

Modelling the Inflation Process in Nigeria

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Abstract

This study is motivated by the conviction that inflation entails sizeable economic and social costs, and controlling it is one of the prerequisites for achieving a sustainable economic growth. The study analyses the main sources of fluctuations in inflation in Nigeria. Using the framework of error correction mechanism, it was found that the lagged CPI, expected inflation, petroleum prices and real exchange rate significantly propagate the dynamics of inflationary process in Nigeria. The level of output was found to be insignificant in the parsimonious error correction model. Surprisingly, the coefficient of the lagged value of money supply was found to be negative and significant only at the 10% level. One of the major implications of this result is that efforts of the monetary regulating authorities to stabilize the domestic prices would continuously be disrupted by volatility in the international price of crude oil.

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1. Introduction

Monetary policy in Nigeria over the past three decades has intended to attain price and exchange rate stability. Despite the apparent continuity in this objective, Nigeria's inflation experience since 1970 has been mixed. The oil boom of the 1970s engendered by the Middle East crisis raised the revenue accruing to government from this non-renewable resource by a remarkable level. Government expenditures gathered momentum in the wake of the determination of the authorities to accelerate post-war reconstruction and development as envisaged in the Second National Development Plan. This time, however, the engine of finance became the massive oil revenues, which have been singularly significant since 1973. From ₦510 million in 1970, Nigeria's export earnings from oil increased phenomenally to ₦1.894 billion three years later in 1973 and soared to an astronomical ₦5.318 billion, or 92% of total exports, in 1974. Parallel to this was the rapid growth in domestic money supply, exacerbated by the monetization of the earnings from oil. This also exerted upward pressure on the general price level.

The weak economic base became problematic from the early 1980s with the persistence of both internal and external disequilibrium. The collapse of oil prices in the world market triggered a series of developments in the Nigerian economy. The huge budget deficits, which cumulated to almost ₦17.4 billion in the five years 1980–1984, are a prime example. The intensification of economic crisis led the government to adopt a structural adjustment programme (SAP) in July 1986. Among the main factors responsible for inflationary pressures during the SAP era were the wholesale depreciation of the naira on the foreign exchange market, which increased the naira prices of imported goods – including raw materials and capital goods – as well as unprecedented growth in money supply during this period. Other factors predisposing the Nigerian economy to inflationary pressures during the SAP era are undoubtedly related to slow growth in output in both the agricultural and the manufacturing sectors. With particular reference to manufacturing, slow output growth has been attributed to the relatively small size of the sector and its over-dependence on imports.

From 1992 to 1999, Nigeria's real gross domestic product (GDP) grew at an average of about 2.6%, which is far short of propelling the economy into sustainable development. Inflation in the early 1990s was exceptionally high at 45%, 57% and 72% in 1992, 1993 and 1995, respectively, but the late 1990s witnessed a sharp reduction in the rate of inflation. It is in this context of sustaining the low inflation rate of the late 1990s that the present study on modelling the inflation process in Nigeria becomes germane.

Research questions and objectives

The overall objective of this study is to analyse the main sources of fluctuations in inflation and to build an econometric model that adequately explains the inflation process in Nigeria. The intention is to address the following questions:

- Can the shifts in the Nigerian inflation process over time be identified?
- What are the key determinants of inflation in Nigeria?
- What are the types of shocks that cause inflationary impulses and what is the nature of the propagation mechanisms?

Organization of the paper

The rest of the paper is organized as follows. Section 2 chronicles Nigeria's inflation experience with a look at inflation episodes, exchange rate changes, oil prices and other factors. Section 3 surveys the theoretical literature and empirical studies of inflation in general and for Nigeria in particular. In Section 4, we present the theoretical framework and methodology for the study, while Section 5 describes the data and presents the empirical results. Section 6 concludes with some policy observations.

2. Nigeria's inflation experience

Nigeria has experienced all manner of inflationary episodes – from creeping to moderate and from high to galloping (see Table 1 and Figure 1). Average inflation during the period 1960–1972 was relatively low, the historical average rate being 5.01%. When assessed on an annual basis, however, rising prices became a cause for concern for the then military government when in 1969 the inflation rate hit double digits at 10.36%. Government's concern seems to have been justified by the fact that Nigeria was experiencing double-digit inflation for the first time, in the face of a raging civil war whose end was not then in sight. In reaction, government imposed a general wage freeze for a period of one year. Apparently aware of possible opposition by labour unions, price control measures were introduced with the official promulgation of the Price Control Decree, early in 1970 (see Fashoyin, 1984, for comprehensive discussion of anti-inflation measures taken during this period). Inflationary pressures continued unabated, however, even with price controls.

Table 1: Inflation episodes in Nigeria

| Period | Average |
|-----------|---------|
| 1960–1972 | 5.01 |
| 1973–1985 | 17.96 |
| 1986–1995 | 31.30 |
| 1986–2002 | 13.34 |

Source: Computed by the authors

Pressures for salary increases led to the setting up of the Wages and Salaries Review Commission. The Commission eventually granted salary increases to all categories of public service employees, and similar adjustments were later made in the private sector. These awards, which came at a time when the dislocation of domestic production and marketing as a result of the civil war had not been fully repaired, generated a measure of excess demand in the economy. This is likely to have been responsible for the rise in the rate of inflation by 16.0% in 1971. Government's immediate response was to lift import restrictions on several categories of goods. Excise duties on a number of goods were also reduced. A credit policy that favoured the production of food was also put in place. These efforts, coupled with the establishment of the Nigerian National Supply Company (NNSC), were credited with yielding the relatively low rate of inflation of 3.2% recorded in 1972.

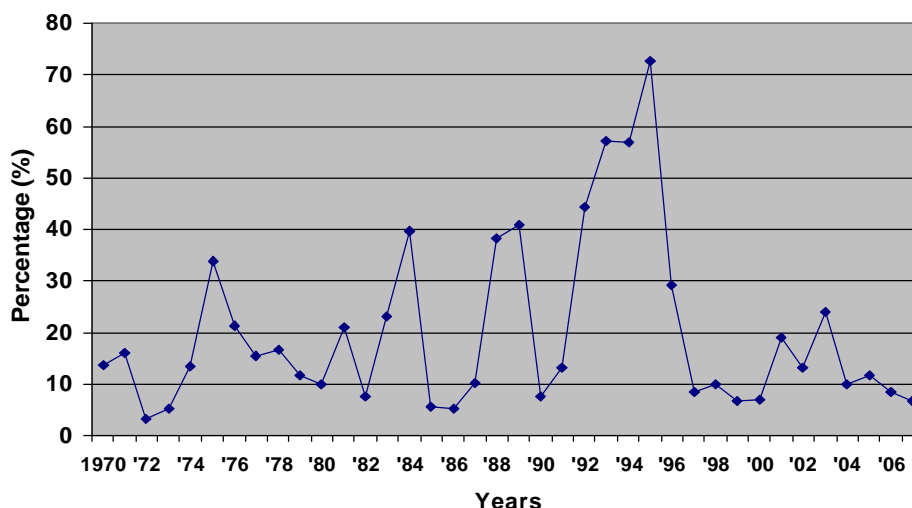
The period 1973–1985 was one of greater inflationary pressures than the period 1960–1972, with an average inflation rate in those years of 17.96%. The effects of the

anti-inflation measures taken in 1971 were carried over into 1973, as evidenced by the relatively low inflation rate (5.4%) recorded. By 1974, however, the inflation rate had reached as high as 13.4%. Late in 1972, the then Federal Military Government set up the Public Service Review Commission, largely in response to popular agitation by workers for a more lasting solution to the hardship inflicted by inflation on the populace.

