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DETERMINANTS OF PRICE LEVEL DYNAMICS IN UGANDA: SOME STYLIZED FACTS AND EMPIRICAL EVIDENCE

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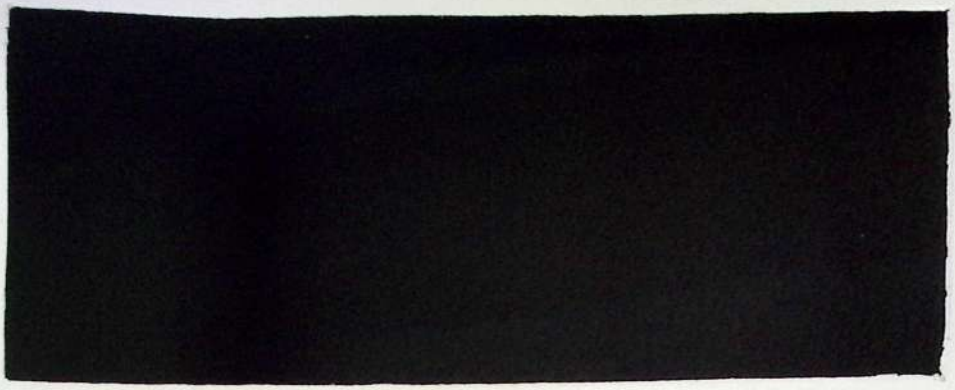

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DETERMINANTS OF PRICE LEVEL DYNAMICS IN UGANDA: SOME STYLIZED FACTS AND EMPIRICAL EVIDENCE

Research Series No. 26

by

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and

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June 2001

Abstract

This paper examines the dynamics of inflation in Uganda during 1989 - 1999. A period characterized by emphasis on macroeconomic stability. It analyses trend, seasonal and irregular unobserved components of inflation. The key finding was that the behavior of the inflation trend was largely underpinned by the macroeconomic policy management stance while indications are that the seasonal character was driven by the pattern of agricultural production and underlying climatic conditions. The irregular component on other hand was driven by external shocks like the "coffee boom" of 1994/95. The paper also finds that real output growth, exchange rate depreciation, money growth and foreign prices drove the domestic rate of inflation.. The policy message appears to be that continued improvement of monetary policy design and implementation is an important process in the management of price level dynamics.

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Executive Summary: Policy Implications

This study characterizes the prime movers of Uganda's inflation and finds it to be characterized by the trend, seasonal and irregular unobserved components. The evolution of the trend was largely underpinned by the macroeconomic policy stance while indications are that the seasonal character was driven in part by the pattern of agricultural production and by underlying climatic conditions. The irregular component on other hand was driven by external shocks such as from the "coffee boom" of 1994/95. The empirical results exhibit theory consistent long and short-run dynamic properties. They indicate that a reasonable impact on headline and underlying prices arose from nominal money growth and exchange rate depreciation. The other source of impact appears to have come from foreign prices. The contemporaneous and lagged components of these prices were important in the domestic price formation process. Again for both headline and underlying inflation, dampening effects tended to originate from real output expansion.

The combined analysis of the two approaches suggests that the changed macroeconomic management stance after 1992/93 was the ultimate reason for the marked deceleration and continued stability in Uganda's inflation rate. Most importantly, the strong expansion in output growth was probably the single biggest factor that helped to dampen prices. The stability of the value of the shilling also assisted in containing inflation that would have passed through if the rate of exchange rate depreciation had been excessive. In terms of the way forward, there are reasons to believe that success in inflation control in Uganda is likely to be long lasting. First, the main shocks to inflation appear to have been related to the food component of the CPI, which is a direct reflection of weather effects. The impact of these shocks has largely been moderated by prudent macroeconomic policies. Second, the stability in the exchange rate should help keep inflation under control and should the real output continue to expand, domestic inflation should remain relatively stable in the medium term.

Maintenance of price stability, which is a cardinal objective of the central bank, requires that the efficiency of monetary policy continues to be improved. Price-stability should be emphasized as the over-riding objective of monetary policy. Transparency in the conduct of monetary policy is essential and building capacity for this process is required in two key areas. First, in model building and second, in the analytical capacity to further investigate the transmission mechanism and improve forecasting ability.

A credible framework for conduct of monetary policy needs to be designed in which the majority of stakeholders have confidence. This will help build credibility and ensure continuity in delivering price stability. This framework must be adapted to local conditions by employing money as an instrument rather than interest rate. The strategy should be simple and should be refined over time to signal commitment to low inflation. This simple mechanism should be implemented as an interim measure while more comprehensive models are built. Real sector data needs to be availed more regularly and on a timely basis. Serious consideration needs to be effected by Uganda Bureau of Statistics towards the generation of real time quarterly Gross Domestic Product series. As a stopgap measure, the bureau could produce a combined index of industrial and agricultural production for possible use as a scale variable in future analytical work. Availability of such tools and early warning indicators is important to strengthen the culture of model-based analysis in policy design.

Transparency of the Central Bank is critical to ensure accountability and to help the public appreciate what the Central Bank is doing. The Central Banks needs to provide enough information for the public to understand the policy regime. It is also important in the sense that the public will be able to verify policy actions and be able to pass judgment on the Central Bank's performance

It is important to agree on the measure of inflation to monitor. The debate here is between headline and underlying. Which should constitute a measure of core inflation? As shown in the analysis headline inflation has been volatile and its use could lead to missing of the set target. In addition, some components of headline inflation are beyond monetary policy. This measure could also be subject to perverse effects from interest rate changes. Again, the use of headline requires the employment of caveats or escape clauses to be specified in advance when target may be breached. However, it is not feasible to specify all contingencies in advance and this may introduce subjective judgment and hence lack of transparency. A good measure of core inflation is required because it removes the volatile component of the consumer price index. It is however, important to make the measure understandable to the public. Currently Uganda Bureau of Statistics calculates headline inflation and underlying inflation excluding food crops. Further research is needed in the area of measuring core inflation so that a more efficient measure of core inflation can be produced. Even where it is not used as a target, such an efficient measure is an important input in the internal monetary policy process. It can be used in taking decisions for action of monetary policy and for forecasting inflation.

Definition of price stability or the level of the target needs to be analyzed. Traditionally and on account of measurement problems of the consumer price index, growth considerations and the zero lower band on nominal interest rates, most central banks aim for annual inflation in the 0-4 percent range. Government has been targeting 5 percent annual inflation rate. The question that arises is whether this is an appropriate definition of price stability. This is an empirical question, but once authorities agree on what constitutes price stability, it ought to be communicated to the public, so that agents understand in quantitative terms, what price stability is.

Work on forecasting inflation needs to be emphasized. This requires understanding of the inflation dynamics to discern, as this study has done variables which matter. It is also important to understand the role of expectations, as these are implicit in other prices such as the exchange rate. It is necessary, to understand the transmission mechanism as this determines the ability of policy instruments to manage inflation. Specifically, Bank of Uganda needs to devise a model for forecasting inflation, make mandatory periodical quarterly surveys of expectations and clearly define through empirical studies, the impact of instruments, and their lags on inflation. Human resource capacity needs to be built up as a relatively large amount of manpower is necessary for the background work of model estimation, surveys and report writing. These are necessary tasks for successful price stability.

The results have shown the important role that productivity plays in dampening inflation. The Central Bank needs to move forward with the process of financial reform. It should continue to improve the prudential and supervisory components so that a strong and viable banking sector can be able to make more and relatively cheap credit available to support real

sector activities. The study also indicates the need to take into consideration the issue of seasonality in formulation of monetary policy decisions. This is important for stability in both the shilling and foreign exchange markets.

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I. INTRODUCTION

The maintenance of low and stable inflation is recognized as the key objective of Bank Uganda's monetary policy. To understand how the Bank fared in this objective, characterized the price level dynamics that the economy experienced from 1989 to 1999. T do this we investigated the impact on inflation from money supply, real income, interest rate terms of trade, exchange rate path through effects and the evolution of prices in tradir partner countries. This was because the management of inflation was perpetual polic challenge of the Central Bank. It should be indicated that, while some Ugandan studi (Morris (1989), Kasekende (1990) and Ashok and Wandera (2000) did examine the inflatio question, none attempted to decompose inflation into it's main components namely a trend, seasonal, and irregular. This gap is bridged in this study. In addition, our derived theoretic model of inflation determination and estimation builds in exchange rate path through effect as well as prices in partner countries, issues that were ignored by earlier empirical studies. Th paper also improves upon previous studies in a number of respects. First, our sample wa extended up to the last quarter of 1999 and this helped to capture a longer phase c liberalization in the Ugandan economy. Second, we paid attention to major shortcomings c most studies in that explicit attention was paid to the data, the only exception being Asho and Wandera (2000). A model that was empirically stable was developed and issues of inflatio components were incorporated. We followed Ndung'u (1995) to specify a long ru equilibrium model of inflation for Uganda that explicitly incorporated both the monetary an foreign sectors, underpinned on an open economy framework. An error correction model fo inflation was developed and tests for cointegrating vectors using the Johansen maximur likelihood procedure were implemented. Policy implications from the empirical exercise wer then derived to help inform the process of monetary policy formulation. This process wa considered important to ensure that uncontrollable inflation pressures do not re-emerge.

It should be pointed out that, this paper attempts to explain inflation dynamics in Uganda over the period 1989-1999. During this period there were a number of policy induced changes as well as externally induced shocks that affected prices. The main external shocks that hit th economy during this period were from oil import prices, the terms of trade effect arising out of the coffee boom of 1994/95 and the freeze on aid in 1992/93 and 1998/99. Other non-policy shocks were related to weather effects, which were mainly in form of El Nino and drought. In addition, the pace of implementation of the Structural Adjustment Program was accelerated through the implementation of large-scale economic liberalization. The financial sector was deregulated and controls on domestic marketing dismantled. In the external sector, exchange rate management was moved away from a control and allocation regime. These changes started in July 1990 when the parallel market for foreign exchange was legalized. Uganda allowed virtually unrestricted purchases of foreign exchange for current and capital account transactions.

The findings are that the behavior of the inflation trend was largely underpinned by the economic policy stance while the seasonal component was driven both by the pattern of agricultural production and underlying climatic conditions. The irregular component on the other hand was driven by external shocks like the "coffee boom" of 1994/95. Empirical results show that real output growth, exchange rate depreciation, money growth, foreign prices and terms of trade drove the domestic rate of inflation. Domestic interest rates also seem to have been important in the short run for the case of headline rather than underlying inflation. The

policy message appears to be that continued maintenance of macroeconomic stability and further expansion in real output growth will provide continued high pay off in the management of price level dynamics.

The remainder of the study is organized as follows: Section II looks at the composition of the Ugandan Composite Consumer Price Index, the following section looks at inflation dynamics during the 1989-1999 period. Section four provides an analysis of trend, seasonal and irregular the unobserved components while section five posits a simple analytical model for inflation. The final section presents the estimation results and the policy implications arising therefrom.

II. BACKGROUND

One of the consequences of controls that existed in Uganda in the late 1980s was that administrative rationing of foreign exchange in the official market stimulated high demand for import finance in the informal market. The consequences were reflected in a high premium between the official and parallel market, which reached 1000%, by January 1987. External imbalances mounted as export revenue plummeted. This was not helped by the high import demand at overvalued currencies. Foreign exchange reserves dwindled and external debt arrears were accumulated. As resource mobilization collapsed against a background of reduced aid inflows government resorted to printing money to finance budgetary operations. Uncontrolled expenditures on non-productive consumption fuelled inflation in the economy and the budget deficit grew. Against this background, a number of policy measures were initiated in order to eliminate the internal and external imbalances. Policies were implemented to improve economic management in foreign trade and foreign exchange, monetary and financial sector, domestic marketing as well as fiscal and sectoral areas. These policies were hinged on the restoration of monetary and fiscal discipline to overcome the then prevailing high rate of domestic inflation, and unsustainable current account deficits.

At that time Ugandan authorities recognized that excessive government borrowing from Bank of Uganda seemed to be the main source of inflation. Government borrowing reached record levels of 64.8% of money supply in 1986/87. In order to address the fiscal problem, Government implemented a number of policy initiatives: First, Government ran a "monthly cash budget" designed to match total government expenditures and receipts. Second, on the expenditure side, the government streamlined its expenditures and identified a number of Priority Program Areas (PPA's) that could be protected. Third, in order to address the problem of an over staffed and inefficient civil service, a reform was effected to remove ghost workers, retrenchment of inefficient and unqualified workers, and enhance remuneration for a more streamlined civil service. This was supplemented by rationalization and restructuring of ministries. The civil service was trimmed from over 320,000 workers in 1987 to slightly above 155,000 workers in 1998/99.

In a further effort to strengthen monetary policy a Reserve Money Program was designed to assist in the design of monetary policy consistent with macroeconomic objectives of price stability and growth. Credit requirements by both government and commercial banks and the foreign exchange reserve build-up were taken into consideration in the design of monetary policy.

Reforms in the area of liberalizing markets were at the heart of restructuring efforts. Th underlying theory was that competition could improve the allocation of resources. Th essential complement was to reduce government interventions that distorted prices and tied u markets. Government allowed individuals, including exporters to hold foreign exchange accounts. This meant the elimination of surrender requirements on all foreign exchang inflows from non-coffee exports and private transfers. By January 1992, the administrativ allocation of foreign exchange was replaced by an auction system for allocating donor impor support resources, which further contributed to a reduction in the spread between official an bureau exchange rates. In November 1993, the auction for donor import support wa abolished and replaced with an interbank system that unified the foreign exchange market. Under this system, there was no longer any surrender requirements on commodity exports or any other foreign exchange receipts. In the internal trade system, domestic prices were fully deregulated. Restrictions on domestic marketing and pricing of products were removed, promoting efficient rural and inter-district trade. This dampened and narrowed disparity in domestic prices. Producer prices were allowed to adjust in line with world prices and exchange rate developments, thus encouraging more production, which in turn helped dampen domestic prices.

