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WP 2001: 12

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Price: NOK 50 + postage

ISSN 0804-3639

ISBN 82-90584-96-2

Indexing terms

Inflation

Econometric models

Tanzania

JEL classification numbers: E31. E37

I. Introduction

The Republic of Tanzania consisting of mainland Tanzania and Zanzibar has one of the lowest per capita incomes of Africa and a rapidly increasing population which currently stands at 30 million. Since becoming independent in 1961, the mainstay of the economy has been based on subsistence agriculture and the production of cash crops such as sisal, coffee and cotton for export.

With the Arusha declaration of January 1967, central planning and government control became the dominant economic strategy with the ultimate aim of achieving self-reliance for its citizens. This strategy of centralized economic planning proved successful initially¹, until the 1970s and early 1980s. Deterioration in the external conditions revealed the inefficiencies of the state-dominated economy. This led to a foreign exchange crisis and economic growth was sharply curtailed.

To address the falling living standards resulting from inefficient economic policies aggravated by severe external shocks², the government began putting in place market based policies starting in the mid 1980s. In 1986, the government launched an Economic Recovery Programme (ERP) to promote a market-based open economy. The ERP focused on macroeconomic stabilization and liberalization, especially the import and agricultural sectors. During the early 1990s, the reform efforts have been aimed at improving fiscal performance, restructuring the civil service and the privatization of state enterprises.

¹ This success is manifested in improved social indicators. For example, Tanzania had one of the best adult literacy rates on the African continent, during this period.

The combined effects of these reforms have generally had a positive impact on the economy. For example, economic growth averaged 3 – 4 percent on average between 1985 – 1991, and the level of international reserves improved to about 3 months of imports by the end of 1992/1993. However, inflation remained above 30 percent and fiscal discipline declined toward the middle of the 1990s with both budget and external current account deficits increasing sharply.³

Maintaining inflation rates within reasonable targets continues to be one of the principal goals of the ongoing economic reforms. The government through the monetary authorities has instituted tight monetary and fiscal policies which often target the demand causes of inflation. On the other hand there are real factors such as food production which also influences inflation.

The aim of this paper is to develop an econometric model to examine the major determinants of inflation in Tanzania. The model will incorporate both the demand and cost-push or structural elements of price movements. It is based on quarterly data which simultaneously explores the importance of time lags of key variables such as the money supply and real output. The paper is organized as follows. The next section discusses the evolution of inflation in Tanzania between 1992 – 1998. In section 3, the econometric model to explain the determinants of inflation will be discussed. Section 4 will be devoted to the discussion of the results. The final section takes up the conclusions and policy implications.

² These external shocks consisted of mainly oil price hikes and falling commodity prices on world markets.

II. The Evolution of Inflation During 1992 – 1998

There are two important measures of inflation computed by the Tanzania Bureau of Statistics (BOS). One measure is the year to year headline inflation which is defined as the percentage change in the National Consumer Price Index (NCPI). The other measure of inflation is the underlying inflation rate which is defined as the rate of inflation excluding changes in food prices.

Table 1
Rates of Inflation (Percent)

Period	Total^a	Food	Non-Food^b
1992	21.9	21.3	22.9
1993	25.2	20.1	33.8
1994	33.1	39.1	23.9
1995	28.4	29.7	26.0
1996	21.0	20.4	22.0
1997	16.1	17.4	13.8
1998	12.8	14.7	8.0

a. Headline inflation.

b. Underlying inflation

Source: Bank of Tanzania, Quarterly Economic Bulletin, Various Issues.

On the whole the general rate of inflation in Tanzania shows a downward trend between the period 1992 – 1998. See Table 1 above. Starting at 21.9% in 1992, the headline inflation increased to approximately 33% in 1994. This could be partly attributed to an expansion in the money supply, exacerbated by growing budget deficits. For example the growth rate in the money supply (M2) compared to the previous period stood at 32.5% in 1994. Note that the comparable figure for the year before, 1993, was only 28.8%. See Table 2. Since then the rates have declined steadily, averaging 12.8% as at the end of 1998.