While the Commission (often referred to as the Udoji Commission) was still sitting, wages were again frozen – an action that likely fuelled expectations about general wage increases and was thus probably responsible for the relatively high rate of inflation recorded in 1974. The Commission, true to expectation, recommended general wage increases, paid between January and February 1975, with arrears backdated to April 1974. Similar increases were later granted in the private sector and the armed forces. The arrears, in particular, generated substantial excess demand in the economy, which was responsible for the period's peak high inflation rate of 33.9% recorded in 1975. It was also during this period that the phenomenon of imported inflation became a significant factor in Nigeria's inflation experience.

As inflationary pressure continued to mount in 1974, government put several measures in place, including reduction in import duties on a relatively wide range of goods and raw materials. Monetary policy measures that encouraged banks to lend more to the productive sectors of the economy were put in place, in addition to measures stepping up the distributive functions of the NNSC. In spite of these actions, the rate of inflation was not significantly brought down in 1975 or even in 1976. Late in 1975, the Federal Military Government had to set up a special Anti Inflation Task Force – an admission on the part of government that past policy measures had largely failed. The task force identified both demand and cost factors in Nigeria's inflation experience but favoured a comprehensive approach to the problem, recommending the establishment of the Productivity, Prices and Incomes Board (PPIB).

Figure 1: Rate of inflation in Nigeria, 1970–2006



The PPIB was set up early in 1976. The price control system already in place was revised. Given a relatively relaxed exchange control system, coupled with the campaign to grow more food under the Operation Feed the Nation programme, the rapid growth in consumer prices was relatively curtailed towards the end of the 1970s. The upward trend resumed in 1981, however, as the inflation rate went up to 20.9%. The government's response was to intensify efforts at importing and distributing "essential" commodities. This action, coupled with the Green Revolution campaign of this period, was apparently responsible for the relative slow-down of the inflation rate to 7.7% in 1982. But the respite from the slow-down was short-lived. In 1983, the inflation rate went up to 23.2%, reaching a high of 39.6% in 1984. The recorded rate of 5.5% for 1985 may be attributed to the force-backed system of price control of the new military government at that time.

On a comparative scale, the period 1986–1995 represents a time of greater inflationary pressures than the preceding periods, as indicated by a historical average rate of 31.50%. When the inflation experience is taken on a year-by-year basis, however, it is found that 1986 and 1987 recorded relatively low rates of 5.4 and 10.2%, respectively. The change is attributed largely to the improved food supply situation, particularly during the year 1986. In 1988, domestic prices went up sharply to 38.3%, reaching an all-time high of 40.9% in 1989. Inflationary pressures eased relatively in 1990, with an inflation rate of 7.5% – again because of rising output growth in the staple food subsection. From 1991, the trajectory of domestic prices was upward trending, with inflation rates of 44.6%, 57.2%, 57.0% and 72.8% recorded in 1992, 1993, 1994 and 1995, respectively.

The inflation rate declined significantly from 72.8% in 1995 to 29.3% in 1996. This reflected the salutary effect of sustained implementation of stabilization measures during the period, including disciplined fiscal and restrained monetary policies. The fight against inflation was highly successful in 1997, when for the first time since 1990 the rate dropped to a single digit of 8.5%, against the 53% average rate in the previous three years. The major factors that influenced the moderation in the inflation rate were the relatively good harvest of staples (brought about by favourable rainfall conditions) and the associated fall in food prices, exchange rate stability, sustained fiscal discipline, and non-accommodating monetary policy. It is significant to note that the low inflation rate was achieved in spite of the adverse effect of the rise in the costs of production and marketing stemming from frequent shortages of petroleum products and disruptions in power supply among other structural bottlenecks.

The inflation rate increased from 8.5% in 1997 to 10% in 1998, thus slipping back to the double-digit level, but remained subdued until the last quarter of the year when domestic and external imbalances mounted. The major factor that influenced the resurgence was the rising cost of production (goods and services) induced by continued scarcity of petroleum products, frequent power outages, deteriorating infrastructure and equipment, and the announcement effect of the upward review of the salary structure of the public sector. However, the economy recorded a mixed performance in 2002. The real gross domestic product (GDP) increased by 3.3% relative to the preceding year's 4.2%. Inflation declined from 18.9% in 2001 to 12.9% at the end of the year. The food index, a dominant component, rose by 13.1% compared with 28.0% in the preceding year. Core inflation, which excludes the impact of food, was 12.5%.

Exchange rate regimes and inflation in Nigeria

Inflation and exchange rates have been identified as two of the key “barometers” of economic performance (Rutasitara, 2004). Exchange rate arrangements in Nigeria have undergone significant changes over the past four decades, shifting from a fixed regime in the 1960s to a pegged arrangement between the 1970s and the mid 1980s, and finally to various types of floating regime adopted in 1986 with the SAP. A regime of managed float, without any strong commitment to defending any particular parity, has been the predominant characteristic of the floating regime in Nigeria since 1986. Exchange rate policy emerged as one of the controversial policy instruments in developing countries in the 1980s, with vehement opposition to devaluation for fear of its inflationary impact, among other effects. Nigeria faced such a situation and there has since been interest in the performance of inflation and the role of the exchange rate in the process.