The result of these policies was that the structure of the Ugandan economy changed significantly. The share of Agriculture in GDP declined from 60 percent in the 1980's to 46 percent in 1995/96 and further down to 43 percent in 1998/99. The share of manufacturing steadily increased from 5.3 percent in 1987/88 to 9.6 percent in 1998/99. Trade and services grew from about 30 percent of GDP in the 1980's to 35.2 percent in 1998/99. The trend that emerged was one of a declining share of agriculture and an increasing importance of manufacturing and trade and service sectors in GDP. The subsistence or the non-monetary component also declined from about 40 percent of GDP in the 1980's to 23 percent in 1998/99. Economic growth averaged 7 percent per annum during the last six years with a peak growth of 10.6 percent recorded in 1994/95. During the financial year 1998/99, the Ugandan economy recovered from adverse weather conditions experienced in 1996/97 and 1997/98 and achieved real GDP growth rate of 7.8 percent. Monetary GDP grew by 8.1 percent per annum during 1998/99 while non-monetary GDP had a growth rate of 6.9 percent per annum over the same period.

In Uganda the most significant factor in economic stabilization was prudent budgetary reforms. Reform in budgetary management enabled Government to generate savings to support an increase in the share of private sector credit from the banking system. The revenue effort increased from about 4.7 percent in 1986/87 to about 12 percent in 1998/99. Responsible budgetary and fiscal reform generated economic stability. Reforms in budgetary management succeeded in reducing the size of the deficit and transformed government from a net domestic borrower to a net saver.

Prudent monetary and credit policies succeeded in controlling inflation. In the period 1986/87 to 1989/90 the program was characterized by Government violation of benchmarks on credit and money supply. Direct controls on domestic credit to the private sector and administered negative real interest rates ended up subsidizing borrowers. This resulted in a rapid expansion in money largely by rapid credit expansion. However, the improvement in budget management since March 1992 underpinned the success in controlling liquidity. The annual rate of growth of M2 decelerated from over 176.7 percent (1987/88) to below 35 percent since

1993/94. The corresponding growth in domestic credit decelerated by the same rate, while the share of net claims on government to total domestic credit decreased in line with the policy to avail more bank credit to the private sector. Money supply was restrained by controlling credit given to government and by checking credit to the private sector through proper management of banking system liquidity. Growth in broad money was brought down significantly from 53.2 percent per annum in 1991/92 to 23.7 percent per annum in 1997/98 and further down to 7.9 percent per annum in 1998/99.Table 1 details the evolution of monetary aggregates.

The Conduct of monetary policy moved away from use of direct to indirect instruments, as a result annual inflation was brought down considerably from 30 percent in 1992/93 to 5.8 percent in 1997/98 and further down to 5.3 percent as at end June 1999.

Table 1: Monetary Aggregates: June 1994 - June 1999 (Shs billion, end of period)

	June 94	June 95	June 96	June 97	June 98	June 99
Net Foreign Assets	-76.2	60.2	178.9	377.0	639.2	844.1
Broad Money - M3	448.7	571.5	684.1	809.1	1020.0	1161.3
Broad Money - M2	402.5	504.4	609.0	705.6	873.1	942.4
	Growth in Monetary Aggregates Relative to June					
Broad Money (M3)	32.8	27.4	19.7	18.3	26.1	13.8
Broad Money (M2)	33.4	25.3	20.7	15.8	23.7	7.9
Base Money	42.7	35.4	0.1	18.3	12.5	19.4

Source: Bank of Uganda.

In summary over the period 1989 to 1999 interest rates fell in tandem with the drop in the rate of inflation. Furthermore, exchange rate volatility reduced due, in part, to massive donor support, a build up in foreign exchange reserves and an appreciation of the exchange rate. Credibility in inflation control was established, however, spikes in inflation dynamics remained. Continued proper management of these spikes was considered essential.

2.1. The Composition and Structure of Uganda's CPI

The 1989 Composite Consumer Price Index replaced the previous Cost-of-Living Indices that were compiled up to the late 1980's. These were, the "Low Income" Index prepared by the Statistics Department on the Ministry of Planning and Economic Development and the "Middle Income" Index prepared by the Bank of Uganda. The new index covered almost double the number of items, which were included in the two old indices. These were 89 items, compared with 37 for the Low Income and 46 for the Middle-Income Index. A breakdown of the items and weights by group and sub-group of the new CPI are given in Table 2 below;

Table 2: Items and Weights of Groups and Sub-groups for the CPI

Group	Sub-group	Weight
Food		50.8
	Matooke, potatoes e.t.c	11.5
	Fruits and Vegetables	9.4
	Meat and Poultry	5.2
	Bread and Cereals	8.4
	Fish	4.1
	Dairy Produce	4.3
	Sugar, tea and coffee	5.4
	Other foods	0.9
	Oils and fats	1.6
Drinks and tobacco		6.3
	Non-alcoholic beverages	1.0
	Alcoholic beverages	3.4
	Tobacco and cigarettes	1.9
Fuel and Power		7.3
Transport		5.9
	Taxi fares	4.0
	Bus fares	0.5
	Motoring Costs	1.4
Clothing and Footwear		5.5
	Footwear	1.3
	Clothing	4.2
Services		15.7
	Rent	8.4
	Education Costs	4.6
	Heath Costs	2.7
Miscellaneous Products		8.5
	Soap & Toiletries	3.3
	House Household Equipment	1.5
	House Household Textile	1.5
	Communication	0.1
	Entertainment	2.1
Total Items		100.0

Source: Uganda Bureau of Statistics

The composite index was computed based on "Modified Laspeyres", which yields the similar results as the "Standard Laspeyres". The modified version was preferred due to its operational ease, particularly when it becomes necessary to replace items in the index. The annual (monthly) inflation rate, or annual (monthly) percentage change in the index are measured as the percentage change in the index over the level 12 (1) month(s) previously.

The 1989 composite index for Uganda was a weighted average for the five urban centres of Kampala/Entebbe, Jinja, Mbale, Masaka and Mbarara. The weights were allocated in proportion to the number of urban households in the region using the 1991 Census of Population and Housing as indicated in Table 3 below;

Table 3: Weights of the Composite Index for Uganda's CPI

Centre	Number of Households	Percentage of Total
Kampala/Entebbe		
Kampala	182,439	
Entebbe	10,218	
50 % of other Central -Njeru	34,387	
Total	227,044	55.4
Masaka		
Masaka	12,844	
50% of other less Njeru	34,388	
Total	47,232	11.5
Jinja		
Jinja	14,987	
Njeru	9,141	
50% of other Eastern Urban	24,168	
Total	48,296	11.8
Mbale		
Mbale	12,503	
50% off other Central -Njeru	24,168	
Total	36,671	9.0
Mbarara		
Mbarara & Other Urban	50,255	12.3
Total Urban households in Central, Eastern & Western	409,498	100.0

Source : Uganda Bureau of Statistics

This study utilized the 1989 Composite Consumer Price Index for Uganda, the index represents both the low and middle-income households. The change in the index introduced in 1989 was based on the findings of the 1989 Household Budget Survey. This survey showed that the dis-aggregation of the index into low-income and mid-income produced no significant difference. At the same time, the inclusion of high-income household made virtually no difference on the broad results of the index. The index was computed for both underlying and headline measures. The underlying index excluded food crops, which are greatly affected by seasonal conditions to even out erratic movements in domestic price. The headline was the overall index and was food inclusive.

III. EVOLUTION OF INFLATION IN UGANDA 1989-1999

Inflation measured by the Composite Consumer Price Index (CCPI) fell from 42.2 percent in 1990/91 to 30.0 percent in 1991/92. However, it remained volatile and sensitive to budget deficits arising from shortfalls in donor financing as was the case in 1992/93. Below average trend GDP growth in 1989/90 to 1991/92 period appeared to have been responsible for part of the inflation out turn during that period. Since 1992/93 to 1998/99 the economy had an average trend real growth of 7.3 percent and this could have had a dampening effect to the evolution of prices. (see Table 4 below)

Broad macroeconomic stability through the restoration of control of government expenditur also appeared to have helped to contain inflation pressures. Another factor affecting the evolution of inflation could discerned by looking at the headline inflation, which includes al items, and underlying inflation, which excludes food. The price of food is important becaus of the fact that when the supply of food falls relative to existing demand for food, its pric rises. The fall in the supply of food in Uganda arises mainly because of drought. For example in the early part of 1999, drought affected most of the food basket areas in the West and Southwest of the country leading to a rise in prices. In addition, the annual headline inflation rate was negative over the period April 1998 to January 1999 because food crops, which comprise 33.6 percent of all items Composite Consumer Price Index (CCPI) fell sharply since December 1997. The fall in food crop prices reflected a reversion to approximately normal price levels after the weather induced supply shocks had driven prices up in 1997. Another source of shocks to the price of food arises from increases in response to changes in production costs. An important cost reflected in the market price of food is the price of transportation of food to markets. The increase of fuel prices in August 1999 quickly led to higher transport costs and consequently to higher food prices. The increase in fuel prices was partly because of the depreciation of the shilling and partly from the increase in the price of crude oil in international markets. Non-food prices in Uganda are sensitive to exchange rate depreciation and money supply growth. For example exchange rate depreciation of 42.9 percent and 30.9 percent in 1990/91 and 1991/92 respectively coincides with high rates of inflation during that period. Again it could be argued that strong monetary growth over the period 1989/90 to 1991/92 also accounts for the high levels of inflation recorded during that period. There have been periods when strong monetary growth and exchange rate depreciation did not exert significant upward impact on non-food crop inflation as would ordinarily be expected. Inspite of the depreciation of the nominal exchange rate between 1995/96 and 1998/99 increases in prices were not as large as expected because imported goods only represent a small proportion of the goods in the basket in the CCPI. If this impact is coupled with a depreciation of the Kenyan Shilling against the dollar, it dampens the impact of the depreciation of the shilling on import prices because Kenya is a key trading partner. A major reason that could reduce the inflationary impact of exchange rate depreciation may enter from profit margin squeeze. This appears to have been a significant explanation for the inflation developments in the last part of 1998/99 given that aggregate demand remained broadly stagnant. Tight fiscal policy helped to diminish inflationary rates because lower injections into aggregate demand from government expenditure slows down aggregate demand and helps to dampen inflationary pressures to levels lower than would prevail without fiscal consolidation. Another factor that may affect price level dynamics in Uganda appears to result from the intervention in the Interbank Foreign Exchange Market. Bank of Uganda's intervention on the sale side reduces money balances with the public, which has a knock-on effect of reducing their purchasing power. The consequences of this could be to reduce inflationary pressures to levels lower than would have prevailed without Central Bank action.

An additional factor that could be brought to bear on inflation development in Uganda is the evolution of the terms of trade. The sharp improvement in terms of trade in 1994/95 coincided with remarkably low domestic prices, while the deterioration of the terms of trade over the period 1998/90 to 1991/92 could in part explain the high domestic prices recorded during that period. Being an importing country, one can not also rule out the impact of prices from our trading partner countries. These issues are taken up in the empirical exercise.

Table 4: Measures of Inflation and Some Possible Explanations

	Headline Inflation eop (%)	Underlying Inflation eop (%)	Terms of Trade Change (%)	Exchange Rate (%)	Real GDP Growth (%)	Broad money Growth (%)
1989/90	32.5	26.9	-25.9	7.4	5.5	56.9
1990/91	32.3	30.1	-1.6	42.9	4.4	46.7
1991/92	66.3	50.0	-21.9	30.5	3.1	53.2
1992/93	-2.4	9.2	3.5	-0.8	8.4	42.0
1993/94	16.1	9.3	44.7	-19.9	5.3	33.4
1994/95	3.4	10.0	78.3	-0.1	10.5	25.3
1995/96	5.4	8.0	-30.7	7.5	8.1	20.7
1996/97	10.4	2.6	3.2	2.1	5.2	15.8
1997/98	-1.4	2.3	16.2	14.8	5.5	21.7
1998/99	5.3	2.8	-24.6	18.3	7.8	7.3

eop - end of period Source: Bank of Uganda, Ministry of Finance, Planning & Economic Development

IV. ANALYSIS OF TREND, SEASONAL AND IRREGULAR (UNOBSERVED) COMPONENTS

In an attempt to study the nature and presence of unobserved components namely; trend, seasonal, cyclic and irregular, we decomposed the inflation series using the classical decomposition technique. We however, did not consider the fourth component "the cyclic" due to the short period covered by the inflation series. In general this component is included in the trend component resulting in a "circular trend". We anticipated the economic policies to underpin the evolution of the trend in underlying inflation, this could be represented by a stochastic trend. The effect of the food prices, with their marked seasonality and other seasonal factors embedded in the series are mainly explained by agricultural and climatic conditions and these could be captured by the seasonal component. It was reckoned that the irregular component represented the external factors affecting domestic prices.

The use of deterministic models to determine the seasonal component has been found to be poor because the causes of seasonal fluctuations such as weather are difficult to model in this manner while the inspection of estimated spectra for economic time series is not robust enough. A more popular approach has been to assume that the seasonal component is stochastic and generated by an ARIMA model. The question of how to evaluate a seasonal adjustment procedure is not an easy one partly because the seasonal and non-seasonal components are not clearly distinguishable (Granger and Watson, 1984). There is no consensus in the literature on the selection criterion and the superior performance of any particular seasonal adjustment technique. In this study we thus apply the classical time series seasonal adjustment procedures namely; exponential smoothing and moving average to extract the seasonal effect from inflation series.