³ See IMF country report on Tanzania, 1999, page 5.

Table 2
Factors Influencing Inflation

Year	Budget Deficit^a (% of GDP)	Exchange Rate^b Depreciation (%)	Real GDP Growth (%)	Broad Money Growth (%)
1992	1.7	16.7 ^c	1.8	38.5
1993	9.1	10.6 ^c	0.4	28.8
1994	6.4	13.3 ^c	1.4	32.5
1995	5.9	16.1	3.6	26.2
1996	4.3	2.9	4.2	16.3
1997	1.6	0.7	3.3	18.3
1998	2.9	6.5	6.5	7.7

- a. Excluding grants.
- b. Annual depreciation of TZS/US\$.
- c. Author's calculations based on actual exchange rates.

Source:

1. Bank of Tanzania website, Statistics link (<http://www.bot-tz.org>).
2. Tanzania, *Recent Economic Developments*, IMF Staff Country Reports No. 99/24, Statistical Appendix.
3. Bank of Tanzania, *Economic Operations Reports, Various Issues*.

The significant decline in inflation rates since 1994 reflects the impact of tight monetary and fiscal policies pursued by the central bank. From Table 2, one observes that the growth rate in the money supply declined from 32.5% in 1994 to approximately 7.7% in 1998. The budget deficit expressed as a percentage of GDP also declined from 6.4% in 1994 to 2.9% in 1998. The year to year underlying inflation rate, which is the rate of inflation excluding changes in food prices also decreased significantly from 13.8% to 8.0% in 1998. The decrease is partly attributed to the decline in prices of most non-food group items such as rents; fuel, light and water; and transportation. The year to year food inflation has also showed a steady decline since 1994 when it reached its apogee of 39.1%. By the end of 1998, this rate had declined to 14.7%.

It should however be pointed out that although the rate of headline inflation has been on the decline as depicted by the numbers in Table 1, it is not within the target levels set by the government. For example, the government had targeted a headline inflation rate of about 10% by the end of June 1998 in her budget statement. However, this target could not be met due low rainfall brought about by the El-nino effect. The low rainfall apparently had an adverse impact on agricultural output and thus the rate of inflation. This result is not surprising since food accounts for about 64.2% of the weights in the Consumer Price Index (CPI), used in computing the rates of inflation.

III. A Simple Theoretical Model of Inflation Determination⁴

Assuming that the overall price level P is a weighted average of the price of tradable goods (P^T) and of nontradable goods (P^{NT}):

$$\text{Log } P_t = \mathbf{a}(\text{log } P_t^T) + (1 - \mathbf{a})(\text{log } P_t^{NT}) \quad (1)$$

Where $0 < \mathbf{a} < 1$.

The price of tradable goods is determined in the world market and depends on foreign prices (P^f) and on the exchange rate (e), assuming that purchasing power parity holds

$$\text{Log } P^T = \text{log } e_t + \text{log } P_t^f \quad (2)$$

⁴ The model draws from the work of Ubide (1997).

Hence a depreciation (appreciation) of the exchange rate or an increase (decrease) in foreign prices will increase (decrease) domestic prices. Further we also assume that the price of nontradable goods is set in the domestic money market, where demand for nontradables is assumed, for simplicity, to move in tandem with overall demand in the economy. This implies that, the price of nontradable goods is determined by the money market equilibrium condition, i.e. real money supply (M^s/P) equals real money demand (m^d):

$$\text{Log } P_t^{NT} = \mathbf{b}(\log M_t^s - \log m_t^d) \quad (3)$$

Where \mathbf{b} is a scale factor representing the relationship between economy-wide demand and the demand for nontradable goods. The demand for real money balances is also assumed to depend on real income and inflationary expectations. Typically, the money demand function should also include interest rates as an opportunity cost variable. However, due to the underdeveloped nature of financial markets in developing countries such as Tanzania, the relevant substitution effect being captured is between goods and money, and among different financial securities. Thus the expected rate of inflation can be used as a proxy to capture the opportunity cost of holding money.

$$m_t^d = f(y_t, E(p_t)) \quad (4)$$

Hence economic theory predicts a positive relationship between money demand and real income, and an inverse relationship between money demand the expected rate of inflation, as summarized in equation (4).