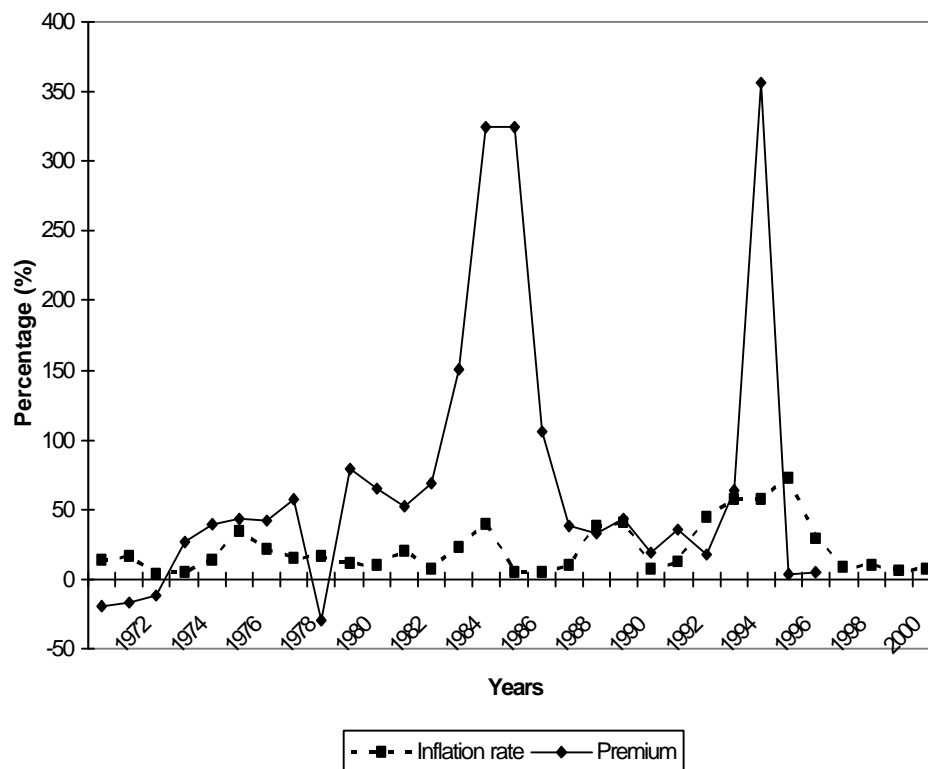
The peculiarity of the Nigerian foreign exchange market needs to be highlighted. The country’s foreign exchange earnings are more than 90% dependent on crude oil export receipts. The result is that the volatility of the world oil market prices has a direct impact on the supply of foreign exchange. Moreover, the oil sector contributes more than 80% of government revenue. Thus, when the world oil price is high, the revenue shared by the three tiers of government rises correspondingly, and as has been observed since the early 1970s, elicits comparable expenditure increases, which are then difficult to bring down when oil prices collapse and revenues fall. Indeed, such unsustainable expenditure levels have been at the root of high government deficit spending.

It became a matter of serious concern that despite the huge amount of foreign exchange, which the Central Bank of Nigeria (CBN) supplied to the foreign exchange market, the impact was not reflected in the performance of the real sector of the economy. Arising from Nigeria’s high import propensity of finished consumer goods, the foreign exchange earnings from oil continued to generate output and employment growth in other countries from which Nigeria’s imports originated. This development necessitated a change in policy on 22 July 2002, when the demand pressure in the foreign exchange market intensified and the depletion in external reserves level persisted. The CBN thus re-introduced the Dutch auction system (DAS) to replace the inter-bank foreign exchange market (IFEM).

Since then, the DAS has been largely successful in achieving the objectives of the monetary authorities. Generally, it assisted in narrowing the arbitrage premium from double digits to a single digit, until the emergence of irrational market exuberance in the fourth quarter of 2003.

Figure 2 charts the details of the movements in inflation and the parallel market premium over the official exchange rate. As can be seen in the figure, movements of the parallel exchange rate premium and inflation rate were very close, especially during the mid 1970 and early 1990s. Indeed, this was the period of widest divergence between the official and parallel market exchange rates. As can be seen from the graph, the peaks and troughs almost always go together, thus confirming that the parallel market exchange rate was significantly correlated with the inflation rate.

Figure 2: Inflation and the exchange rate premium



Trends in fiscal deficit and inflation in Nigeria

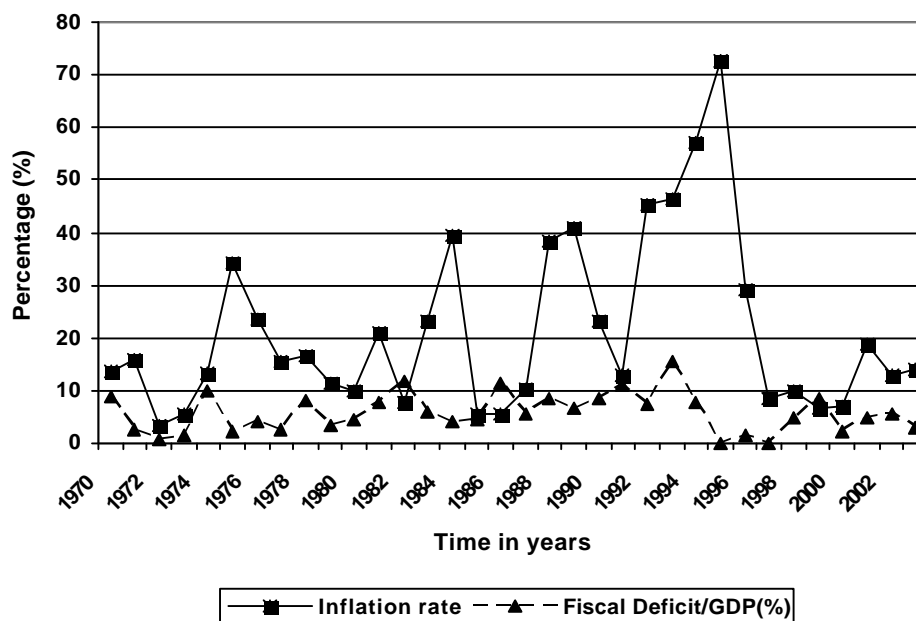
The ratio of fiscal deficit to gross domestic product (GDP) during the period 1971–1977 averaged 2.5%. This was not surprising as increased oil revenue during the period considerably narrowed the fiscal gap. The windfall from the country’s oil earnings was used in promoting infrastructural development and ambitious and unproductive projects.

At face value, it could be argued that in the 1970s government expenditures fuelled inflation. Government was advised by policy makers to embark on ownership and control of not only the “commanding heights” of the economy, like the petroleum sector and mining, but also direct involvement in banking, insurance, clearing and forwarding activities, etc. With the promulgation of the Nigerian Enterprises Promotion Decree (Indigenization Decree) of 1972, and its amendment in 1974, government became directly involved in virtually all aspects of the economy, especially as foreign exchange was no longer a constraint to development.

During the period spanning about 15 years, from 1978 to 1993, the ratio of fiscal deficit to GDP averaged 7.8%. This rate was less than the 9.2% recorded during the nine years of Nigeria’s SAP (1986–1994). The growth in the fiscal deficit was substantial during the SAP years except in 1987. During this period, the fiscal deficit/GDP ratio increased from 4.2% in 1984 to 15.6% in 1993, but in 1987 it stood at only 5.5%. The

inflation rate during the entire stabilization period was permanently in double digits except for 1982, 1985 and 1986, when it declined to 7.5%, 5.5% and 5.4% respectively. Therefore, it could be inferred that inflation did not abate during the period of stabilization and structural adjustment. Figure 3 shows the relationship between the fiscal deficit/GDP ratio and the inflation rate over the period 1970–2003.