More recently, such structural components have been modeled with the trend and seasonal components following stochastic rather than deterministic models. These models have become increasingly popular for modeling, forecasting and seasonal adjustments for time series. We

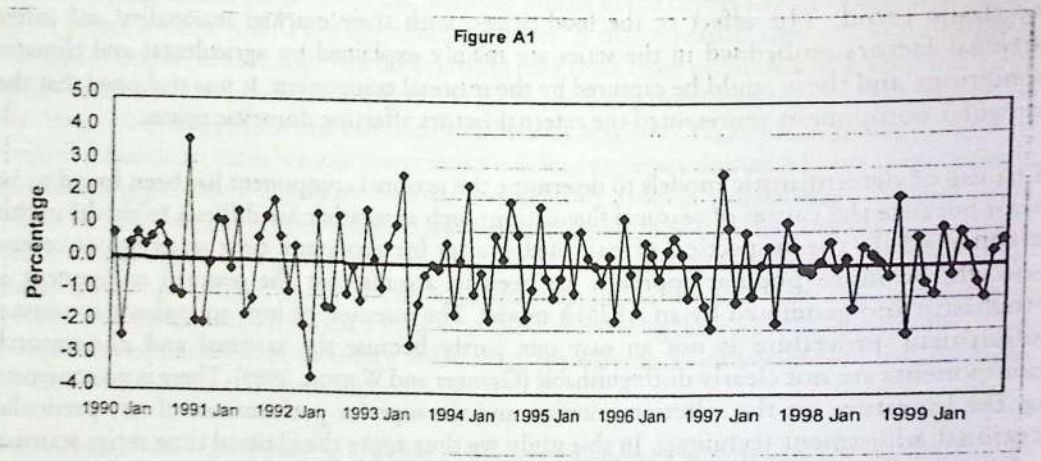
therefore, model all the three components of inflation using ARIMA (Box □ Jenkin Approach. Model parsimony and well-behaved residuals were used in the selection o appropriate model in each case. In general the model was specified as ARIMA (p, d, q)(P, D Q), where p is the number of regular auto-regressive (AR) terms, q the number of regul moving average (MA) terms and d the number of regular differencing performed to atta stationarity. Similarly P was the number of seasonal auto-regressive (AR) terms, Q the numb of seasonal moving average (MA) terms and D the number of seasonal differencing carried ou

4.1. Unobserved Components

4.1.1 Unobserved Components for Underlying Inflation

Underlying inflation in Uganda consists of two sub-groups, i.e. the goods and services sub groups. These enter with 51.4 and 15.0 as the weights respectively. Results of the convention univariate time series analysis of underlying inflation indicated that underlying inflation ha three components namely, trend, seasonality and irregular components. ARIMA (1 1 2)(1 0 was fitted to the monthly inflation rate. Well-behaved residuals and model parsimony wer the guiding factors in model selection, all possible over-fits were tried-out and these did no show any model improvement in terms of significant coefficients and reduction in mea square error. Thus ARIMA (1 1 2)(1 0 0) was considered the appropriate model for monthl underlying inflation rate. The trend component in Figure A1 shows that monthly inflatio rate decreased gradually over time from levels between 3.0 and -2.0 in 1990 to levels betwee 1.0 and -1.0 in 1999. This could mainly be attributed to policies geared towards low and stabl inflation that have been pursued by the central bank from 1990s to date.

Figure A1: The Trend Component of Monthly Underlying Inflation Rate



The seasonal component in Figure A2 indicates sizeable seasonal pattern, peaking in January-February, July and September and with troughs in March - May, October - December. The two sub-groups of underlying inflation have significant seasonality. The goods sub-group shows seasonality that peaks in January-February and July, with a trough in November, while the services sub-group peaks in January-February, and May - September, with troughs in

March – April, October and December. Although it would be expected that underlying inflation in the case of Uganda should have no or weak seasonality, it is rather surprising to see such marked seasonality. ANOVA tests also indicated strong seasonality for underlying inflation and also for goods and services sub-groups. (See ANOVA test results in Appendix B).

Figure A2: The Seasonal Component of Monthly Underlying Inflation Rate

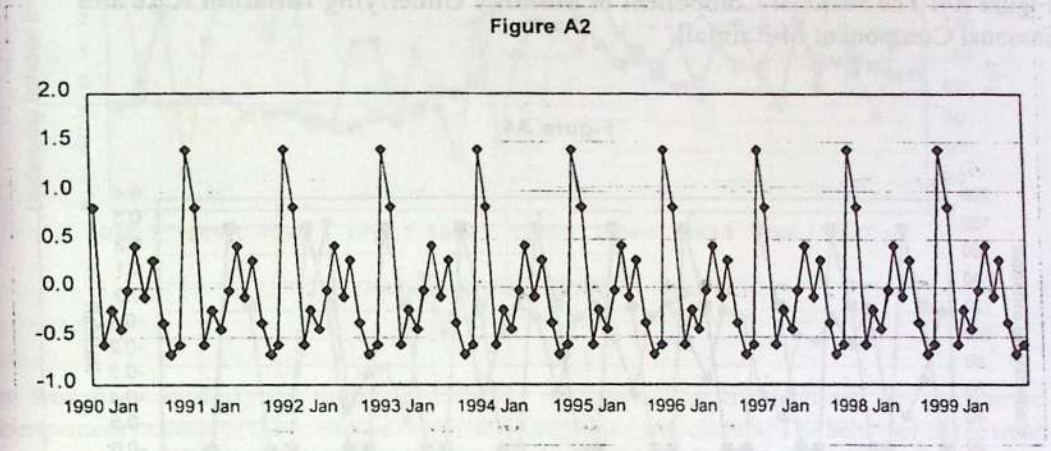
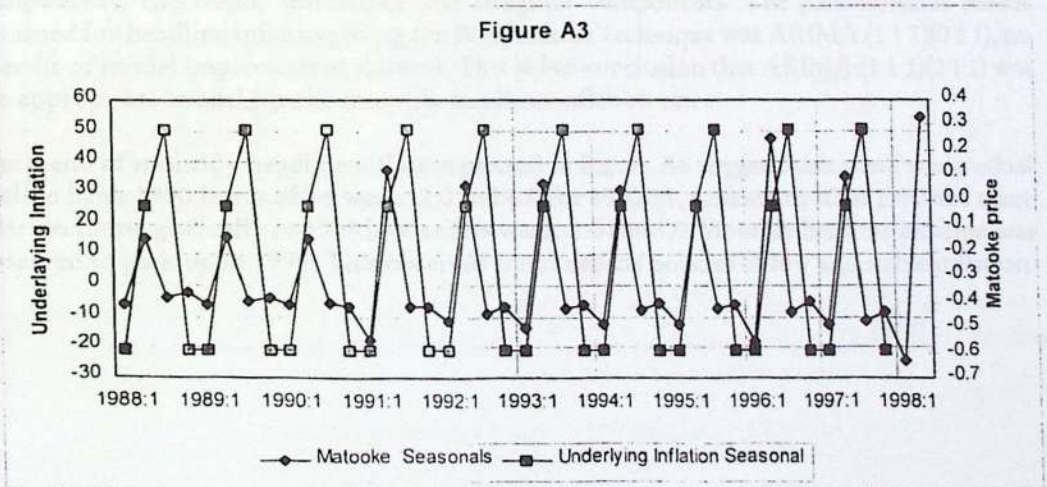


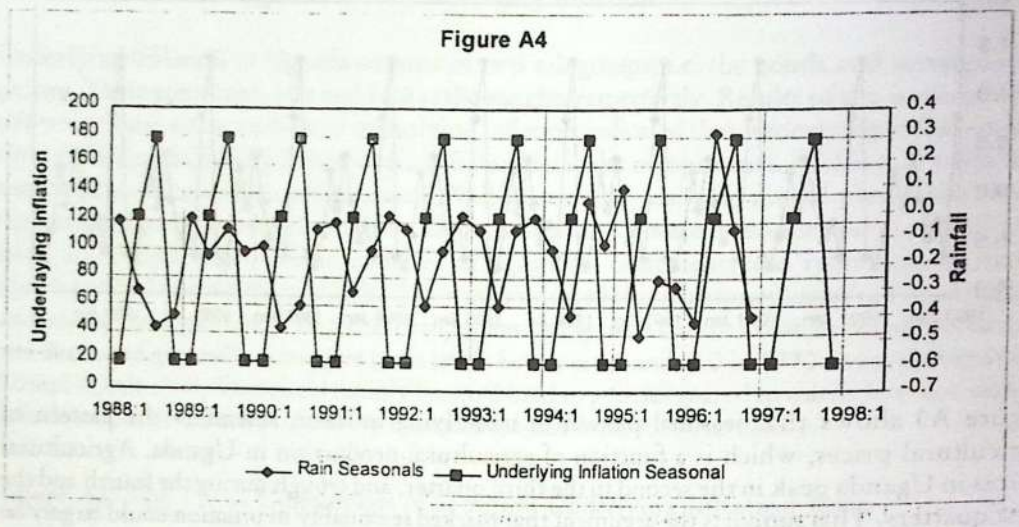
Figure A3 shows that seasonal pattern in underlying inflation resembles the pattern of agricultural prices, which is a function of agricultural production in Uganda. Agricultural prices in Uganda peak in the second to the third quarter, and trough during the fourth and the first quarters. This supports the argument that marked seasonality in inflation could largely be attributed to agricultural seasonality.

Figure A3: The Seasonal Component of Monthly Underlying Inflation Rate and Seasonal Component of Matooke Prices



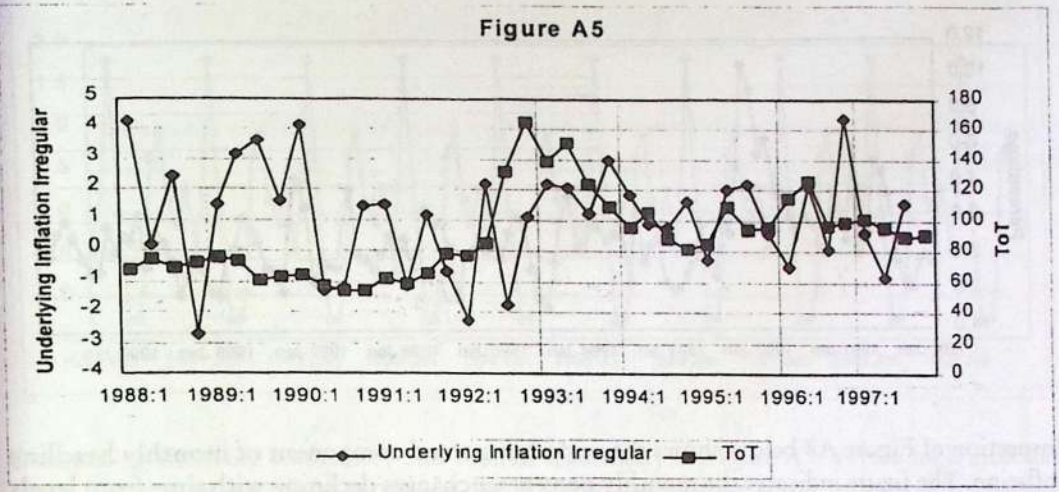
The inspection of the seasonal component pattern with the seasonal pattern of rainfall i Figure A4 suggests that there is a reverse relationship pattern between rainfall and inflatio We observe low rates of inflation associated high rates of rainfall. This could be interpreted i terms of high agricultural output associated with good rains leading to low prices. W therefore, conclude that there is evidence to suggest that inflation in Uganda is attribute substantially to climatic conditions.

Figure A4: The Seasonal Component of Monthly Underlying Inflation Rate and Seasonal Component of Rainfall



Inspection of the irregular component of inflation in Figure A5 shows that the irregula component mimics terms of trade from 1993 to 1995, this may indicate capturing of th "coffee boom" of 1994. Thereafter, there seems to be a near reverse relationship between th terms of trade and the irregular component.

Figure A5: The Irregular Component of Monthly Underlying Inflation Rate and Terms of Trade



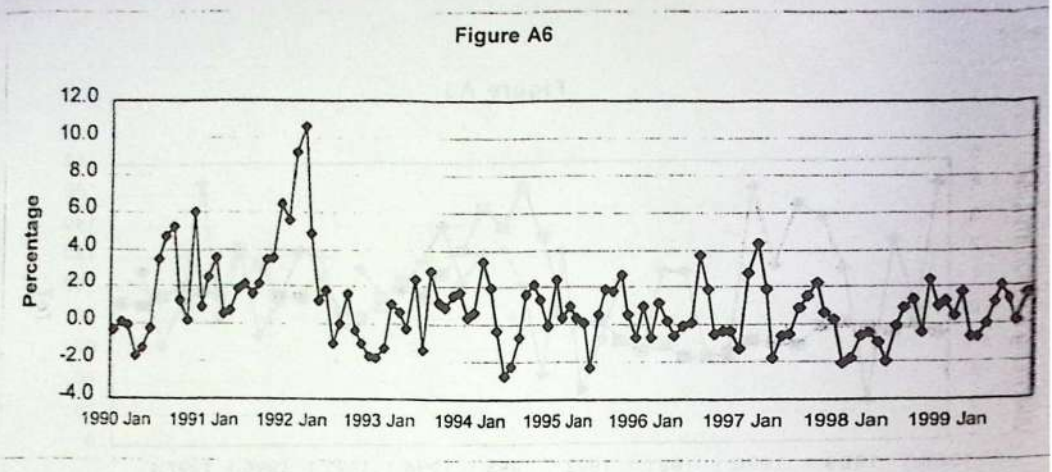
In summary underlying monthly inflation in Uganda is characterized by unobserved components namely; the trend, seasonal and irregular components. The behavior of the trend seems to suggest the economic policy underpinning the trend. There is indication that the seasonal was characterized by the seasonal pattern of agricultural production and climatic conditions. The irregular component on the other hand appeared to capture externalities like the "coffee boom" of 1994/95. However, due to the lack of rainfall series up to the last quarter of 1999, it was not possible to establish and capture the effect of El Nino on inflation.

4.1.2 Unobserved Components for Headline Inflation

Headline inflation in Uganda is composed of three sub-groups, namely; food, goods and services. Univariate time series decomposition suggested the presence of all the three components, the trend, seasonality and irregular components. The parsimonious model obtained for headline inflation using the Box-Jenkins' technique was ARIMA (1 1 1)(0 1 1), no over-fit or model improvement showed. This led to conclusion that ARIMA (1 1 1)(0 1 1) was the appropriate model for the monthly headline inflation rate.

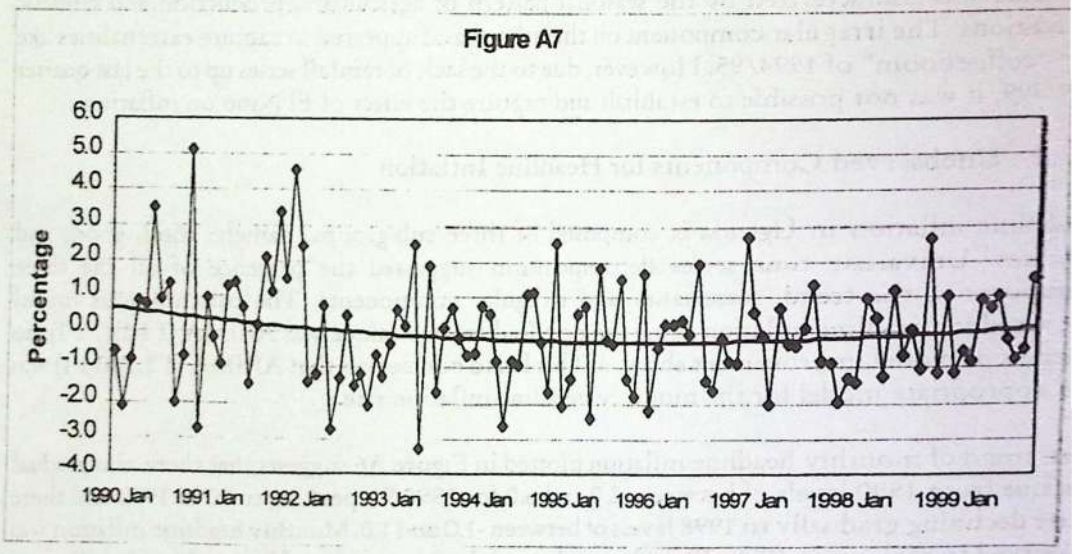
The trend of monthly headline inflation plotted in Figure A6 suggests that there was gradual decline from 1990 levels of between -2.0 and 6.0 for 1990-91, peaking to 10 in 1992 and there after declining gradually to 1998 levels of between -1.0 and 1.0. Monthly headline inflation was observed to pick up in 1999. This observed trend depicts policies of low and stable inflation.