Expected inflation can be modeled in several ways. Following Ubide (1997), the following general formulation is employed:

$$E(\mathbf{p}_t) = d(L(\mathbf{p}_t)) + (1 - d) \mathbf{D} \log P_{t-1} \quad (5)$$

Where $L(\mathbf{p})$ represents a distributed lag learning process for the agents of the country. If all the weights in $L(\mathbf{p})$ are equal, then an adaptive expectations prevails. On the other hand if weights decrease with time, then a learning process evolves. For simplicity, we assume that $d = 0$. After doing all the relevant substitutions and rearranging, the price level can be expressed generally as follows:

$$P_t = f(M_t, y_t, e_t, P_{t-1}, P_t^f) \quad (6)$$

However due to data constraints⁵ we shall simply use a variant of equation (6). That is

$$P_t = \mathbf{f}(M_t, y_t, e_t) \quad (7)$$

Log-linearizing equation (7), we can write the long run inflation equation as

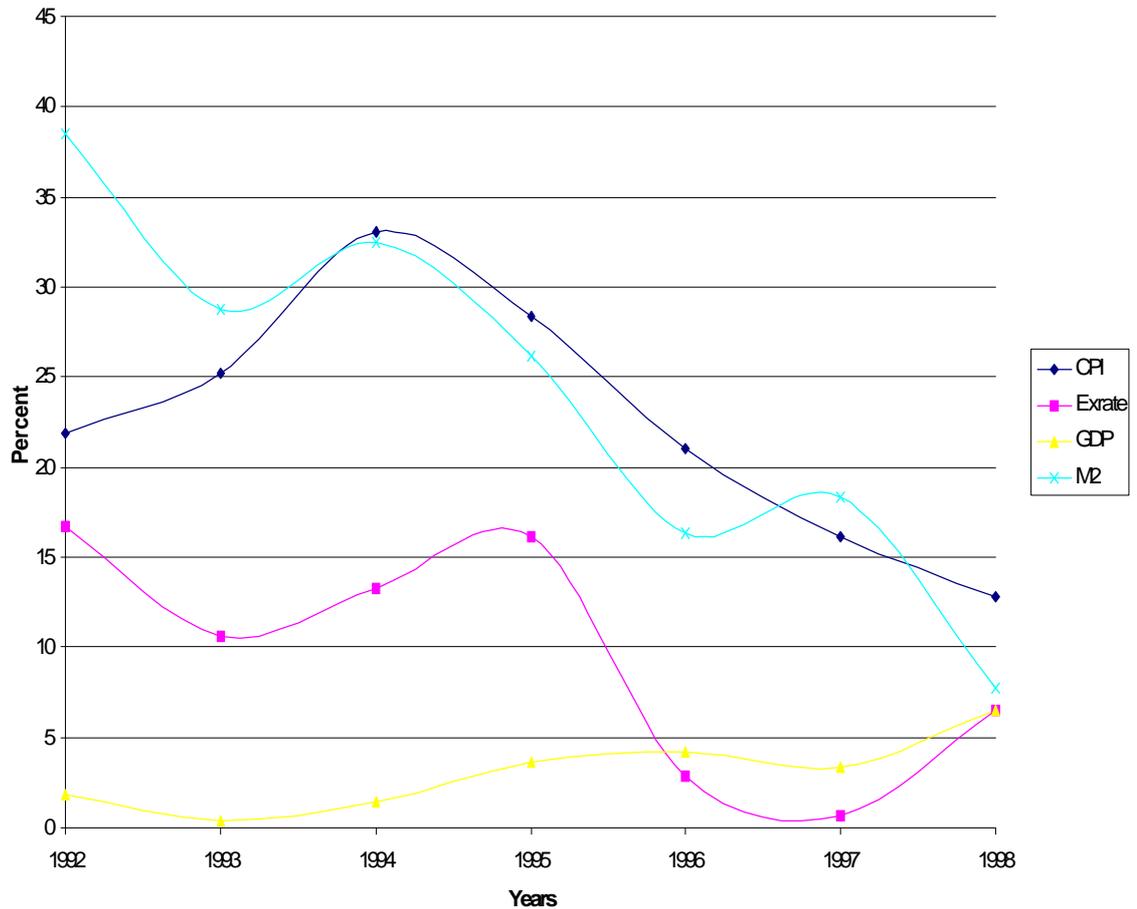
$$\log P_t = \mathbf{a}_0 + \mathbf{a}_1 \log y_t + \mathbf{a}_2 \log M_t + \mathbf{a}_3 \log e_t + u_t \quad (8)$$

