	108.8	108.2	3.4
2004M04	122.3	130.4	36227	21015	13877	88.2	8.9	10.0	109.2	108.7	3.4
2004M05	122.6	131.3	36202	20786	13524	77.2	8.8	9.9	109.8	109.1	3.4
2004M06	123.8	133.0	36957	21336	14434	77.8	8.9	10.2	110.2	109.1	3.4
2004M07	123.3	134.3	37063	21006	13901	68.9	8.9	10.3	110.0	108.9	3.4
2004M08	124.6	135.9	37872	21524	14889	66.0	8.9	10.2	110.0	109.1	3.4
2004M09	125.8	136.7	38006	21384	14197	73.0	8.9	10.2	110.3	109.3	3.4
2004M10	126.9	139.0	37784	20909	17392	69.6	8.9	10.5	110.9	109.6	3.4
2004M11	125.9	136.4	38126	20946	20070	65.5	8.9	10.9	110.9	109.5	3.4
2004M12	125.0	134.9	39605	22312	22706	67.3	8.9	11.3	110.5	110.0	3.4
2005M01	126.6	135.4	41069	23745	23316	73.9	9.0	11.0	110.7	109.4	3.4
2005M02	127.1	135.7	40410	22956	22998	78.4	9.0	10.8	111.4	109.7	3.4
2005M03	129.7	139.9	41835	24101	20626	81.6	8.9	11.1	112.3	110.5	3.5
2005M04	132.0	143.7	42478	24297	20834	88.1	8.8	11.1	113.0	111.0	3.5
2005M05	133.0	145.8	43563	25584	20547	94.4	8.7	10.8	112.9	111.2	3.5
2005M06	138.3	153.9	44541	25609	23913	93.6	8.8	10.5	113.0	111.3	3.5
2005M07	140.1	155.1	44884	25123	23364	86.9	8.8	10.3	113.5	111.2	3.5
2005M08	141.1	156.4	45421	25508	24340	77.0	8.8	10.6	114.1	111.5	3.5
2005M09	143.4	158.9	46382	25894	24515	66.2	8.8	10.6	115.4	112.1	3.5
2005M10	142.0	157.2	46227	25656	24458	53.5	8.8	10.4	115.7	112.4	3.5
2005M11	141.6	156.4	45988	25328	23994	52.6	8.8	10.2	114.8	112.1	3.5
2005M12	140.4	155.0	46968	25981	24269	59.0	8.8	10.2	114.3	112.5	3.5
2006M01	141.2	155.2	48261	27194	24244	65.3	8.8	10.4	115.2	112.0	3.5
2006M02	142.7	156.7	48336	27137	23936	74.4	8.9	10.3	115.4	112.3	3.5
2006M03	144.2	158.4	49521	28022	22754	84.3	8.8	10.2	116.0	112.9	3.5
2006M04	144.6	159.1	49781	27995	21599	101.6	9.0	10.2	117.0	113.7	3.5
2006M05	151.2	166.9	51322	29143	22321	109.6	9.1	10.7	117.6	114.0	3.5
2006M06	154.3	170.5	51540	28891	21182	111.8	9.1	10.6	117.8	114.1	3.6
2006M07	159.0	175.8	52627	29378	20850	119.4	9.1	10.6	118.2	113.9	3.6
2006M08	161.2	178.3	53125	29534	19936	118.7	9.1	10.7	118.4	114.0	3.6
2006M09	162.9	179.9	54271	30276	21164	119.8	9.1	10.7	117.8	114.0	3.6
2006M10	164.2	181.9	54984	30950	20868	125.2	9.1	10.6	117.2	114.1	3.6
2006M11	165.0	182.8	55063	30971	22683	125.0	9.1	10.8	117.0	114.2	3.6
2006M12	166.4	184.4	56359	32056	22223	122.7	9.1	11.1	117.2	114.6	3.6

Appendix 3.