Figure A6: The Ugandan Monthly Headline Inflation Rate



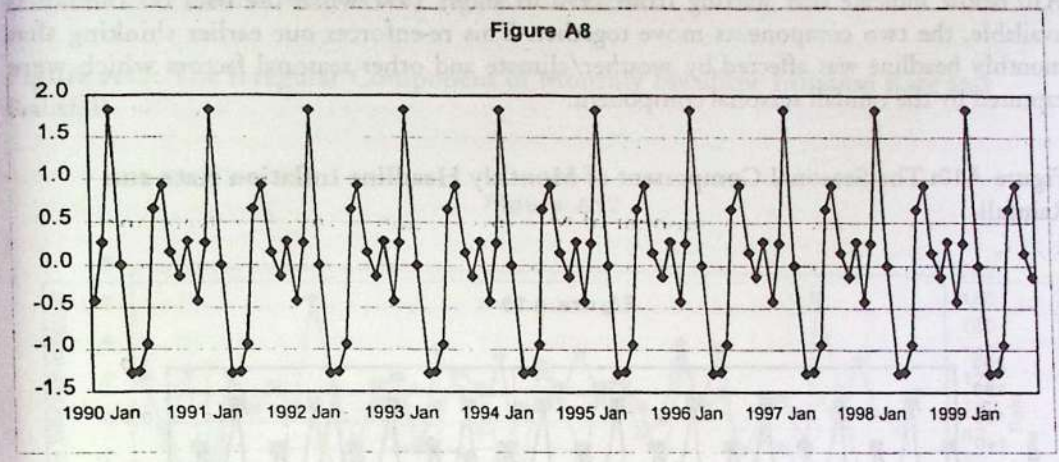
Inspection of Figure A7 below shows the underlying trend component of monthly headli inflation. The figure indicates the monthly percentage changes declining with time from lev of about 1 percent in 1990 the 0 in 1993. We then begin to observe negative percentage chan through 1999, before the changes again begin to pick up gently.

Figure A7: The Trend Component of Monthly Headline Inflation



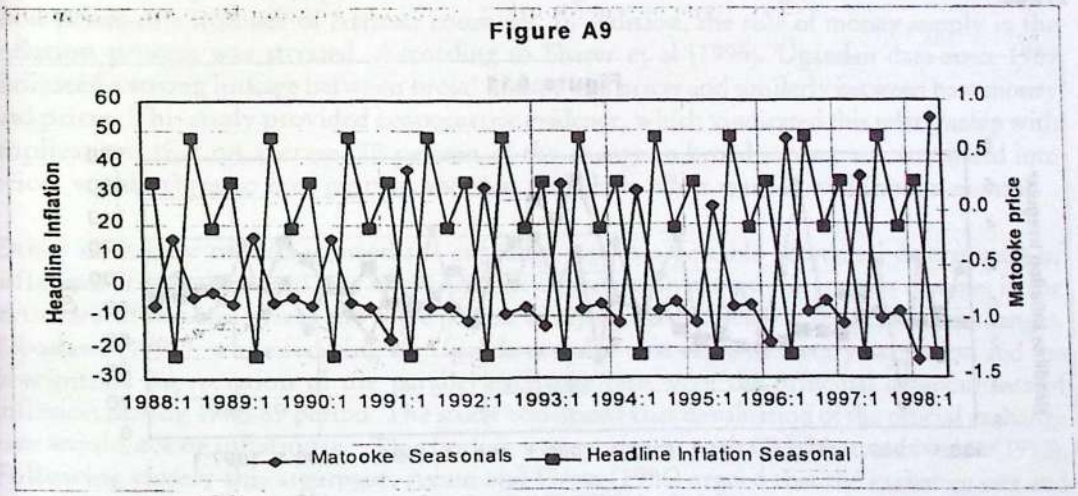
A review of the seasonal component of headline inflation in Figure A8 shows marke seasonality, peaking in the months of March, August, September and December.

Figure A8: The Seasonal Component of Monthly Headline Inflation Rate



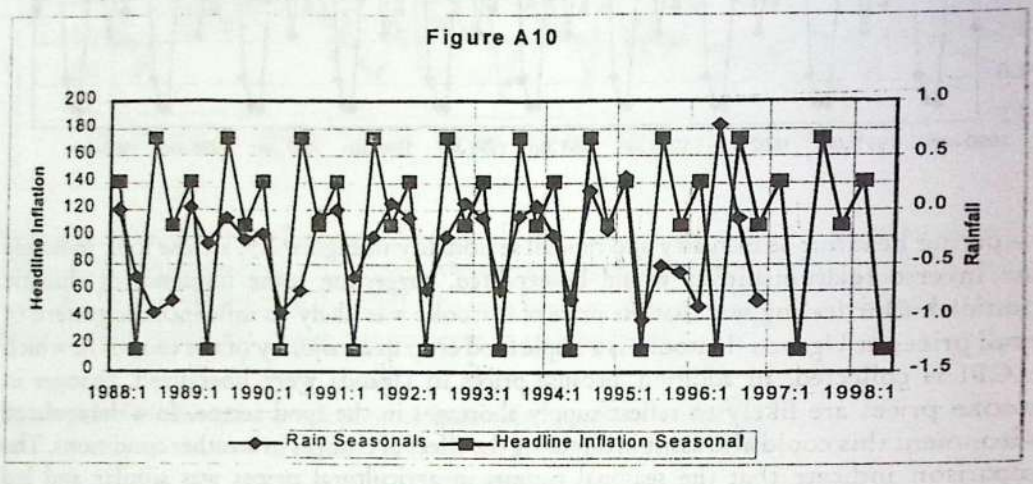
Comparing headline seasonality and rainfall seasonality in Figure A9, a close look indicates some inverse relationship as would be expected, suggesting some influence of climatic conditions. Our feeling was that the price of matooke was likely to influence the pattern of overall prices in Uganda. Matooke is a staple food crop in a majority of the centres in which the CPI is collected, in addition, because prices in Uganda were liberalized, changes in matooke prices are likely to reflect supply shortages in the food sector. In a deregulated environment this could also assist in capturing the effect of changes in weather conditions. The comparison indicate that the seasonal pattern in agricultural prices was similar and led headline inflation by one quarter. This further supported the argument of price seasonality being attributed to agricultural seasonality.

Figure A9: The Seasonal Component of Monthly Headline Inflation Rate and Seasonal Component of Matooke Prices



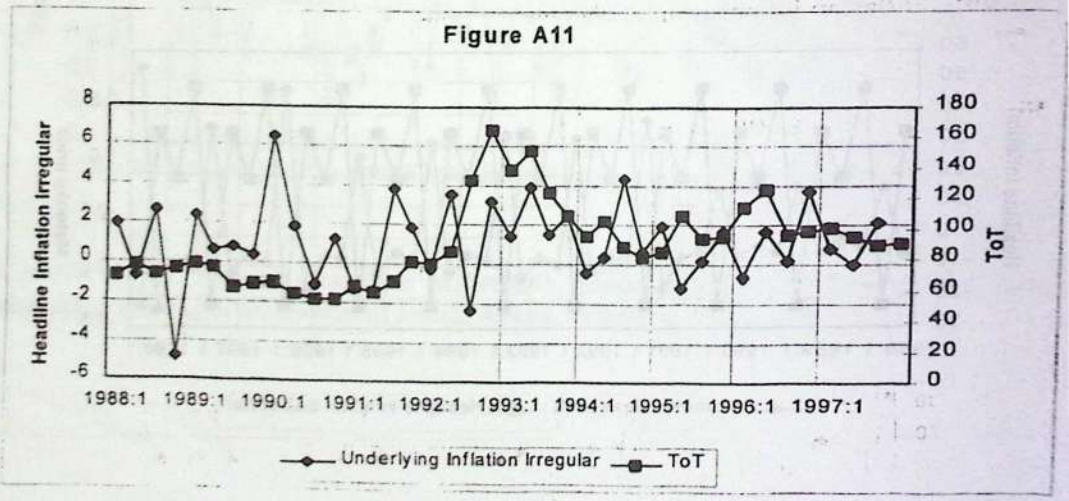
A plot of the seasonal component of monthly headline inflation and rainfall seasonal in Figu A10 below indicate that starting from 1990 to about 1997 when the data on rainfall available, the two components move together. This re-enforces our earlier thinking th monthly headline was affected by weather/climate and other seasonal factors which we captured by the rainfall seasonal component.

Figure A10: The Seasonal Component of Monthly Headline Inflation Rate and Rainfall



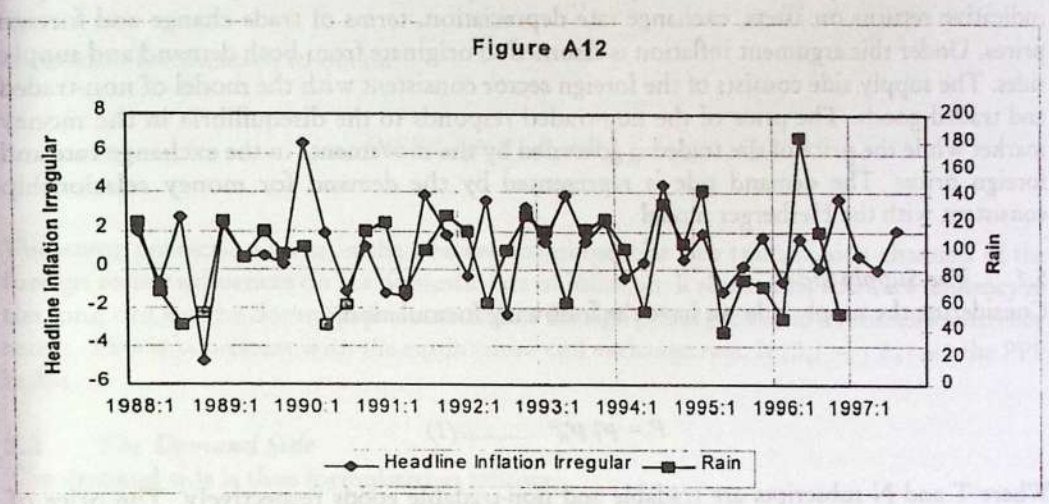
The irregular component of headline inflation on the other hand traced the terms of trad from 1989 to 1992, when Uganda experienced weak terms of trade, and in 1992 to 199 captured the "coffee boom" as indicated in Figure A11 from 1992 to 1995.

Figure A11: The Irregular Component of Monthly Headline Inflation Rate and Terms o Trade



The movement of rainfall was also well captured by the irregular component from 1990 to 1993 and 1994 to 1997 as shown by Figure A12 below.

Figure A12: The Irregular Component of Monthly Headline Inflation Rate and Rainfall



V. FRAMEWORK FOR INFLATION DETERMINATION

A few studies in Uganda have investigated the prime movers of the country's inflation process. In particular, the earlier generation studies stressed a strong relationship between money supply growth and supply-side factors as the key movers of Uganda's price level (Morris (1989). Related studies identified financing of the budget deficit, high food and transport costs, high taxation of petroleum products and imports generally and drought as factors which drove food prices in a number of African countries. In addition, the role of money supply in the inflation process was stressed. According to Sharer et al (1995), Ugandan data since 1989 indicated a strong linkage between broad money and prices and similarly between base money and prices. This study provided econometric evidence, which vindicated this relationship with implications that on average, 70 percent of the change in broad money was translated into prices within three to four months and that the whole effect was felt within nine months.

Other monetary models stressed the exchange rate as a possible additional determinant of inflation. It was suggested that exchange rate depreciation caused the greatest changes in the structure of sectoral prices and were potent in laying the foundation for price level changes. Elbadawi (1990), while focusing on Uganda revealed that rapid monetary expansion and the precipitous depreciation of the parallel exchange rate were the principal determinants of inflation during 1988-89 period. The study concluded that devaluation of the official exchange rate would not be inflationary. This finding was consistent with Chhibber and Nemat (1992). Following closely this argument, Adam and Gross (1986) argued that the exchange rate and money supply are indexed to the price level. This line of reasoning was taken up by Klein

(1990) who argued convincingly that exchange rate changes and the rate of inflation affect e other to produce an inflation-devaluation spiral or even a vicious circle in flexible exchar rate regimes, or pass-through-effects from the exchange rate changes and the foreign pr level. These effects may thus worsen the rate of inflation.

The underlying theoretical framework in this paper proposes that a suitable analyti mechanism for the price level should provide for impacts from the money stock, real outp indicative returns on assets, exchange rate depreciation, terms of trade change and forei prices. Under this argument inflation is assumed to originate from both demand and supp sides. The supply side consists of the foreign sector consistent with the model of non-trad and traded goods. The price of the non-traded responds to the disequilibria in the mon market while the price of the traded is governed by the movements in the exchange rate a foreign prices. The demand side is represented by the demand for money relationsh consistent with the Herberger model.