⁵ It is unclear which countries' prices will serve as foreign prices for Tanzania. An obvious choice could be Tanzania's major trading partners. Lag structures of the past prices and other variables will be incorporated in the error correction model.

Where u_t is an error term which is assumed to normally distributed and of mean zero. Theory predicts that the partial derivatives of price with respect to money stock and exchange rates be positive. This is because, if it is assumed that the velocity of money is constant and that the economy is operating at full capacity, then according to the quantity theory of money, any increases in the money supply will result in an increase in the price level, which if sustained, would be inflationary. To explain why the partial derivative of price with respect to the exchange rate is positive, we observe that exchange rate developments can contribute to consumer price inflation either directly through their impact on the costs of imported consumer goods or indirectly through their impact on the costs of intermediate goods. On the other hand, inflation is predicted to be a decreasing function of output, since an increase in output eases the demand pressures in the economy.

Figure 1 above is a graphical illustration of the theoretical relationships discussed earlier on. The figure depicts a very strong positive correlation between the inflation rate measured by the CPI and growth rates in both M2 measure of the money supply and changes in the value of the Tanzanian shilling vis-à-vis the US dollar. That is, in those years when the inflation rate is declining, one also observes a decline in the growth rate of the money supply and an appreciation of the shilling against the US dollar and vice-versa.

Figure 1: Growth Rates of Key Determinants of Inflation, 1992-1998



On the other hand, Figure 1 also shows a negative correlation between the rate of inflation and growth rates in real GDP. That is, in those years that inflation is declining, we observe an increase in the growth rate of real GDP and vice-versa. The empirical results, which we will discuss in the next section will also shed light on the statistical significance of the key determinants of inflation.

IV. Empirical Results

We estimated equation 8, using ordinary least squares (OLS) and correcting for first order autocorrelation and heteroskedasticity where necessary. The estimations were carried out using quarterly data for the period 1992:1 – 1998:4, a total of 28 potential

observations. The results of the OLS regression has been summarized in Table 3 below.

Table3
Long Run OLS Estimation Results of Inflation
Dependent Variable: Log CPI

Variable	Equation I	Equation II	Equation III	Equation IV
Log M1	1.02 (7.38)**		0.77 (6.17)**	
Log M2		1.11 (11.47)**		1.02 (10.02)**
Log EXRATE	0.20 (0.63)	-0.077 (-0.34)	0.67 (2.45)**	0.12 (0.52)
Log GDP	-0.106 (-3.58)**	-0.099 (-4.78)**	-0.085 (-3.82)**	-0.089 (-4.79)**
CONSTANT	-8.08 (-13.25)	-8.09 (-19.05)	-8.17 (-9.96)	-8.27 (-17.09)
R ²	0.97	0.98	0.98	0.98
DW	1.37	1.62	2.27	2.07
F – Statistic	370.51	742.66	106.51	414.84

Notes:

1. T-values in parentheses.
2. EXRATE = Exchange rate i.e. TZS/US\$.
3. ** Significant at the 1% level.

Equations I and II in Table 3 were estimated without ascertaining whether the residuals from the OLS regression were serially correlated or homoskedastic. Whereas in equations III and IV, we corrected for first order autocorrelation and heteroskedasticity. Furthermore, in equations I and III, we employed a narrow definition of money as a measure of the money supply, i.e. M1, which consists of currency in circulation plus demand deposits. In equations II and IV on the other hand, we adopted a broader definition of money, i.e. M2, defined as M1 plus time and savings deposits. We decided to experiment with various definitions of the money stock, since there was no a priori reason to determine which definition will perform better.