Figure 3: Relationship between the inflation rate and the fiscal deficit/GDP ratio



Domestic fuel price and inflation in Nigeria

The prices of various grades of petroleum products have been adjusted upward more than 12 times since the first uniform pricing was introduced on 1 October 1973. In that year the price of premium motor spirit (PMS) or petrol was fixed at ₦0.95 per litre, diesel at ₦0.88 and kerosene at ₦0.18. Six years later, petrol went to ₦1.53 per litre, diesel to ₦1.10 and kerosene to ₦1.05. The problem with the implementation of uniform pricing at that time was that it was more profitable to market products in some areas, around seaports for example, so that oil firms were not willing to expand their facilities to the hinterland.

In 1986, with the introduction of SAP and subsequent devaluation of the naira, petroleum products prices were reviewed upwards to ₦3.95 per litre for petrol, ₦2.95 for diesel and ₦1.05 for kerosene. From 1986 to 2000, the prices of petroleum products were reviewed seven times. The adjustment in 2000 under the democratically elected government marked a turning point in the economy as petrol moved up to ₦30 per litre, diesel to ₦29 and kerosene to ₦27. According to the government, the upward review of domestic prices of petroleum products was necessitated by the high spot market price of crude oil and the need for higher margins for the Nigerian National Petroleum Corporation

(NNPC) to meet operational and capital costs. Owing to public outcry championed by the Nigeria Labour Congress (NLC), a government negotiating team was set up to dialogue with the NLC team. As a result, the prices of petrol, diesel and kerosene were reduced to ₦22, ₦21 and ₦17 per litre, respectively. However, determined to find a lasting solution to perennial fuel crisis in the country, the team that negotiated with NLC in January 2000 was inaugurated as a standing committee on petroleum prices. Led by a former secretary for national planning, the special committee, code-named Petroleum Products Pricing and Regulatory Committee (PPPRC), sought to ensure effective deregulation of the oil sector to allow private sector participation and investment.

On 1 January 2002 the federal government announced yet another hike in prices of petroleum products as a way of allowing oil firms to participate in products importation. The price of petrol rose to ₦26 per litre, diesel to ₦26 and kerosene to ₦24 per litre. Although the PPPRC almost achieved its desire as quite a few of the oil marketing firms such as Mobil Oil Nigeria PLC, Unipetrol, African Petroleum PLC and Texaco ventured into product importation, this was short-lived as crude oil prices in the international market rose from US\$22 per barrel to over US\$30 per barrel towards the end of that year. This, however, led to the withdrawal of the oil firms from the importation of refined petroleum products, thereby leaving only the NNPC. Between 2000 and 2002, the NNPC claimed to have lost about ₦159 billion because of subsidies on imported fuel.

Composition and structure of the consumer price index

The composition of the consumer price index (CPI), being used by the statistical office for over two decades, reflects household expenditure patterns in Nigeria. Composite food prices dominate the CPI, representing 69% of the total market basket. Therefore, the weight of food in the CPI is high (Table 2). The composite food items are susceptible to the changes in agro-climatic conditions (rainfall). This is because the agricultural system in Nigeria remains mostly peasant with little mechanization. Besides, irrigation farming system is not pronounced and rainfall does not occur year-round. Thus, the impact of weather changes in terms of poor rainfall automatically affects food prices and accentuates price inflation in the economy.

Changes in the structure of the CPI have therefore remained the same over the years. In 1998, for example, the food price index, which accounted for 69.1% of total household expenditure, rose by 6.3%, compared with 8.9% in the preceding year. Good harvests have largely contributed to the moderation in the food index over the years. Towards the end of 1999, the composite CPI was about 3,414 (CBN, 2000). This implies that the cost of the retail prices of consumer goods and services rose by about 34-fold between 1985, the base period, and 1999. Some of the items that recorded price increases and drove the rise in the index were food items, kerosene and clothing material.

From the trend analyses and developments in the domestic economy, various factors affect inflation in Nigeria. Among these are fiscal deficits, monetary expansion, wage increases, exchange rate depreciation, fuel prices and vagaries of weather. While the transmission from fiscal and monetary operations to inflation has been well explained

Table 2: Consumer price index market basket (%)

| Commodity | Consumer price index (weights) | | |
|---|--------------------------------|-------------------|-------------------|
| | Combined urban and rural | All urban centres | All rural centres |
| Food | 69.1 | 65.9 | 69.9 |
| Drinks, tobacco and cola | 4.7 | 3.6 | 5.0 |
| Accommodation, fuel and light | 11.9 | 14.0 | 11.5 |
| Clothing and footwear | 4.7 | 4.3 | 4.8 |
| Household goods | 3.6 | 3.4 | 3.6 |
| Health-related | 1.1 | 1.2 | 1.1 |
| Transportation | 2.4 | 5.0 | 1.8 |
| Recreation, education and entertainment | 1.4 | 1.9 | 1.3 |
| Other services | 1.2 | 1.3 | 1.2 |

Sources: Federal Office of Statistics; Moser (1985).

in the literature; the peculiarity of the Nigerian economy accounts for the significant influence of other determinants on inflation. For example, the vagaries of weather, which affect food production and therefore food prices, influence inflation because food constitutes the largest proportion of the Nigerian CPI basket. The persistent increases in fuel prices, following the gradual liberalization of the oil sector, also accounts for the movement in inflation owing to the linkage between fuel prices and virtually all other prices of goods and services in Nigeria, especially transportation. The mechanism through which increases in wages explain inflation in Nigeria is found in the impact that such increases exert on the purchasing power of consumers, which creates shortages of goods and services, leading to price increments.

Inflation targeting in Nigeria

Inflation targeting is a monetary policy framework that sets an explicit inflation target and uses an operating target without an explicit intermediate target to achieve a central bank's policy objective (Uchendu, 2000). The monetary policy framework thus aims at pre-empting future inflationary expectations through changes in operating targets (King, 1997).

While many countries have adopted the practice of inflation targeting, the Central Bank of Nigeria still targets monetary aggregate, notably the broad measure of money (M2). From late 1990s, CBN has persistently expressed its commitment to low inflation and also set annual inflation targets. Nonetheless, these fall markedly short of a full-fledged adoption of an inflation targeting framework, which has as its pre-conditions: explicit commitment to meet a specified inflation rate target or target range within a specified time frame; regular announcement of the target to the public; public accountability for achieving the goals; and independence in the conduct of monetary policy (Khan, 2003; IMF, 2003). A full-fledged inflation targeting strategy would require the government's full commitment. It could make it harder for the government to conduct fiscal policies that are incompatible with the announced monetary policy objective.