5.1 The Supply Side

Considering the supply side we have the following formulation,

$$P = P_T^{\alpha} P_N^{1-\alpha} \quad \text{.....(1)}$$

Where T and N subscripts are tradable and non-tradable goods respectively. The price tradable goods is determined in the world market and depends on foreign price Pf and on t exchange rate ER, assuming that the purchasing power holds then

$$P_T^{\alpha} = ER_t + Pf_t \quad \text{.....(2)}$$

Hence a depreciation of the exchange rate or an increase in foreign prices will increa domestic prices. This analysis is in line with Killick and Mwega (1989) and Ndung'u (199

The analysis of inflation originating from the foreign sector can be decomposed int transmission effects coming from imported input prices in foreign currency terms ar inflation that follows a depreciation of the exchange rate as;

Where $NEER_t$ is the log of the multilateral nominal exchange rate index and Pf_t is the log

$$P_t = \beta_0 + \beta_1 NEER_t + \beta_2 FP_t \text{.....(3)}$$

the foreign price index reflecting the import prices. Equation (3) above is in line with Klei (1990) and incorporates exchange rate pass-through-effects. Equation (3) above can b rewritten as an autoregressive distributed lag model of order m to take care of the dynamic and adjustment lags;

$$P_t = \sum_{i=1}^{n} \alpha_{Ti} P_{t-i} + \sum_{i=0}^{n} \alpha_{Ni} NEER_{t-i} + \sum_{i=0}^{n} \alpha_{yi} FP_{t-i} + \varepsilon_{1t} \text{.....(4)}$$

Where ε_{1t} is a white noise error process. Equation (4) allows expression of CPI as being

influenced by its own past and present values as well as the present and past values of the explanatory variables. If indeed some of the variables expressed in the above theoretical relationship are non-stationary, it is then possible to re-parameterize equation (3) as an error

$$\Delta P_t = \sum_{i=1}^{n-1} \alpha_{1i} \Delta P_{t-i} + \sum_{i=0}^{n-1} \psi_{4i} \Delta NEER_{t-i} + \sum_{i=0}^{n-1} \psi_{5i} \Delta FP_{t-1} +$$

correction formulation to obtain:

$$\alpha_{11} [NEER - \beta_4 P - \beta_5 FP]_{t-m} + \varepsilon_{4t} \ldots\ldots (5)$$

The error correction term in the brackets combines the two transmission channels of the foreign sector influences on the domestic rate of inflation. It shows that there is a tendency in the long run for the domestic prices to follow foreign prices measured in domestic currency terms. This is consistent with the equilibrium real exchange rate. If $|\beta_4| = |\beta_5| = 1$ the PPP holds.

5.2 *The Demand Side*

The demand side is thus formulated as follows;

$$M_t - P_t = c_1 RGDP_t + c_2 TBR_t \ldots\ldots\ldots\ldots (6)$$

Where M_t represents log of nominal money stock, P_t is the log of the domestic price level, $RGDP_t$ is the log of real income and TBR_t is the rate of interest that reflects the cost of holding money balances. This implies that the demand for real money balances is a function of real income and the rate of interest, which is the same as:

$$M^d = f(TBR, RGDP) \ldots\ldots\ldots (7)$$

In this model the price level is assumed to adjust to excess supply in the money market so equation (6) can be re-written as a price equation in the form of equation (8) below

$$P_t = c_0 M_t - c_1 RGDP_t - c_2 TBR_t \ldots\ldots\ldots\ldots (8)$$

Equation (8) above can be re-parameterized as a general autoregressive distributed lag form of order m, for example, AR(m) as

$$P_t = \sum_{i=1}^{m} \alpha_{1i} P_{t-i} + \sum_{i=0}^{m} \alpha_{2i} M_{t-i} + \sum_{i=0}^{m} \alpha_{3i} RGDP_{t-i} + \sum_{i=0}^{m} \alpha_{4i} TBR_{t-i} + \varepsilon_{1t} \quad \ldots\ldots\ldots$$

ε_{1t} is the white noise process with the usual properties. Equation (9) expresses the price leve a function of the lagged values of nominal money supply, real income and the rate of inter This equation has non-stationary variables and differencing them would yield stationary se but we would loose the long run information in the data set, which may actually underpinning the theoretical model. In order to incorporate the long run informati assuming that the variables are integrated of the first order and at the same time att stationarity in the data set we can re-write equation (9) into equation (10) below

$$\Delta P_t = \sum_{i=1}^{m-1} \alpha_{6i} \Delta P_{t-i} + \sum_{i=0}^{m-1} \psi_{1i} \Delta M_{2t-i} + \sum_{i=0}^{m-1} \psi_{2i} \Delta RGDP_{t-1} + \sum_{i=0}^{m-1} \psi_{3i} \Delta TBR_{t-}$$

$$\alpha_5 [M2 - \beta_1 P - \beta_2 RGDP + \beta_3 TBR]_{t-m} + \varepsilon_{1t} \ldots\ldots(10)$$

The bracketed term is the error correction term, which shows that increases in the mon stock above the long run equilibrium level are transmitted into inflation. This term forms t long run structure of the model from the demand side of the economy. We can then combi equation (5) and (10) into the inflation model in equation (11) below

$$\Delta P_t = \sum_{i=1}^{m-1} \theta_{1i} \Delta P_{t-i} + \sum_{i=0}^{m-1} \theta_{2i} \Delta M_{t-i} + \sum_{i=0}^{m-1} \theta_{3i} \Delta RGDP_{t-1} + \sum_{i=0}^{m-1} \theta_{4i} \Delta TBR_{t-}$$

$$\sum_{i=0}^{n-1} \theta_{5i} \Delta NEER_{t-i} + \sum_{i=0}^{n-1} \theta_{6i} \Delta FP_{t-1} + \alpha_{21} [M - \beta_1 P - \beta_2 RGDP + \beta_3 TBR$$

$$\alpha_{22} [NEER - \beta_4 P - \beta_5 FP]_{t-m} + \theta_0 + \psi_1 D_{st} + \varepsilon_{4t} \ldots\ldots(11)$$

Where ε_{4t} is iid(0, □) white noise process, θ_0 is a constant and D_{st} is a vector of season dummies. Equation (11) has both the short run and the long run components. The long ru component of the model is given by the two error correction terms. Their coefficients sho the amount of disequilibrium or strength of adjustment transmitted in each period into th rate of inflation. Cointegration analysis will help to unravel and identify the relevan cointegrating vectors.

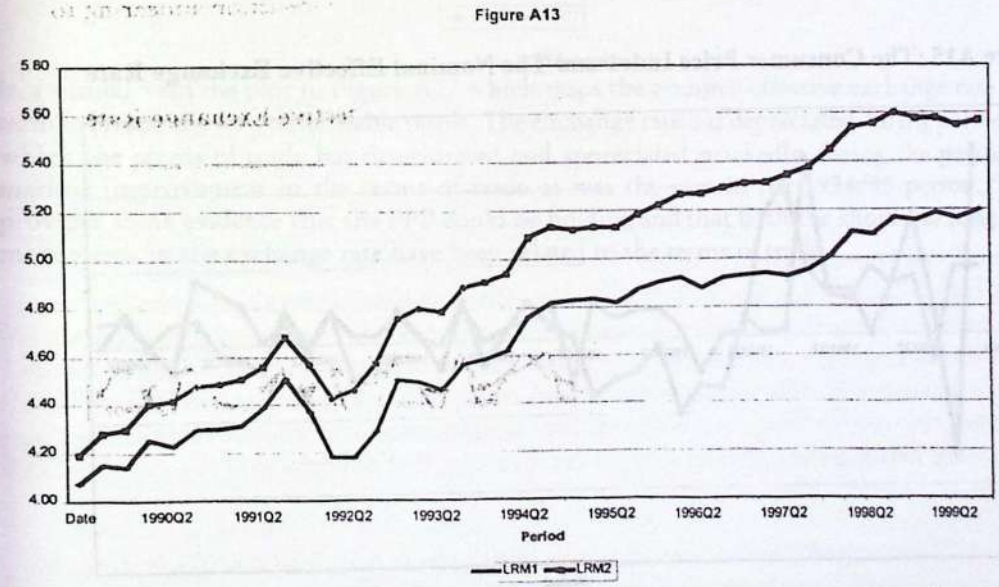
VI. ESTIMATION RESULTS AND POLICY IMPLICATIONS

6.1 A Review of the Data

We employ graphical display as a first shot towards unraveling the character of our data. As already indicated the data employed are a quarterly series spanning 1989 to 1999. The character of Headline CPI was plotted in Figure A6 shown earlier. The chart measures the monthly change in the Headline Composite Consumer Price Index. It shows that Inflation fell sharply in the later part of 1989. It peaked momentum in 1991 before attaining a peak level in 1992. It fell sharply in the later part of 1992 and has been remarkably stable since 1994 although there are fairly large fluctuations between months. There were also signs of a picking up of inflationary pressures in the latter part of 1999.

A choice also had to be made as to which measure of money stock was to be employed in our equation. Figure A13 below plots the logarithm of narrow money (M1) and Broad money (M2) deflated by the consumer price index. Both series appear to exhibit a remarkably similar short-run pattern. They do not even differ markedly in the long run, owing probably to the short time span rather than to inherent time series characteristics. Both series grow over time and none appears to be stationary. Given that GDP has grown remarkably by an average of 6.4 percent during this period both series appear to have grown in line with real GDP, hence either series appears to have captured well the transactions demand for money.

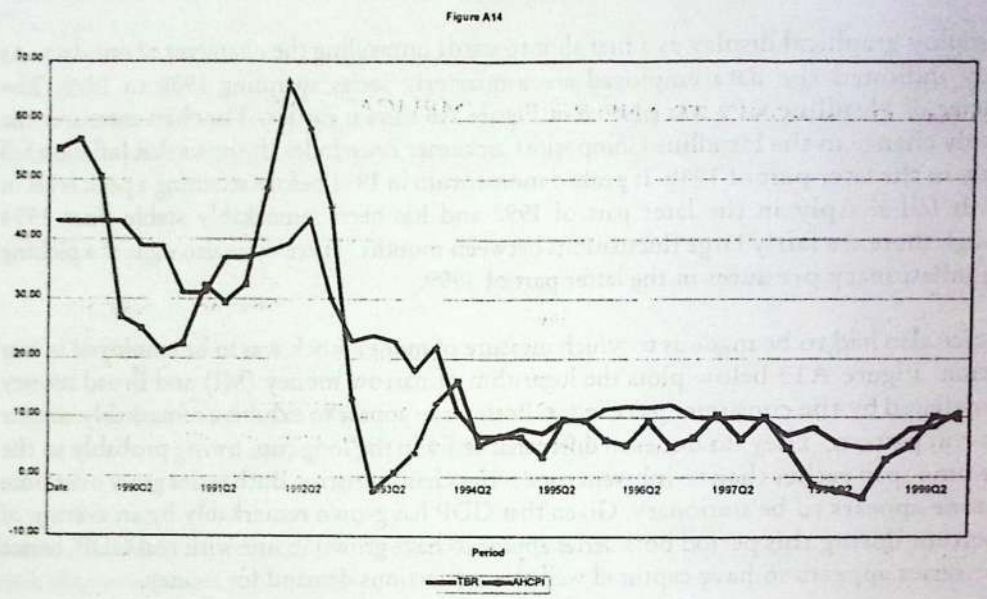
Figure A13 :Evolution of Narrow (M1) and Broad Money (M2) Deflated by CPI



We employ the three months (91) day Treasury bill rate to measure the rate of return on money in the long run. As shown in Figure A14 below, the plot of Headline composite

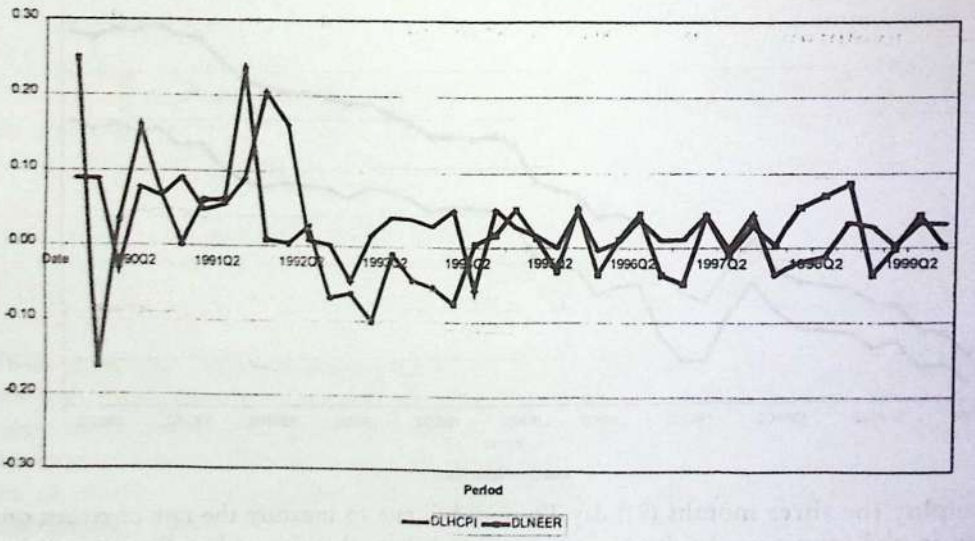
inflation rate and the Treasury bill rate, both series appear to follow each other remarkab well. The treasury bill rate has declined in line with the movements in inflation.

Figure A14 :Inflation and Treasury Bill Rate Developments



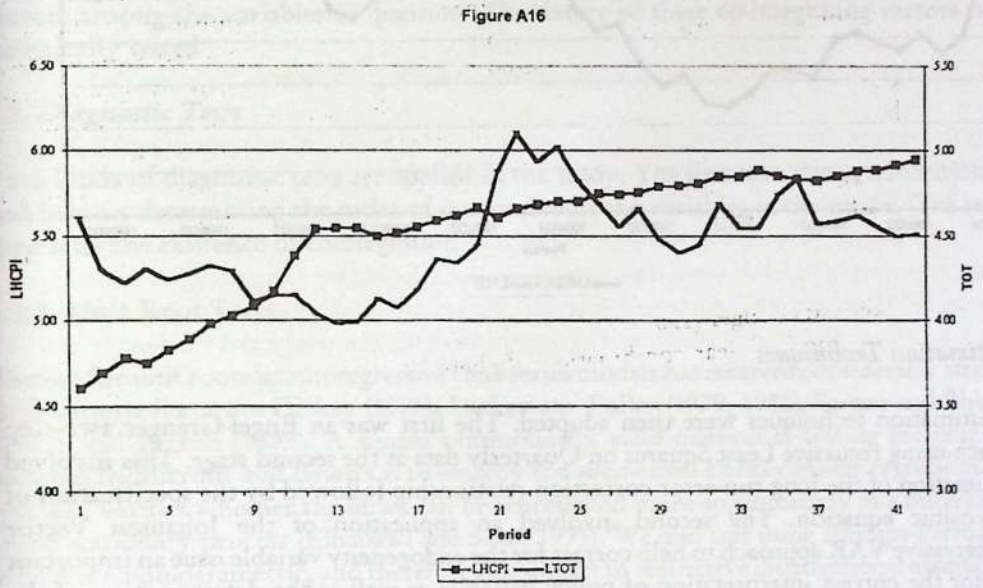
In Figure A15 we introduce external dynamics by plotting the change in the logarithm of the consumer price index and the nominal effective exchange rate calculated as a weighted average of the bilateral exchange rates of Uganda's main trading partners. There appears to be a relationship between the CPI and NEER with the NEER depreciation appearing to lead developments in the CPI.