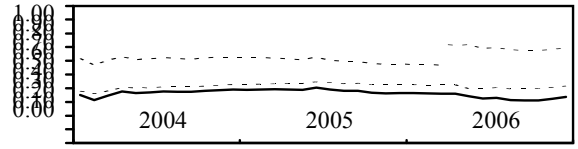
Figure 6. Impulse Response Functions



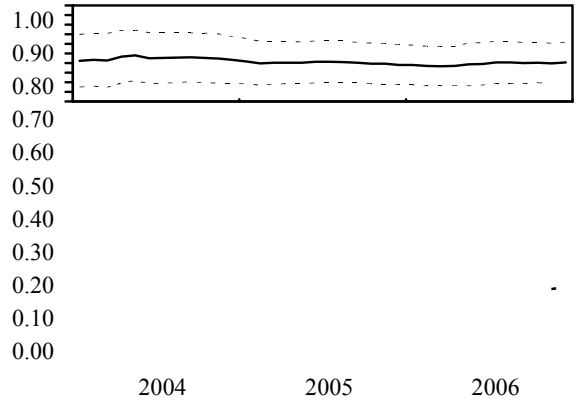
Note: The bold lines show the effect of a one percent change of the explanatory variable on inflation. Also shown are two standard error Monte Carlo error bands.

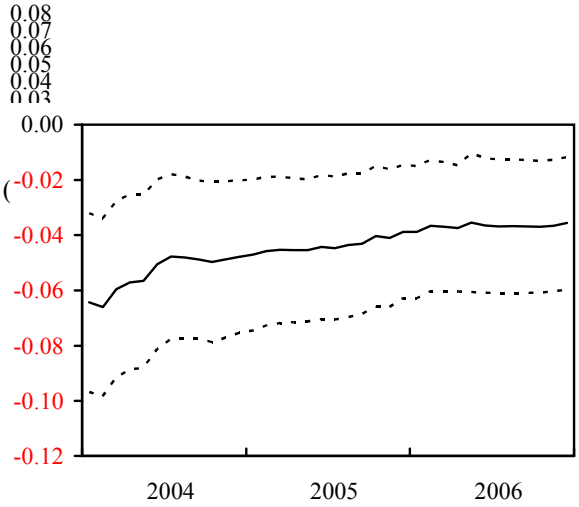
Figure 5. Recursive estimates

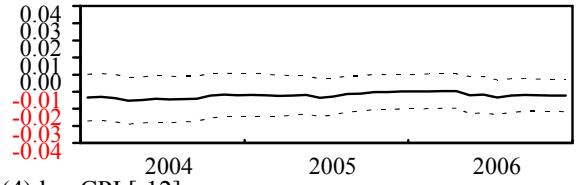
(1) Percentage change of CPI [-1]



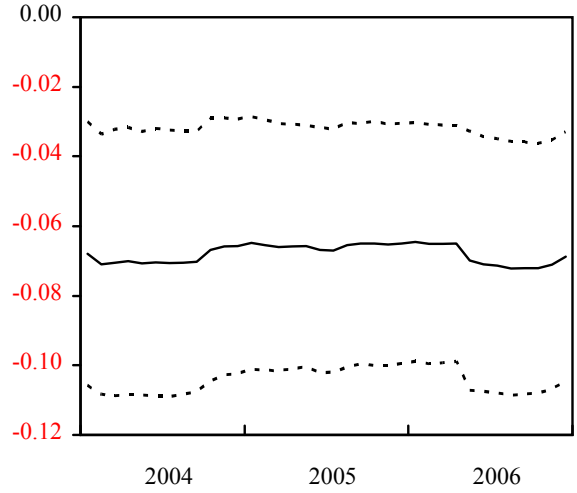
(2) Percentage change of M2



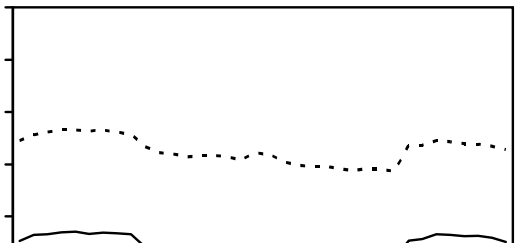




(4) log CPI [-12]



(5) log M2 [-12]



(6) log Agricultural production index [-9]