In spite of the granting of instruments autonomy to the CBN in 1998, fiscal profligacy remained a key feature of the Nigerian economy with its attendant extenuating effects on the effective operation of monetary policy. It has been argued (Batini, 2004) that if for over 20 years, the CBN had been granted independence in setting monetary conditions and had followed a Taylor rule consistent with a single-digit inflation target, monetary conditions might have been less accommodative and, hence, inflation in Nigeria might have been lower and less volatile than what was observed.

3. Literature review

Inflation has received considerable attention and has been widely studied by economists in developed as well as developing economies. Theoretically, two main schools of thought attempt to explain the inflation process. These are the monetarist and the structuralist schools. While the former holds that inflation is purely a monetary phenomenon, the latter opines that inflation results mainly from government fiscal operations and from the gap between potential output and aggregate demand. Most empirical studies have followed this dichotomization with slight modifications in providing empirical evidence for inflation in various countries.

In Nigeria, Oyejide's 1972 study constitutes a pioneering attempt at providing an explanation of the causes of inflation in Nigeria, most especially from the structuralist perspective. Specifically, he examined the impact of deficit financing in propagating inflation processes in Nigeria and concluded that there was a very strong direct relationship between inflation and the various measures of deficit financing that were in use between 1957 and 1970. In a commissioned study for the Productivity, Prices and Incomes Board of Nigeria, Ajayi and Awosika (1980) found that inflation in Nigeria is explained more by external factors, most especially the fortunes of the international oil market and to a limited extent by internal influences.

An important conference on the Nigerian inflation process was organized by the Nigerian Institute of Social and Economic Research (NISER) in Ibadan in 1974. In general, the findings of some of the key articles suggested that neither monetary nor structural phenomena alone explained Nigeria's inflation. One striking conclusion from this conference was that a combination of both factors precipitates the inflation process (Onitiri and Awosika, 1982).

Adeyeye and Fakiyesi (1980) estimated and tested the hypothesis that the main factor responsible for instability of prices and inflationary tendencies in Nigeria was government expenditure. Working with annual time series data spanning 1960–1977, they tested the hypothesis that the rate of inflation in Nigeria is linearly related to the rate of growth of money stock, government expenditure, especially deficit, and growth of government revenue, especially monetization of foreign exchange from oil export. The result established some significant positive relationships between inflation rate and growth in bank credit, growth of money supply and growth in government expenditure, while the relationship with growth of government revenue was uncertain.

Using quarterly data, Osakwe (1983) attempted to verify the amount of government expenditure that affected money supply in the ten-year period 1970–1980. Significant statistical evidence obtained from the analysis showed strong relationships between increases in net current expenditure and growth in money supply, on the one hand, and

growth in money supply and inflation, on the other hand. Further increase in money wage rate and money supply (with a lag in effect) were identified as the two most important factors that influenced the movement of prices during the period.

Elsewhere, Chhibber et al. (1989) employed a highly disaggregated econometric model for Zimbabwe. They found that monetary growth, foreign prices, exchange and interest rates, unit labour cost, and real output are the key determinants of inflation in that country. For Ghana, Sowa and Kwaye (1993) concluded that the inflation problem is a multi-faceted issue with many causes. It suffices to note that their study did not address certain issues, especially the structural factors, and the long-run identified causes of inflation. Also, their model was highly aggregative, implying that the study could not establish those aspects of the economy that require fine-tuning.

The quantitative impact of monetary expansion and exchange rate depreciation on price inflation in Nigeria was the focus of Egwaikhide et al. (1994), who used time series econometric techniques of cointegration and error correction mechanism (ECM). They concluded that Nigerian inflation seems to find explanation in both monetary and structural factors and that both the official and the parallel market exchange rates exert upward pressure on the general price level. They recommended the use of a combination of policy measures to put inflation under effective control in Nigeria.

Ajakaiye and Ojowu (1994), using an input-output price model, investigated the impact of the exchange rate depreciation witnessed in Nigeria between 1986 and 1989 on the structure of sectoral prices under alternative pricing regimes. They further simulate and analyse empirically the impact of exchange rate depreciation under three different mark-up pricing regimes: a fixed mark-up pricing regime, a flexible pricing regime with rational expectation; and a mixed mark-up pricing regime. Of the three pricing regimes considered, the influence of exchange rate depreciation on the structure of sectoral prices was found to be greatest under the mixed mark-up pricing regime. It was also found that although exchange rate depreciation under the universal flexible mark-up pricing regime with rational expectation will contribute reasonably to the changes in the structure of sectoral prices, the associated inflationary consequences are the highest. Thus, prices in all sectors are determined on the basis of actual and anticipated increases in the cost of imported inputs on account of exchange rate depreciation.

In a study for the African Economic Research Consortium (AERC), Kilindo (1997) tried to increase the understanding of Tanzanian inflation by investigating the links among fiscal operations, money supply and inflation. Finding a strong relationship among the three, he recommended the adoption of a restrictive monetary policy in which the supply of money must be constrained to grow steadily at the rate of growth of real output. In another study for AERC, Barungi (1997) examined the determinants of inflation in Uganda. His paper analyses the relative importance of monetary, cost-push and supply-related causes of inflation. He concluded that inflation in Uganda is persistently a monetary phenomenon.

4. Theoretical framework and methodology

We specify an empirical model where inflation is assumed to originate from both the demand side and the supply side¹. Specifically, the supply side is captured by the tradeable sector whereas the demand side is represented by the non-tradeable sectors. The price of non-traded goods responds to disequilibria in the money market and the price of traded goods is governed by the movements in the exchange rates and foreign prices. The overall price level (P) is a weighted average of the price of tradeable (P_T) and non-tradeable goods (P_N) with α representing the share of tradeable goods in total expenditure. The price index is:

$$P = EP_T^\alpha P_N^{1-\alpha} \dots\dots\dots 0 < \alpha < 1 \quad (1)$$

where E is the nominal exchange rate. We can rewrite (1) as

$$P = E \frac{P_T^\alpha}{P_N^\alpha} P_N = e^\alpha P_N \quad (2)$$

where $e^\alpha \frac{EP_T^\alpha}{P_N^\alpha}$ and e is the real exchange rate.

Now,

$$P_N = P_{NF}^b P_{NO}^{1-b} \quad (3)$$

Expressing Equation 3 in log-linear form and using lower case letters to denote logs, we have

$$p_N = bp_{NF} + (1 - b)p_{NO} \quad (4)$$

in which the subscripts NF and NO mean “nontraded food” and “nontraded other” goods. Substituting (3) into (2) gives

$$P = e^\alpha P_{NF}^b P_{NO}^{1-b} \quad (5)$$

Expressing (5) in log-linear form and using lower-case letters to denote logs, again we have

$$p = \mathbf{a}e + \mathbf{b}p_{NF} + (1 - \mathbf{b})p_{NO} \quad (6)$$

$$\text{At equilibrium } \frac{M^s}{p} = \frac{M^D}{P}, \text{ or } p = \log(M^s) - m^D \quad (7)$$

where p and m^D are the logs of P and real money demand, respectively, and M^s represents the nominal stock of money.