Figure A15 :The Consumer Price Index and The Nominal Effective Exchange Rate



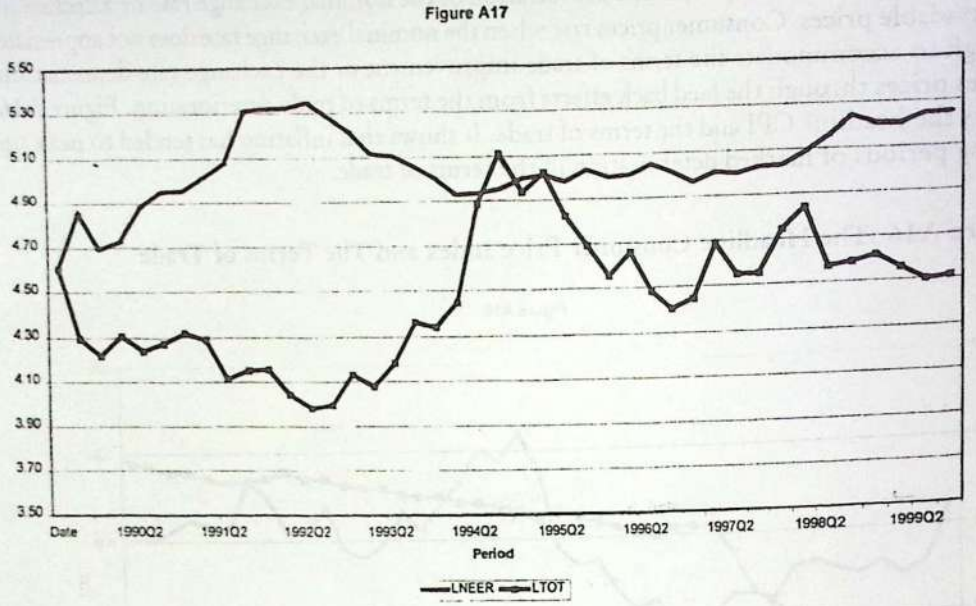
Inflation occurs when the relative price between non-tradeable and tradeable goods deviates from equilibrium. An increase in terms of trade requires either the nominal exchange rate to appreciate, or the price of non-tradable to increase, for equilibrium to be restored, while a decrease in terms of trade requires a depreciation of the nominal exchange rate or a decline in non-tradable prices. Consumer prices rise when the nominal exchange rate does not appreciate enough to accommodate the terms of trade improvement or the exchange rate depreciation pushes prices through the feed back effects from the terms of trade deterioration. Figure A16 shows the headline CPI and the terms of trade. It shows that inflation has tended to peak up during periods of marked deterioration in the terms of trade.

Figure A16 :The Headline Consumer Price Index and The Terms of Trade



In a similar vein the plot in Figure A17 which maps the nominal effective exchange rate and terms of trade shows a remarkable result. The exchange rate has depreciated during periods in which the terms of trade has deteriorated and appreciated markedly during the period of marked improvement in the terms of trade as was the case in the 1994/95 period. This provides some evidence that the PPP could be holding and that both the short and long run movements in the exchange rate have been related to the terms of trade.

Figure A17 :The Nominal Effective Exchange Rate and The Terms of Trade



6.2 Estimation Techniques

Two estimation techniques were then adopted. The first was an Engel-Granger two-step approach using recursive Least Squares on Quarterly data at the second stage. This involved the estimation of the long run error correction relationship followed by the specification of the dynamic equation. The second involved an application of the Johansen Vector Autoregressive VAR approach to help correct for the endogeneity variable issue an important factor for the correct interpretation of policy variables as well as the determination of the exact size of the cointegrating vectors. We recognized the developments in econometric modeling, that have tended to question standard regressions based on none stationary variables. In particular, because the Ugandan time series of inflation measures are likely to posses unit roots and are therefore, non-stationary yet economic theory requires variables employed in regression analysis to be stationary. Granger & Newbold (1974) and Stock and Watson (1988) have shown that Ordinary Least Squares Estimators can be inconsistent when economic time series are not stationary. Although Ordinary Least Squares Estimation results return high R-squared and significant t-statistics, inferences based on traditional statistical tests could be misleading. For modeling purposes it is vital to test for stationarity of time series before conducting regression analyses. According to Box and Jenkins (1970), a time series can be made stationary by differencing and then performing the regressions using differenced data. However, this methodology suffers from loss of information in respect of the long-run relationship between the variables since in the long run, first differences of the variables are Zero.

Engel and Granger (1987) have shown that even if variables in their levels are I(1), it is possible that a special linear combination of these I(1) series is I(0). This means that the long-run

components of these variables cancel each other to generate stationary series; these variables are then said to be co-integrated. The vector that spans the coefficients of this linear relationship becomes the co-integrating vector. The theoretical strength of this statement is that it suggests the existence of an adjustment process that stops the movement from the long-run equilibrium function from becoming larger and larger. In particular Engel and Granger (1987) provide a two step method for estimating co-integrated systems by Ordinary Least Squares. It has been shown by Banerjee et al (1986) that when confronted with multiple contegration and VARs, there are two problems associated with the two step method. First, bias in the estimation can be a problem. Second, there is the issue of non-uniqueness when more than one co-integrating vector is spanned by the variables under investigation. Johansen and Juselius (1990) provide a maximum likelihood estimation mechanism that captures the long-run association between the variables and also estimates all the available co-integrating vectors among the variables in question. The nature of these co-integrating vectors is also statistically tested.

6.3. Diagnostic Tests

Two kinds of diagnostic tests are applied in the study. The first tests detect nonstationarity and help in determining the order of integration of the variables in the model. The second type tests the existence of cointegration.

6.3.1. Unit Root Tests

Testing for unit roots in autoregressive time series models has received considerable attention in economic literature Dickey (1976), Dickey and Fuller (1979, 1981), Sargan and Bhargava (1983) and Perron (1989). A simple symptotically valid method of testing for unit roots adopted in Microfit and Eviews is to employ the augmented Dickey Fuller regression. This test also verifies whether the series can be represented more appropriately as a difference or trend stationary process (Elbadawi and Soto, 1995). We also test using Phillips-Perron test, which is a non-parametric, and therefore not subject to restrictive distributional assumptions of the Dickey Fuller tests. Table 5 reports the results of the ADF and Philips Perron unit root test carried out for logs of each of the variables of interest. We conclude that the bulk of the variables are at least I(1).

Table 5: Unit Root Tests

Variable	ADF	PP Test Stat	Integration Rank
Narrow Money	-1.432	-1.964	I(1)
Broad Money	-0.932	-1.691	I(1)
Headline CPI	-1.792	-1.802	I(1)
Underlying Composite CPI	-1.834	-1.923	I(1)
Market Exchange rate	-1.282	-2.075	I(1)
Nominal Effective Exchange Rate	-1.505	-2.518	I(1)

Variable	ADF	PP Test Stat	Integration Rank
Real GDP	-3.339	-1.854	I(1)
Terms of Trade	-2.064	-2.552	I(1)
Treasury Bill Rate	-1.667	-1.822	I(1)
Matooke Price Shs/kg	-2.708	-3.398	I(1)
Petroleum Price Shs/litre	-4.640	-4.389	I(0)
Foreign Wholesale Price	-0.494	-0.314	I(1)
Petroleum Import Price CIF	-2.709	-2.841	I(1)

critical values at 95% ADF -3.524 and PP -3.522

6.3.2. Cointegration Analysis of the Monetary and Foreign Sectors

Engel and Granger two step procedure may either identify a unique cointegrating Vector, i there exists only one, or a linear combination of all cointegrating vectors. Johansen an Jeselius (1990) have provided a method of how to compute a maximum likelihood estimato for the Alpha and Beta coefficients in a multivariate relationship. Stated simply thi methodology presents a likelihood ratio test of the hypothesis that there exists at most r co-integrating relationships among a set of variables. We proceed to apply Johansen and Jesuliu (1990) procedure to test whether there is co-integration in the monetary and foreign sectors o our model. This test produced the results indicated in Tables 6 and 7 below. The test is vital because, if economic time series are co-integrated, then their relationship is best estimated by an error correction representation which permits the incorporation of both short-run impacts in addition to feed-back innovations. The speed of adjustment to the long-run equilibrium is also availed as suggested by (Engel and Granger 1987).

6.4. Estimation Results

Having established the order of integration of the variables, we move on to test for and estimate long run relationships in the monetary and foreign sectors. Tables 6 and 7 present the results of these tests. In the monetary sector the LR test indicates the availability of two possible cointegration equations at the 5% level of significance while only 1 cointegration equation is available in the foreign sector.

Table 6: Johansens Cointegration Tests for the Monetary Sector

Series : Headline inflation, Real GDP, money and treasury bill rate

Eigenvalue	Likelihood Ratio Test	5 Percent critical Value	1 Percent Critical Value	Hypothesized No. of CE(S)
0.510699	60.91775	47.21	54.46	None**
0.427783	32.32662	29.68	35.64	At most 1*
0.204443	9.997140	15.41	20.04	At most 2
0.020992	0.848622	3.76	6.65	At most 3

* (**) denotes rejection of the hypothesis of at least 5% significance level.
LR test indicates 2 cointegrating equations at 5% significance level.

Table 7: Johansens Co-integration Tests for the Foreign Sector

Series : Terms of trade, Nominal effective exchange rate and Foreign Prices

Eigenvalue	Likelihood Ratio Test	5 Percent critical Value	1 Percent Critical Value	Hypothesized No. of CE(S)
0.510699	60.91775	47.21	54.46	None**
0.427783	32.32662	29.68	35.64	At most 1*
0.204443	9.997140	15.41	20.04	At most 2
0.020992	0.848622	3.76	6.65	At most 3

* (**) denotes rejection of the hypothesis of at least 5% significance level.
LR test indicates 1 cointegrating equation at 5% significance level.

6.4.1 The Long Run Analysis

$$LHCPI = 1.03 - \underset{(-4.24)}{0.66}LGDP + \underset{(1.86)}{0.17}LM1 + \underset{(8.04)}{0.44}LNEER + \underset{(7.83)}{2.2}LPF \quad .....(12)$$

The OLS regression results for the complete model yields equation (12) below;
The signs of the coefficients on the explanatory variables make economic sense. An increase in real income feeds into an increased transactions demand for money balances which is turn lowers the price level. Growth in nominal money balances beyond that demanded by the economy would rationally be expected to feed through to higher domestic prices. A depreciation of the nominal effective exchange rate would pass through to prices while deterioration of the terms of trade would lead to increase in domestic prices. Since Uganda also depends on imported goods it implies that an increase in wholesale prices of partner countries would lead to deterioration in domestic prices. These results are consistent irrespective of the definition of monetary aggregate applied in the estimation.

Equation (12) shows that a 10 percent rise in real GDP would lead, *ceteris paribus*, to a 6.6 percent fall in price level. As expected monetary expansion has an influence on price level, a 10 percent rise in money stock would lead to a 1.7 percent rise in price level. On the other hand a

10 percent depreciation in the nominal effective exchange rate would lead to a 4.4 percent ris in the domestic consumer price index in the long run. A 10 per increase in foreign prices lead to a 22.4 percent increase in domestic prices. We also estimate long run inflation equatio using the underlying composite consumer price index, which produced the relationship shown in equation (13) below;

$$LUCCPI = 10.94 - 1.18LGDP + 0.45LM1 + 0.27LNEER + 1.65LPF \quad (13)$$
$$(-7.76) \quad (5.00) \quad (5.02) \quad (5.88)$$

The results for underlying inflation return the expected signs as was the case for headlin inflation.

6.4.2. The Short Run Dynamic Analysis of Headline and Underlying CPI

We start with an over-parameterized equation that incorporates the ECM in differences usin ordinary least squares. The results obtained for headline and underlying CPI are shown i tables 8 through 9 and the monetary aggregate employed is M1. The estimation proces involves the dropping of variables that are insignificant and this is done in conformity wit the variable deletion tests. Real GDP growth leads to a favorable downward trend in evolutio of the domestic price level in both the headline and underlying cases. In the short-run th second lag of money was important. In the foreign sector nominal depreciation of th exchange rate fed into increased inflation. The evolution of the foreign price level wa important. There was a 49 percent and 53 percent feedback from the ECM to the short-ru adjustment process in the headline and underlying inflation equations respectively.