Using criteria such as the statistical significance of coefficient estimates and the coefficient of determination (R^2), equation III was judged to have the best fit. Thus all our subsequent discussions will be based on equation III. Regarding equation III, all the variables were highly significant at the 1- percent level, and they all possessed the correct signs. The high R – squared also suggests a high degree to which variations in the inflation rate are explained by variations in output, money supply and the parallel exchange rate.

The results also suggest that in the long run, monetary factors have a bigger impact on the rate of inflation in Tanzania, compared to output effects. This is because the long run elasticity of money and output are 0.77 and –0.085 respectively. This finding also supports the monetarist argument on the power of monetary factors in the long run inflationary process.

An Error Correction Model of Inflation

Time-series data on most developing countries such as Tanzania are non-stationary. Estimation within such environment not only violates most classical econometric assumptions, but also renders policy making from such econometric results less accurate. In cases where the data series exhibit unit roots, the short run dynamic properties of the model can only be captured in an error correction model, when the existence of co-integration has been established.⁶

⁶ See Engle and Granger (1987)

An investigation of the time series properties of the data using both the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests, showed that all the variables have unit roots. That is, the autoregressive distributed lag functions of the variables are of $I(1)$ series. This implies that the variables are non-stationary and hence may exhibit some spurious correlations.

Having established the unit root properties of the data series, we proceeded to ascertain if the residuals of equation 8 is of $I(0)$ series, using both the Dickey-Fuller (DF) and Phillips-Perron (PP) tests. In other words we wanted to establish if the inflation rate was cointegrated with output, the money supply and the parallel exchange rate. Our results showed that the variables were cointegrated using the PP test.⁷

To capture the short run dynamics of inflation, we imposed lag structures on the cointegration equation in (8), and proceeded to estimate within an error-correction framework. We therefore formulate a general inflation model of the type

$$\begin{aligned} Dp = & \mathbf{b}_0 + \mathbf{b}_1 Dp_{t-1} + \mathbf{b}_2 Dp_{t-2} + \mathbf{b}_3 Dy + \mathbf{b}_4 Dy_{t-1} + \mathbf{b}_5 Dy_{t-2} + \mathbf{b}_6 Dm + \mathbf{b}_7 Dm_{t-1} + \mathbf{b}_8 Dm_{t-2} + \\ & \mathbf{b}_9 De + \mathbf{b}_{10} De_{t-1} + \mathbf{b}_{11} De_{t-2} + \mathbf{b}_{12} Uhat_{t-1} + \mathbf{e}_t \end{aligned} \quad (9)$$

where $Uhat_{t-1}$ is the error correction component and \mathbf{e}_t is a serially uncorrelated error term. The lag length chosen was based on data constraints, since longer lags will result in loss of more observations. Note that the initial sample size is only 28. The results of the over-parameterized model in (9) are summarized in Table 4 below.

⁷ For more on these tests see Dickey and Fuller (1981); Phillips and Perron (1988).