Equating (6) and (7) and solving for p_{NO} yields

$$p_{NO} = \Phi [\log(M^s) - m^D - \mathbf{a}e - \mathbf{b}p_{NF}] \quad (8)$$

where $\Phi = (1 - \mathbf{b})^{-1}$

The demand for real balances is assumed to be a function of all or some of the following variables:

$$m^d = f(y, p^e, i) \quad (9)$$

where y is real income, p^e is the expected rate of inflation and i is the interest rate.

Writing Equation 9 explicitly, we have:

$$m^d = \mathbf{t}_1 y - \mathbf{t}_2 p^e - \mathbf{t}_3 i \quad (10)$$

Substituting (10) into (8) yields:

$$p_{NO} = \Phi [M^s - \mathbf{t}_1 y + \mathbf{t}_2 p^e + \mathbf{t}_3 i - \mathbf{a}e - \mathbf{b}p_{NF}] \quad (11)$$

Again, substituting (11) into (4), gives:

$$p_N = \mathbf{a}_1 M^s - \mathbf{a}_2 y + \mathbf{a}_3 p^e + \mathbf{a}_4 i + \mathbf{a}_5 e \quad (12)$$

This removes the possibility of regressing food prices, which is a component of CPI, on CPI. From (6),

$$p = \mathbf{a}e + p_N \quad (13)$$

Substituting for P_N in (13) using the expression in (12) yields:

$$p_t = a_1 m_t^s + a_2 y_t + a_3 p_t^e + a_4 i_t + a_5 e_t \quad (14)$$

Considering the possible linkage of international oil prices with the domestic price level, Equation 14 is augmented by international oil prices in domestic currency, say d , to obtain:

$$p_t = a_0 + a_1 m_t^s + a_2 y_t + a_3 p_t^e + a_4 i_t + a_5 e_t + a_6 d_t + u_t \quad (15)$$

where a_0 is a constant and u_t is a well behaved error term.

We can now specify Equation 15 as a general dynamic equation called an autoregressive distributed lag (ADL) of order k as follows:

$$p_t = a_0 + \sum_{j=1}^k a_1 p_{t-j} + \sum_{j=0}^k a_2 m_{t-j}^s + \sum_{j=0}^k a_3 y_{t-j} + \sum_{j=0}^k a_4 p_{t-j}^e + \sum_{j=0}^k a_5 i_{t-j} + \sum_{j=0}^k a_6 e_{t-j} + \sum_{j=0}^k a_7 d_{t-j} + v_t \quad (16)$$

All this does is to add lags 1 through k of the dependent variable and all independent variables to the original model. It can be seen that the lags of the dependent variable start at $j=1$, and lags of the independent variables start at $j=0$ because of the need to include the contemporaneous values as in Equation 15. This equation can then be rewritten to obtain the error correction representation of the form:

$$\begin{aligned} \Delta p_t = & a_0 + \sum_{j=1}^{k-1} b_1 \Delta p_{t-j} + \sum_{j=0}^{k-1} b_2 \Delta m_{t-j}^s + \sum_{j=0}^{k-1} b_3 \Delta y_{t-j} + \sum_{j=0}^{k-1} b_4 \Delta p_{t-j}^e + \sum_{j=0}^{k-1} b_5 \Delta i_{t-j} + \sum_{j=0}^{k-1} b_6 \Delta e_{t-j} \\ & + \sum_{j=0}^{k-1} b_7 \Delta d_{t-j} - g(p_{t-1} - d_1 m_{t-1}^s - d_2 y_{t-1} - d_3 p_{t-1}^e - d_4 i_{t-1} - d_5 e_{t-1} - d_6 d_{t-1}) + v_t \end{aligned} \quad (17)$$

The terms in parentheses in Equation 17 represent the error correction term. The coefficients of this equation are functions of the coefficients of (16); the two equations are completely the same. It can be seen from (17) that as long as the variables are cointegrated, all the variables on both sides of (17), including the error correction term, are stationary. If inflation rises above its long-run equilibrium at time $t-1$, the term in the bracket assumes a positive sign. Because γ is negative, its effect at time t is to dampen the inflation towards its steady state path.

5. Data and empirical results

In this section we describe the data available and consider their basic properties. We also present the findings of the stationarity and diagnostic tests and a list of the variables of interest. In addition, the section describes the findings of the cointegration analysis and the error correction modelling.

Data description and sources

All data are annual, spanning 1970–2003. The consumer price index (CPI) is the central series of this study, and choosing an appropriate measure for it is complicated. The most publicly visible measure is the headline CPI published by the National Bureau of Statistics (NBS). However, the headline CPI includes a number of components that are subject to strong transitory fluctuations, that are controlled or influenced by the official sector, or that are unambiguously determined outside the Nigerian economy. While these components affect Nigerian consumers, they are not necessarily readily modelled. Thus no final judgement exists as to which components should be excluded, but in this study we use the headline CPI in the empirical analysis to represent the CPI.

Other series that are of interest to the study are expected inflation, real output, real exchange rate, interest rate, the ratio of fiscal deficits to GDP, money supply, oil prices and, to capture food supply shocks, rainfall. The real gross domestic product (real GDP) is used to represent the real output in the empirical analysis. The inflation rate in this study is simply the percentage annual growth rate of the headline CPI. The first difference of the log of the current price level was used to approximate expected inflation in the empirical analysis. Two major factors necessitated this approach to calculating expected inflation. One, it is consistent with both the rational and adaptive expectation hypotheses as noted by Dhakal et al. (1993). Two, inflation cannot be filtered to generate expected inflation as in the case of the use of a Hodrick–Prescott filter in the generation of potential output.

Table A1 in the Appendix provides the summary descriptive statistics of the variables for the study. Given the time scope of the study (1970–2003) and the frequency of the data (annual), all the variables have 34 observations. As indicated by the various statistics, the variables are not haphazardly distributed. The Jarque–Bera statistic of the variables accepts the null hypothesis of normality at 5% level of significance. All the data were sourced from the CBN *Annual Reports and Statements of Account* and *Statistical Bulletin* (various issues) and the International Financial Statistics of the International Monetary Fund (IMF).

The following variables are used:

cpi = consumer price index
 exinf = expected inflation
 fisc = fiscal deficits/GDP ratio
 gdp = gross domestic product
 int = interest rate
 mss = money supply
 pet = oil prices
 rain = average rainfall
 rer = real exchange rate

Empirical analysis and results

Before modelling the CPI, it is useful to determine the orders of integration for the variables considered. As shown in Table 3, we use both the augmented Dickey–Fuller (ADF) and the Phillips–Peron statistics. It was found that all the variables of the study exhibit unit root process at various critical levels but mostly at 1% level of significance. In other words, all the variables are found to be non-stationary at their levels but stationary at their first differences.