Table 8: Estimation Results for Headline Inflation

Ordinary Least Squares Estimation

Dependent variable is DLHCPI
37 observations used for estimation from 1990Q4 to 1999Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	.022591	.021651	1.0434[.306]
DLHCPI(-2)	.24576	.096674	2.5422[.017]
DLGDP	-2.0084	1.1945	-1.6814[.104]
DLM1(-2)	.19591	.095791	2.0452[.050]
DLNEER	.19310	.086398	2.2351[.034]
DLNEER(-1)	.28977	.081380	3.5606[.001]
DLNEER(-4)	-.12297	.062038	-1.9821[.057]
DLPF	1.4347	.34965	4.1031[.000]
ECM1(-1)	-.49370	.14534	-3.3968[.002]

R-Squared	.79316	R-Bar-Squared	.73406
S.E. of Regression	.025413	F-stat. F(8, 28)	13.4209[.000]
Mean of Dependent Variable	.030312	S.D. of Dependent Variable	.049278
Residual Sum of Squares	.018083	Equation Log-likelihood	88.5382
Akaike Info. Criterion	79.5382	Schwarz Bayesian Criterion	72.2890
DW-statistic	1.8694		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 5.8816[.208]	F(4, 24)= 1.1340[.364]
B:Functional Form	CHSQ(1)= 4.5580[.033]	F(1, 27)= 3.7934[.062]
C:Normality	CHSQ(2)= 1.7967[.407]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .018798[.891]	F(1, 35)= .017791[.895]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Table 9: Estimation Results for Underlying Inflation

Ordinary Least Squares Estimation

Dependent variable is DLUCCPI
37 observations used for estimation from 1990Q4 to 1999Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	.030775	.019475	1.5802[.128]
DLUCCPI(-2)	.56517	.10924	5.1738[.000]
DLUCCPI(-4)	.29992	.10363	2.8941[.008]
DLGDP	-3.1115	1.3954	-2.2298[.036]
DLGDP(-1)	3.8513	1.9352	1.9902[.059]
DLGDP(-2)	-4.9029	1.6131	-3.0394[.006]
DLGDP(-4)	2.1481	.96681	2.2219[.036]
DLM1(-2)	.25525	.082248	3.1034[.005]
DLNEER	.22885	.060236	3.7993[.001]
DLNEER(-2)	-.18457	.069647	-2.6501[.014]
DLPF	.74686	.30916	2.4158[.024]
DLPF(-1)	-1.1014	.27612	-3.9888[.001]
DLPF(-4)	-.58924	.26679	-2.2086[.037]
ECM2(-1)	-.52666	.11115	-4.7384[.000]

R-Squared	.86169	R-Bar-Squared	.78351
S.E. of Regression	.017707	F-stat. F(13, 23)	11.0221[.000]
Mean of Dependent Variable	.027306	S.D. of Dependent Variable	.038056
Residual Sum of Squares	.0072114	Equation Log-likelihood	105.5449
Akaike Info. Criterion	91.5449	Schwarz Bayesian Criterion	80.2685
DW-statistic	2.0544		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 1.9128[.752]	F(4, 19)= .25895[.901]
B:Functional Form	CHSQ(1)= 5.4235[.020]	F(1, 22)= 3.7787[.065]
C:Normality	CHSQ(2)= .052976[.974]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .27879[.597]	F(1, 35)= .26572[.609]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

The long and short run models based on M2 as a measure of monetary based are presented in the appendix.

6.5. Conclusions and Implications for Policy

Quarterly and monthly data for the period 1989 to 1999 was employed to estimate an inflation equation and characterize inflation into three unobserved components namely; the trend, seasonal and irregular respectively. The behavior of the trend components suggests that it was the nature of the macroeconomic policy management stance that largely underpinned it's evolution, while, preliminary indications were that the seasonal component was affected by shocks from seasonality related to agricultural production and weather. The irregular component however, appeared to have been affected by externalities such as shocks arising from coffee boom effect.

The preferred models for inflation exhibit theory consistent long- and short-run dynamic properties. A reasonable impact on underlying prices was found to originate from nominal

money growth and exchange rate depreciation. The strongest impact on underlying prices however appears to come from foreign prices. The contemporaneous and lagged components of these prices are very important in the domestic price formation process. For headline prices dampening effects tended to originate from real output expansion. Growth in money tended to increase prices as did nominal depreciation in the exchange rate. The overall impact was that an increase in foreign prices fed through to increased domestic prices.

The maintenance of price stability in an economy is a cardinal objective of the Central Bank. It presupposes rigorous and continued investigation into the prime movers of price level dynamics. This is important if the efficiency of monetary policy is to be improved. Price-stability should be emphasized as the over-riding objective of monetary policy. Transparency in the conduct of monetary policy is essential and building capacity for this process is required in two key areas. First, in model building and second, in the analytical capacity to further investigate the transmission mechanism and improve forecasting ability. A credible framework for conduct of monetary policy needs to be designed in which the majority of stakeholders have confidence. This will help build credibility and ensure continuity of deliverance of price stability. This framework must be adapted to local conditions by employing money as an instrument rather than interest rate instrument. The strategy should be simple and should be refined over time to signal commitment to low inflation. This simple mechanism should be implemented as an interim measure while more comprehensive models are built.

Transparency of the Central Bank is critical to ensure accountability and to help the public appreciate what the Central Bank is doing. The Central Banks needs to provide enough information for the public to understand the policy regime. It is also important in the sense that the public will be able to verify policy actions and be able to pass judgment on the Central Bank's performance. Part of the transparency requirement is that the definition of price stability or the level of the target needs to be analyzed. Traditionally and on account of measurement problems of the consumer price index, growth considerations and the zero lower band on nominal interest rates, most central banks aim for annual inflation in the 0-4 percent range. Government has been targeting 5 percent annual inflation rate. The question that arises is whether this is an appropriate definition of price stability. This is an empirical question, but once authorities agree on what constitutes price stability, it ought to be communicated to the public, so that agents understand in quantitative terms, what price stability is.

It is important to agree on the measure of inflation to monitor. The debate here is between headline and underlying. Which should constitute a measure of core inflation? As shown in the analysis headline inflation has been volatile and its use could lead to missing of the set target. In addition, some components of headline inflation are beyond monetary policy. This measure could also be subject to perverse effects from interest rate changes. Again, the use of headline requires the employment of caveats or escape clauses to be specified in advance when target may be breached. However, it is not feasible to specify all contingencies in advance and this may introduce subjective judgement and hence lack of transparency. A good measure of core inflation is required because it removes the volatile component of the consumer price index. It is however, important to make the measure understandable to the public. Currently Uganda Bureau of Statistics calculates headline inflation and underlying inflation excluding food crops. Further research is needed in the area of measuring core inflation so that a more

efficient measure of core inflation can be produced. Even where it is not used as a target, suc an efficient measure is an important input in the internal monetary policy process. It can b used in taking decisions for action of monetary policy and forecasting inflation.

Work on forecasting inflation needs to be emphasized. This requires understanding of th inflation dynamics to discern as this study has done variables, which matter. It is als important to understand the role of expectations, as these are implicit in other prices such the exchange rate. It is necessary, to understand the transmission mechanism as this determine the ability of policy instruments to manage inflation. Specifically, Bank of Uganda needs t devise a model for forecasting inflation, make mandatory periodical quarterly surveys o expectations and clearly define through empirical studies, the impact of instruments, and the lags on inflation. Human resource capacity need to be built up as a relatively large amount o manpower is necessary for the background work of model estimation, surveys and repo writing. These are necessary tasks for successful price stability. Data requirements for succe in inflation forecasting are huge but not insurmountable. For example, real sector data need to be availed more regularly and on a timely basis. Serious consideration needs to be effecte by Uganda Bureau of Statistics towards the generation of real time quarterly Gross Domesti Product series. As a stopgap measure, the Bureau could produce a combined index of industri and agricultural production for possible use as a scale variable in future analytical work Availability of such tools and early warning indicators is important to strengthen the cultur of model-based analysis in policy design.

The results have shown the important role that productivity plays in dampening inflation The Central Bank needs to move forward with the process of financial reform. It should continue to improve the prudential and supervisory components so that a strong and viable banking sector can be able to make more and relatively cheap credit available to support real sector activities. In addition, The study also indicates the need to take into consideration the issue of seasonality in formulation of monetary policy decisions. Currently, the key policy instruments available to the central Bank are foreign exchange intervention, treasury bill sales, the Bank of Uganda Bills and Repurchase Agreements. It is important that this range of instruments is expanded and balanced as liquidity management is important for stability in both the shilling and foreign exchange markets.

REFERENCES

Adams, C.S and Gross, D. (1986); "The consequences of Exchange Rate Rules for Inflation: Some Illustrative Examples". *IMF Staff Papers*, Vol. 33, Sept 1986.

Angel Ubide (1997); "Determinants of Inflation in Mozambique". *IMF Working Paper*, WP/97/145.

Ashok and Wandera (2000), "A Methodology for Forecasting Inflation in Uganda" Bank of Uganda Staff Papers Journal, Vol. 2 No.1, June 2000 pp. 83-111.

Banerjee et al (1986) Exploring equilibrium relationships in econometrics through static models: Some Monte Carlo evidence, Oxford Bulletin of Economics and Statistics, 52, pp. 95-104.

Box G. E. P and G. M. Jenkins (1970) "Time Series Analysis: Forecasting and Control". (San Francisco, Helden Day).

Box E. P. Geoege, Jenkins M. Gwilym and Reinsel C. Gregory (1994) Time Series Analysis - Forecasting and Control, Prentice Hall, Englewood Cliffs, New Jersey.

Chhibber, A and S. Nemat (1992); "Devaluation and Inflation with parallel markets: An Application to Ghana" Journal of African Finance and Economic Development pp. 107 – 133.

Dick Durevall and Njuguna S. Ndung'u (1999) : "A Dynamic Model of Inflation in Kenya, 1974 - 1996". *IMF Working Paper*, WP/99/97

Dickey, D.A (1976) Estimation and hypothesis testing for non-stationary time series, PhD dissertation, Iowa State University.

Dicky D. and W. Fuller (1981): "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", Econometrics, Vol. 49 pp. 1057 - 1072.

Egwaikhide, F.O and L.N. Chete (1994) " Exchange Rate Depreciation, Budget Deficit and Inflation. The Nigerian Experience. "*Final Report AERC Nairobi.*

Elbadawi I. and R. Soto (1995): "Real Exchange Rate and Macroeconomic Adjustment in Sub-Saharan Africa and Other Developing Countries. "Presented at Biannad Research Workshop AECR Johansberg South Africa.

Elbadawi, I (1990) " Inflationary Process, Stabilization, and the Role of Public Expenditure In Uganda." *Mimeo, July, World Bank*, Washington D.C.

Engel R. F. and C.W. J Granger (1987) "Cointergration and Error Correction Representation, Estimation and Testing ", Econometrica Vol. 55 pp251-76

Engle, R.F and Granger, C.W.J, (1991) Long-Run Economic Relationships in econometrics (Readings in Cointegration) Oxford University Press. Chapter 1 (Introduction).

Granger (1981): "Investigating causal relationships by Econometric models and Cross Spect
Methods" In Rational Expectations & Economic practice (edited by Robert Lucus, Jr, a
Thomas J. Sargene) (Minneapolis: University of Minessota).
Granger and New Bold (1974): "Spurious Regressions in Econometrics" Journal
Econometrics, Vol. 35, pp. 143-59

Granger and Watson (1984) in Handbook of Econometrics, Vol II, Eds. Griliches a
Intriligator (1984), Elsevier Science Publishers, Holland.

Johansen and Jeselius (1990) "Maximum likelihood estimation and influence on cointegrati
with applications to the demand for money", Oxford Bulletin of Economics and Statistic

Johansen S. and Jesulius (1990) "Maximum likelihood Estimation and Inference

cointergration with Applications to the Demand for Money" Oxford Bulletin of Economi

and Statistics, Vol 52

Johansen, S. (1988) "Statistical Analysis of Cointegration Vector Autoregressive Models
Oxford University Press, Oxford.

Jonathan D. Cryer (1986) Time Series Analysis, PWS-KENT Publishing Company, Bosto
Massachusetts.

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

Kasekende, L. A (1990); " The Relationship Between Monetary Aggregates and Inflation
Bank of Uganda Research Abstracts No 1.

Kenen, P.B & Pack, C. (1980); " Exchange Rates, Domestic Prices and the Adjustmen
Process". *Occasional Paper No.1, The Group of Thirty, New York, 1980.*

Killick, T. And Mwega, F. M. (1989) "Monetary Policy in Kenya", 1967-88,□ *ODI Workin
Paper, No. 39*, July 1990.

Klein, M. W (1990); " Macroeconomic Aspects of Exchange Rate-Pass -Through". *Journal o
International Money and Finance, Vol.9*, No.4 Dec. 1990.

Morris, S (1989); " The Relationship Between Money, Prices and The Parallel Marke
Exchange Rate". *Discussion Paper No. 1, MPED.*

Ndung'u N.S. (1994) "A Monetary Model of Inflation: Kenyan Case "*African Development
Review, Vol. 6, No. 2, December.*

Ndung'u N.S (1995); " Monetary and Exchange Rate Policy in Kenya". *Research Proposal
Presented to AERC Workshop*, Johannesburg.

Ndung'u N.S (1995); " Price and Exchange Rate Dynamics In Kenya: An Empirical Investigation". *A Final Report Presented to the AERC Workshop May/June 1995 Nairobi, Kenya.*

Ndung'u N.S. (1996) "An Exchange Rate Pass-Through Equation for Kenya: 1970 - 1993", *African Journal of Economic Policy, Vol. 3, No. 1, June.*

Ndung'u N.S. (1998) "Monetary and Exchange Rate Policy in Kenya" *(Forthcoming AERC Research Paper).*

Perron P. (1988) Trends and random walks in macroeconomic time series: Further evidence from a new approach, Journal of Economic Dynamic and Control, 12, pp. 297-332.

Perron P. (1990) testing for a unit root in a time series with a changing mean. Journal of Business and Economic Statistics. 8, pp. 153-62.

Sargan J.D and A. Bhargava (1983) "Testing residuals from Least Squares Regression for being generated by the Gaussian random walk" Econometricica, vol. 51, 1153-167.

Sharer et al (1995) Uganda: Adjustment With Growth. *IMF Occasional Paper Series.*

Sharer R.L et al (1995): "Uganda: Adjustment With Growth, 1987-1994" Occasional Paper No. 121, March 1995, International Monetary Fund, Washington, D.C.

Stock (1987) A Symptotic properties of Least Squares estimators of cointegrating vectors, Econometrician, 55, pp. 1035-56.

APPENDIX : A

HCCPI is the Headline Composite Consumer Price Index obtained from the Uganda Bureau of Statistics (UBOS).

UCCPI is the Underlying Composite Consumer Price Index obtained from the Uganda Bureau of Statistics (UBOS). Helps to assess the impact of seasonal volatility in food prices on long-term inflation by excluding the volatile food prices.

Money, M1, is the currency in circulation plus private demand deposits and M2 is M1 plus total private deposits including certificates of deposits, M3 is M2 plus foreign exchange deposits obtained from the Bank of Uganda Database

Output , RGDP, is the yearly GDP in 1991 prices from UBOS database, interpolated to a quarterly series.

Nominal Effective Exchange Rate, NEER, is the market weighted exchange rate, where the weights are based on the trade shares for each year for each of the following countries; United States, United Kingdom, France, Italy, Japan, Netherlands, Germany, India and Kenya. The sources are IFS database, World Trade Yearbook and Bank of Uganda.

Interest rate, TBI, is the three months treasury bill interest rate measured as the nominal treasury bill rate for underlying CPI and real treasury bill rate for headline CPI

Foreign Price Level, Pf, is the weighted wholesale price index, using the same weights as for the exchange rate, and the consumer price indices for country. For oil imports the oil price was employed.