Table 4
A General Specification Error Correction Model (ECM) of Inflation

Variable	Coefficients	T-Value
$\Delta Cpi(-1)$	0.503	2.843**
$\Delta Cpi(-2)$	-0.218	-1.337
ΔGdp	-0.0402	-1.764*
$\Delta Gdp(-1)$	0.0225	1.051
$\Delta Gdp(-2)$	0.0255	1.046
ΔM	0.322	4.465**
$\Delta M(-1)$	-0.113	-1.191
$\Delta M(-2)$	-0.0631	-0.668
$\Delta Exrate$	0.0787	0.609
$\Delta Exrate(-1)$	-0.144	-1.195
$\Delta Exrate(-2)$	0.220	1.718*
$Uhat(-1)$	-0.432	-4.065**
Constant	0.0226	3.126

Notes:

1. $\Delta x(t) = \text{Log } x(t) - \text{Log } x(t-1)$
2. $R^2 = 0.99$ $DW = 1.97$ $F\text{-statistic} = 2558.29$
3. * Significant at the 10% level ** Significant at the 1% level.

In order to arrive at a more parsimonious and congruent model, variables with low t-values or incorrect signs in the over-parameterized regression were excluded. The regression results of the restricted model are presented in Table 5.

Table 5
Restricted Error-Correction Model of Inflation

Variable	Coefficient	T-value
$\Delta Cpi(-1)$	0.0108	1.439
ΔM	0.3008	5.373**
ΔGdp	-0.0627	-7.76**
$\Delta Exrate$	0.1703	1.526
$\Delta Exrate(-2)$	0.0076	1.547
$Uhat(-1)$	-0.763	-5.946**
Constant	0.0274	4.506

Notes:

1. $\Delta x(t) = \text{Log } x(t) - \text{Log } x(t-1)$
2. $R^2 = 0.98$ $DW = 1.98$ $F\text{-statistic} = 3299.71$
3. * Significant at the 10% level ** Significant at the 1% level

The results summarized in Table 5 indicate that our parsimonious model has nice statistical properties. The huge F-statistic indicates that the explanatory variables are jointly significant. Furthermore the results also show that both money and output are significant explanatory variables of the inflationary spiral in Tanzania in the short run, whereas the parallel exchange rate is not, at least in the short run. These results corroborate studies on inflation in other African economies. For example, Sowa (1994), Sowa and Kwakye (1991) and Chhibber and Shafik (1992) obtain similar results for Ghana. Also the short run elasticity of money, 0.3, is greater than the short run output elasticity -0.06, emphasizing the importance of monetary factors in the inflationary process in Tanzania.

One should also observe that the error-correction term $Uhat(-1)$ is significant at the 1% level, confirming the point that the variables are cointegrated, which we alluded to earlier on. It also shows the rapid adjustment of inflation toward its equilibrium value. That is, there is a 76% feedback from the previous period into the short run dynamic process.

V. Conclusions

The rate of inflation in Tanzania which hovered around 30% on average in the early 1990's, dropped to about 13% by the end of 1998. In this paper, we employ various econometric techniques to explain the main determinants of inflation both in the long run and in the short run. In the short run, output and monetary factors are the main determinants of inflation. However, in the long run, the parallel exchange rate

also plays a key role, in addition to output and money. The positive coefficients on the exchange rate variable reflects the effect on inflation via trade in goods, mainly through imports in the informal sector.

Looking at the magnitudes of the elasticities of price with respect to both money and output, there is also evidence that inflation in Tanzania is engineered more by monetary factors than by real factors. This result applies to both the long run and the short run. The key policy implication is that inflation in Tanzania is a monetary phenomenon. Thus to control inflation the government will have to pursue a contractionary monetary and fiscal policy. The significance of the output variable in our analysis, especially in the long run, also suggest that the government can reduce inflation by increasing output, especially agricultural output. This is because food accounts for about 65% of the weight used in the consumer price index.

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Summary

Tanzania's inflation rate which averaged about 30% in the early 1990's dropped to about 13% at the end of 1998. Using an error correction model (ECM), this paper estimates an inflation equation for Tanzania based on quarterly data, for the period 1992:1 to 1998:4. The results from the econometric regression analysis shows that inflation in Tanzania, either in the short run or the long run, is influenced more by monetary factors and to a lesser extent by volatility in output or depreciation of the exchange rate. It is recommended that to control inflation in Tanzania, the government should pursue tight monetary and fiscal policies. In the long run, the government should also pursue policies to increase food production to ease some of the supply constraints.

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