Table 3: Results of stationarity tests

| Variables | ADF | Phillips–Peron | Decision |
|-----------------|----------|----------------|----------|
| lcpi | 0.208 | 0.816 | I(1) |
| Δ lcpi | -3.260** | -3.260** | |
| lexinf | -2.273 | -2.368* | I(1) |
| Δ lexinf | -4.271** | -5.318** | |
| lfisc | -2.537 | -2.183 | I(1) |
| Δ lfisc | -4.430** | -6.734** | |
| lfisc | -1.079 | -1.352 | I(1) |
| Δ lfisc | -5.595** | -5.607** | |
| lint | -1.297 | -1.181 | I(1) |
| Δ lint | -6.713** | -6.775** | |
| lmss | -0.460 | 0.108 | I(1) |
| Δ lmss | -3.392** | -3.442** | |
| lpet | -0.765 | -0.687 | I(1) |
| Δ lpet | -6.982** | -6.949** | |
| llrain | -2.909 | -2.988* | I(1) |
| Δ llrain | -7.115** | -7.131** | |
| lrer | 0.959 | 0.522 | I(1) |
| Δ lrer | -4.101** | -4.232** | |

Note: D represents the first difference operator and I the logarithm. Critical values, ADF test: 1% = -3.654, 5% = -2.957. Phillips–Peron 1% = -3.646, 5% = -2.954; ** (*) means significant at 1% and 5%, respectively.

Cointegration analysis and error correction modelling

Cointegration analysis helps to clarify the long-run relationships between integrated variables. Johansen's (1988, 1991) procedure is maximum likelihood for finite-order vector autoregressions (VARs) and is easily calculated for such systems, so it is used in this study. The Johansen technique was chosen not only because it is VAR based but also because it performs better than single-equation and alternative multivariate methods. Table 4 reports the results from the cointegration test.

Table 4: Johansen hypothesized cointegrating relations

| Null | Alternative | Eigenvalue | Max-eigen statistic | 5% critical value | 1% critical value |
|-----------------|-------------|------------|---------------------|-------------------|-------------------|
| $r = 0^{**}$ | $r = 1$ | 0.9509 | 96.41 | 57.12 | 62.80 |
| $r \leq 1^{**}$ | $r = 2$ | 0.8603 | 62.99 | 51.42 | 57.69 |
| $r \leq 2^{**}$ | $r = 3$ | 0.8015 | 51.74 | 45.28 | 51.57 |
| $r \leq 3$ | $r = 4$ | 0.6921 | 37.70 | 39.37 | 45.10 |
| $r \leq 4$ | $r = 5$ | 0.6079 | 29.96 | 33.46 | 38.77 |
| $r \leq 5$ | $r = 6$ | 0.4235 | 17.62 | 27.07 | 32.24 |
| $r \leq 6$ | $r = 7$ | 0.3148 | 12.10 | 20.97 | 25.52 |
| $r \leq 7$ | $r = 8$ | 0.1846 | 6.53 | 14.07 | 18.63 |

*(**) denotes rejection of the hypothesis at the 5% (1%) level.

Max-eigenvalue test indicates 3 cointegrating equation(s) at both 5% and 1% levels.

The max-eigenvalue test shows that there are three cointegrating equations in the analysis. The PT-matrix of the beta coefficients from the Johansen cointegration analysis and the preferred cointegrating (CI) equation of the model are presented in Table A2 of the Appendix. Only one cointegrating relation was chosen among the three, based on statistical significance and conformity of the coefficients with economic theory. As shown by the chosen CI equation, which normalized the coefficient of log *CPI*, nearly all the explanatory variables are significant in influencing changes in prices except money supply. The most significant of the determinants of prices are expected inflation and fiscal deficit. The non-significance of money supply in the long-run CI equation is not unexpected because of the hypothesized neutrality of money in the long run. The relationship depicted by the CI equation shows that in the long-run expected inflation, fiscal deficit, petroleum prices and real exchange rate exert positive influences on general prices, while real output, interest rate, money supply and weather shocks affect prices negatively.

Having ascertained that the variables are non-stationary at their levels but stationary after differencing once and that they are cointegrated, the stage is set to formulate an error correction model. The intuition behind such a model is the need to recover the long-run information lost by differencing the variables. The error correction model rectifies this problem by introducing an error correction term. This term is derived from the long-run equation based on economic theory and enables us to gauge the speed of adjustment of inflation rate to its long-run equilibrium. It gives us the proportion of disequilibrium errors accumulated in the previous period that are corrected in the current period. The results show that the speed of adjustment of the consumer price index to the long-run equilibrium path is low. Specifically, only about 4% of the disequilibrium

errors that occurred in the previous year, are corrected in the current year. It also shows feeble persistence of the inflation rate (10%), thereby suggesting the existence of weak inflation inertia.

Preceding the dynamic analysis, the results from the estimated static model show that fiscal deficit, changes in broad money and exchange rates are the long-run determinants of inflation in Nigeria.

Table 5 presents the results of the parsimonious ECM. The over-parameterized model from which the parsimonious ECM emanated is presented in Table A3 of the Appendix. The adjusted R-square of the estimated model shows that about 90% of the variation in CPI is explained by the combined effects of all the determinants while the F-statistic shows that the overall regression is significant at 1% level. Also, the Durbin–Watson statistic value of 2.164 indicates the absence of autocorrelation in the analysis and the equation standard error of 0.044 signifies that for about two-thirds of the time the predicted value of CPI would be within 4.4% of the actual value.

Table 5: Results from the error correction model

| Regressor | Coefficient | Probability |
|---------------------------|-----------------|-------------|
| Intercept | 0.038 (2.032) | 0.056 |
| $\Delta\text{lcpi}(-1)$ | 0.101 (7.423) | 0.000 |
| Δlexinf | 0.130 (7.442) | 0.000 |
| $\Delta\text{lexinf}(-1)$ | 0.027 (2.177) | 0.042 |
| $\Delta\text{lfisc}(-1)$ | 0.008 (1.158) | 0.261 |
| $\Delta\text{lgdp}(-1)$ | 0.188 (1.648) | 0.115 |
| $\Delta\text{lmss}(-1)$ | -0.134 (-1.753) | 0.095 |
| $\Delta\text{lpet}(-1)$ | 0.037 (1.746) | 0.096 |
| $\Delta\text{lrain}(-1)$ | -0.111 (-1.892) | 0.073 |
| Δlrer | 0.080 (2.820) | 0.011 |
| $\Delta\text{lrer}(-1)$ | -0.134 (-3.203) | 0.005 |
| ECM(-1) | -0.037 (-2.352) | 0.029 |

Adjusted R² = 0.909

Standard error = 0.044

F-statistic = 29.094

D-W statistic = 2.164

Note: The figures in parentheses are t-statistics and all variables are as defined earlier.