Matooke prices, Price in Shillings per Kg supplied by the Uganda Bureau of Statistics, Uganda

Petroleum Price, supplied by Ministry of Energy and Mineral Resources and the Bank of Uganda, Uganda.

ANOVA Test for Seasonality in Headline and Underlying Inflation

The regression equation is
head = 1.40 jan + 0.587 feb + 1.22 mar + 2.59 apr + 0.745 may - 0.358 jun
- 0.208 jul + 0.226 aug + 1.78 sep + 1.95 oct + 1.15 nov + 1.03 dec

Predictor	Coef	Stdev	t-ratio	p
Noconstant				
jan	1.3982	0.6890	2.03	0.045
feb	0.5867	0.6537	0.90	0.371
mar	1.2233	0.6537	1.87	0.064
apr	2.5917	0.6537	3.96	0.000
may	0.7446	0.6537	1.14	0.257
jun	-0.3578	0.6537	-0.55	0.585
jul	-0.2083	0.6537	-0.32	0.751
aug	0.2261	0.6537	0.35	0.730
sep	1.7757	0.6537	2.72	0.008
oct	1.9498	0.6537	2.98	0.004
nov	1.1474	0.6537	1.76	0.082
dec	1.0339	0.6537	1.58	0.117

s = 2.067
Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	12	204.344	17.029	3.99	0.000
Error	107	457.216	4.273		
Total	119	661.561			

The regression equation is
under = 2.46 jan + 1.83 feb + 0.530 mar + 0.574 apr + 0.539 may + 0.918 jun
+ 1.49 jul + 0.993 aug + 1.28 sep + 0.590 oct + 0.304 nov + 0.462 dec

Predictor	Coef	Stdev	t-ratio	p
Noconstant				
jan	2.4623	0.4921	5.00	0.000
feb	1.8307	0.4669	3.92	0.000
mar	0.5300	0.4669	1.14	0.259
apr	0.5735	0.4669	1.23	0.222
may	0.5387	0.4669	1.15	0.251
jun	0.9182	0.4669	1.97	0.052
jul	1.4897	0.4669	3.19	0.002
aug	0.9926	0.4669	2.13	0.036
sep	1.2823	0.4669	2.75	0.007
oct	0.5895	0.4669	1.26	0.209
nov	0.3039	0.4669	0.65	0.517
dec	0.4616	0.4669	0.99	0.325

s = 1.476
Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	12	160.531	13.378	6.14	0.000
Error	107	233.228	2.180		
Total	119	393.759			

The regression equation is
services = 1.67 jan + 2.51 feb + 0.480 mar + 0.851 apr + 1.85 may + 2.09 jun + 1.34 jul + 1.43 aug + 2.09 sep + 0.430 oct + 0.546 nov + 0.494 dec

Predictor	Coef	Stdev	t-ratio	p
Noconstant				
jan	1.6721	0.6493	2.58	0.011
feb	2.5078	0.6160	4.07	0.000
mar	0.4796	0.6160	0.78	0.438
apr	0.8510	0.6160	1.38	0.170
may	1.8519	0.6160	3.01	0.003
jun	2.0909	0.6160	3.39	0.001
jul	1.3429	0.6160	2.18	0.031
aug	1.4253	0.6160	2.31	0.023
sep	2.0857	0.6160	3.39	0.001
oct	0.4304	0.6160	0.70	0.486
nov	0.5463	0.6160	0.89	0.377
dec	0.4943	0.6160	0.80	0.424

s = 1.948
Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	12	264.747	22.062	5.81	0.000
Error	107	405.985	3.794		
Total	119	670.731			

The regression equation is
goods = 2.83 jan + 1.54 feb + 0.554 mar + 0.418 apr - 0.038 may + 0.445 jun + 1.58 jul + 0.876 aug + 0.782 sep + 0.757 oct + 0.123 nov + 0.485 dec

Predictor	Coef	Stdev	t-ratio	p
Noconstant				
jan	2.8261	0.5432	5.20	0.000
feb	1.5428	0.5153	2.99	0.003
mar	0.5542	0.5153	1.08	0.285
apr	0.4180	0.5153	0.81	0.419
may	-0.0378	0.5153	-0.07	0.942
jun	0.4449	0.5153	0.86	0.390
jul	1.5772	0.5153	3.06	0.003
aug	0.8763	0.5153	1.70	0.092
sep	0.7819	0.5153	1.52	0.132
oct	0.7566	0.5153	1.47	0.145
nov	0.1234	0.5153	0.24	0.811
dec	0.4850	0.5153	0.94	0.349

s = 1.629
Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	12	149.393	12.449	4.69	0.000
Error	107	284.105	2.655		
Total	119	433.498			

The regression equation is
food = - 0.91 jan - 1.92 feb + 3.16 mar + 7.23 apr + 1.14 may - 3.21 jun
- 4.17 jul - 1.64 aug + 3.21 sep + 5.19 oct + 3.13 nov + 2.31 dec

Predictor	Coef	Stdev	t-ratio	p
Noconstant				
jan	-0.914	1.570	-0.58	0.562
feb	-1.919	1.490	-1.29	0.201
mar	3.161	1.490	2.12	0.036
apr	7.226	1.490	4.85	0.000
may	1.136	1.490	0.76	0.448
jun	-3.206	1.490	-2.15	0.034
jul	-4.174	1.490	-2.80	0.006
aug	-1.640	1.490	-1.10	0.273
sep	3.211	1.490	2.16	0.033
oct	5.190	1.490	3.48	0.001
nov	3.126	1.490	2.10	0.038
dec	2.313	1.490	1.55	0.123

s = 4.711
Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	12	1506.85	125.57	5.66	0.000
Error	107	2374.63	22.19		
Total	119	3881.48			

Table 10: Annual Percentage Changes in CPI and the Programmed Target

Financial Year	Programme Target (*P*)	Headline (*Ph*)	Underlying (*Pu*)	Deviation (*Ph-P*)	Deviation (*Pu-P*)
1995/1996	5.0	7.5	10.9	+2.5	+5.9
1996/1997	5.0	6.4	4.4	+1.4	-0.6
1997/1998	5.0	7.1	1.0	+2.1	-4.0
1998/1999	5.0	0.2	2.8	-4.8	-2.2
1999/2000	5.0	5.9	5.0	+1.9	0.0
2000/2001	5.0	4.6	5.1	-0.4	+0.1

Source: UBOS and Bank of Uganda

Table 11:Estimation Results for Headline Inflation with Terms of Trade

lhcpi = 1.49 cons –0.68lgdp+0.24lm1+0.05ltbr+0.38lneer+0.2ltot+2.15lpf
(0.5) (-4.2) (2.2) (1.3) (4.6) (0.3) (6.8)

Ordinary Least Squares Estimation

Dependent variable is DLHCPI
38 observations used for estimation from 1990Q3 to 1999Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	.036515	.023128	1.5788[.126]
DLGDP(-2)	-3.1709	1.2784	-2.4804[.020]
DLM1(-2)	.51240	.090263	5.6767[.000]
DLM1(-3)	.25371	.098662	2.5715[.016]
DLTBR	.053846	.025879	2.0807[.047]
DLTBR(-1)	.074799	.027424	2.7275[.011]
DLNEER(-1)	.28340	.087489	3.2393[.003]
DLPF(-1)	-.94193	.43128	-2.1841[.038]
DLPF(-3)	.86529	.34421	2.5138[.018]
DLTOT	.070840	.044553	1.5900[.123]
ECM2(-1)	-.31957	.13320	-2.3993[.024]

R-Squared	.77197	R-Bar-Squared	.68751
S.E. of Regression	.027505	F-stat. F(10, 27)	9.1403[.000]
Mean of Dependent Variable	.031549	S.D. of Dependent Variable	.049202
Residual Sum of Squares	.020425	Equation Log-likelihood	89.1229
Akaike Info. Criterion	78.1229	Schwarz Bayesian Criterion	69.1162
DW-statistic	1.8761		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	*CHSQ(4)= 4.9434[.293]	*F(4, 23)= .85988[.503]
B:Functional Form	*CHSQ(1)= 3.5415[.060]	*F(1, 26)= 2.6722[.114]
C:Normality	*CHSQ(2)= 1.2259[.542]	Not applicable
D:Heteroscedasticity	*CHSQ(1)= 3.0339[.082]	*F(1, 36)= 3.1236[.086]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Table 12. Estimation Results for Underlying Inflation with M2

luccpi = 15.6 cons –1.34lgdp+0.60lm2+0.05ltbr+0.15lneer+1.08lpf
(-4.4) (-7.8) (5.1) (1.7) (2.0) (2.9)

Ordinary Least Squares Estimation

Dependent variable is DLUCCPI
36 observations used for estimation from 1991Q1 to 1999Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	-.012871	.0074035	-1.7385[.094]
DLM1(-2)	.19631	.082859	2.3692[.025]
DLNEER	.20865	.078525	2.6572[.013]
DLNEER(-1)	.29037	.067859	4.2790[.000]
DLNEER(-3)	.11564	.061967	1.8661[.073]
DLPF	.84514	.29926	2.8241[.009]
DLPF(-2)	.50295	.24712	2.0352[.052]
DLPF(-3)	.60660	.26013	2.3319[.027]
ECV2(-1)	-.38583	.11747	-3.2844[.003]

R-Squared	.73995	R-Bar-Squared	.66290
S.E. of Regression	.022375	F-stat. F(8, 27)	9.6034[.000]
Mean of Dependent Variable	.026961	S.D. of Dependent Variable	.038537
Residual Sum of Squares	.013517	Equation Log-likelihood	90.8898
Akaike Info. Criterion	81.8898	Schwarz Bayesian Criterion	74.7640
DW-statistic	1.6709		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 9.2788[.054]	F(4, 23)= 1.9967[.129]
B:Functional Form	CHSQ(1)= 3.6511[.056]	F(1, 26)= 2.9345[.099]
C:Normality	CHSQ(2)= .78640[.675]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .47371[.491]	F(1, 34)= .45336[.505]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Table 13: Short Run Results for Headline CPI Based on M2 as a Measure for the Monetary Base

lhcpi = 1.65 cons – 0.67lgdp + 0.17lm2 + 0.43lneer + 2.16lpf
(0.5) (-3.9) (1.7) (7.4) (6.1)

Ordinary Least Squares Estimation

Dependent variable is DLHCPI
37 observations used for estimation from 1990Q4 to 1999Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	.049031	.020534	2.3878[.026]
DLHCPI(-1)	.41702	.13962	2.9869[.007]
DLHCPI(-2)	.52778	.10582	4.9874[.000]
DLHCPI(-3)	.36045	.11953	3.0156[.006]
DLGDP	-6.3163	1.6262	-3.8840[.001]
DLGDP(-1)	4.4576	1.5107	2.9506[.007]
DLM2(-1)	-.38022	.12904	-2.9465[.007]
DLM2(-3)	-.43058	.11540	-3.7311[.001]
DLNEER	.38496	.075473	5.1006[.000]
DLNEER(-1)	.26437	.095308	2.7739[.011]
DLNEER(-2)	-.27601	.094851	-2.9099[.008]
DLNEER(-4)	-.32252	.076097	-4.2382[.000]
DLPF	2.8372	.42093	6.7404[.000]
DLPF(-1)	-.74229	.36596	-2.0283[.055]
M2SERR(-1)	-1.0266	.15149	-6.7765[.000]

R-Squared	.89329	R-Bar-Squared	.82538
S.E. of Regression	.020592	F-stat. F(14, 22)	13.1548[.000]
Mean of Dependent Variable	.030312	S.D. of Dependent Variable	.049278
Residual Sum of Squares	.0093287	Equation Log-likelihood	100.7825
Akaike Info. Criterion	85.7825	Schwarz Bayesian Criterion	73.7006
DW-statistic	2.1683		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 3.0098[.556]	F(4, 18)= .39848[.807]
B:Functional Form	CHSQ(1)= 5.2757[.022]	F(1, 21)= 3.4923[.076]
C:Normality	CHSQ(2)= 3.2651[.195]	Not applicable
D:Heteroscedasticity	CHSQ(1)= 1.2232[.269]	F(1, 35)= 1.1966[.281]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

Table 14: Short Run Results for Underlying CPI Based on M2 as a Measure for the Monetary Base

$$\underset{}{\text{luccpi}} = \underset{(4.4)}{15.61}\ \text{cons} - \underset{(-7.7)}{1.34}\text{lgdp} + \underset{(5.1)}{0.60}\text{lm2} + \underset{(1.7)}{0.05}\text{ltbr} + \underset{(2.0)}{0.15}\text{lneer} + \underset{(2.9)}{1.08}\text{lpf}$$

Ordinary Least Squares Estimation

Dependent variable is DLUCCPI
37 observations used for estimation from 1990Q4 to 1999Q4

Regressor	Coefficient	Standard Error	T-Ratio[Prob]
CONS	-.0037073	.021571	-.17187[.865]
DLUCCPI(-2)	.45347	.12424	3.6498[.001]
DLUCCPI(-4)	.25744	.11251	2.2882[.030]
DLGDP	-2.8312	1.1563	-2.4485[.021]
DLGDP(-4)	2.6405	1.0146	2.6025[.015]
DLM2(-2)	.29865	.088630	3.3696[.002]
DLNEER	.16864	.064576	2.6115[.014]
DLPF(-1)	-.61634	.28343	-2.1746[.038]
M2USERR(-1)	-.54072	.12845	-4.2095[.000]

R-Squared	.74662	R-Bar-Squared	.67422
S.E. of Regression	.021721	F-stat. F(8, 28)	10.3131[.000]
Mean of Dependent Variable	.027306	S.D. of Dependent Variable	.038056
Residual Sum of Squares	.013211	Equation Log-likelihood	94.3455
Akaike Info. Criterion	85.3455	Schwarz Bayesian Criterion	78.0964
DW-statistic	1.7579		

Diagnostic Tests

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(4)= 8.5935[.072]	F(4, 24)= 1.8151[.159]
B:Functional Form	CHSQ(1)= 10.7145[.001]	F(1, 27)= 11.0057[.003]
C:Normality	CHSQ(2)= .44216[.802]	Not applicable
D:Heteroscedasticity	CHSQ(1)= .45840[.498]	F(1, 35)= .43906[.512]

A:Lagrange multiplier test of residual serial correlation
B:Ramsey's RESET test using the square of the fitted values
C:Based on a test of skewness and kurtosis of residuals
D:Based on the regression of squared residuals on squared fitted values

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