As shown in Table 5, the lagged values of the CPI marginally influence the volatility of inflation over time with weak inertia of a mere 10%. Current expectations about future price levels significantly influenced the volatility of inflation. Specifically, the coefficient of expected inflation is positive and significant at the 1% critical level. Another interesting result from the analysis is the impact of weather conditions on general prices. As shown in the table, lagged values of rainfall exert significant negative impact on the level of current inflation. This shows that good weather conditions as reflected by high rainfall in the previous year lead to lower food prices (the most important component of the CPI basket) in the current year.

Real exchange rate exerts very significant positive influence on the level of CPI, while its lagged values affect inflation negatively. It was also found that the coefficient of output represented by the real GDP was positively signed and is not significant in determining the level of CPI. In addition, petroleum price is found to be significant at only 10% critical level and is positively signed.

The coefficient of the fiscal variable (ratio of fiscal deficits to GDP) is not significantly different from zero, although it is positively signed. This apparent weak impact of the fiscal variable, in spite of the fiscal dominance in Nigeria, may be attributed to the inclusion of money supply and expected inflation in the analysis, both of which reflect deficit financing. Unexpectedly, however, the coefficient of money supply was found to be negatively signed and significant at the 10% level.

Overall, the empirical analysis revealed that while fiscal deficit and changes in broad money drive inflation in Nigeria in the long run, lagged CPI, inflation expectations and weather significantly affect inflation in the short run. Exchange rate was found to be a significant determinant of inflation in both the short run and the long run. This special characteristic of the exchange rate in Nigeria may be clearly understood when the activities in the parallel foreign exchange market rate are taken into consideration.

Diagnostic tests

Having presented the results from the empirical analysis, it is also necessary to examine the statistical properties of the estimated model. The model was tested for normality, serial correlation, autoregressive conditional heteroscedasticity, heteroscedasticity, specification error and stability. The results, reported in Table 6, suggest that the model is well specified. The diagnostics indicate that the residuals are normally distributed, homoscedastic and serially uncorrelated and the parameters appear to be stable.

Table 6: Diagnostic tests

| Test | F-statistics | Probability |
|---|------------------|------------------|
| 1. Normality Jarque-Bera statistic | 0.2835 | 0.8679 |
| 2. Serial correlation Breusch-Godfrey serial correlation LM test | 0.3925 | 0.6810 |
| 3. Autoregressive conditional heteroscedasticity ARCH LM test | 3.9458 | 0.1565 |
| 4. Heteroscedasticity White heteroscedasticity test | 2.3150 | 0.3967 |
| 5. Stability Chow breakpoint test (mid sample) Chow forecast test (1970–2002) | 3.7270 5.1642 | 0.3896 0.1915 |
| 6. Specification error Ramsey reset test | 11.8572 | 0.2703 |

6. Summary and conclusion

Identifying the key determinants of inflation in Nigeria was the intent of this study, specifically by using the framework of an error correction mechanism. The results from the study show that the lagged CPI, expected inflation, real exchange rate and petroleum price significantly influence the dynamics of the consumer price index in Nigeria. The level of output was found to be insignificant in the parsimonious error correction model.

From the results of the parsimonious error correction model, two variables are found to be of particular importance. These are the expected inflation rate and the real exchange rate. The major inference that can be drawn from the high significance of the former in the inflation equation is that the expectation that is formed about the future level of prices affects current purchase decisions. In order to put expected inflation under control there is need for high transparency in monetary policy making and implementation, and the fiscal posture of the government must also be made to regularly align with monetary policy objectives. For the real exchange rate, since its only component that is relatively under the control of the monetary authority in Nigeria is the nominal effective exchange rate, efforts must be made to ensure exchange rate stability in order to stem inflationary tendencies.

As expected, the petroleum price was also found to be significant in influencing inflation in Nigeria. This result may be attributed to both the high dependence of the Nigerian economy on oil exports and the high import of refined petroleum products. Oil exportation accounts for about 97% of total government foreign earnings and about 82% of total annual government revenue. A major implication of this result is that efforts by the monetary authorities to stabilize domestic prices are likely to be continuously disrupted by volatility in the international price of crude oil. To reduce the impact of crude oil prices on domestic inflation, there is need to reduce the dependence of the economy on crude oil exports by diversifying the productive base of the economy to non-oil exports.

Exploring relationships among oil revenue, money expansion and fiscal deficits, and experimenting with the differential between the parallel exchange rate and the official exchange rate as regressors, are future research areas that have potential to continuously improve the understanding of the dynamics of inflation in Nigeria.

Notes

1. This section benefits from deBrouwer and Ericsson (1998) and Kenny and McGettigan (1999) and Vinals (1998).

References

- Adeoye, Tunde. 2002. *Economic Policy Shift, Agro-Climatic Conditions and Inflation in Nigeria*. NISER Monograph Series No. 7. Nigerian Institute of Social and Economic Research, Ibadan.
- Adeyeye, E.A. and T.O. Fakiyesi. 1980. "Productivity Prices and Incomes Board and anti inflationary policy in Nigeria". In *The Nigerian Economy under the Military, Proceedings of the 1980 Annual Conference of the Nigeria Economic Society*, Ibadan.
- Ajakaiye, D.O. and O. Ojowu. 1994. *Exchange Rate Depreciation and the Structure of Sectoral Prices in Nigeria under an Alternative Pricing Regime, 1986-89*. AERC Research Paper No. 25. African Economic Research Consortium, Nairobi.
- Ajayi, S.I. and K. Awosika. 1980. "Inflation in Nigeria: Domestic or imported". Paper commissioned for the Productivity, Prices and Incomes Board, Ibadan, January.
- Barungi, B.M. 1997. *Exchange Rate Policy and Inflation: The Case of Uganda*. AERC Research Paper No. 59. African Economic Research Consortium, Nairobi.
- Batini, Nicoletta. 2004. "Achieving and maintaining price stability in Nigeria". IMF Working Paper WP/04/97. International Monetary Fund, Washington, D.C.
- Central Bank of Nigeria. 2000. *CBN Statistical Bulletin*, Vol. 11(2), December.
- Chhibber, A., J. Cottani, R. Firuzabadi and M. Walton. 1989. "Inflation, price controls and fiscal adjustment in Zimbabwe". Working Paper No. WPS 192, April. The World Bank, Washington, D.C.
- deBrouwer, G. and N. Ericsson. 1998. "Modelling inflation in Australia" *Journal of Business and Economic Statistics*, 16(4).
- Dhokal, D., M. Kandil and S.C. Sharma. 1993. "Causality between the money supply and share prices: A VAR investigation". *Quarterly Journal of Business and Economics*, 32(2): 52–73.
- Egwaikhide, F.O., L.N. Chete and G.O. Falokun. 1994. "Exchange rate, money supply and inflation in Nigeria: An empirical investigation". *African Journal of Economic Policy*, 1(1): 57–73.
- Fashoyin, T. 1984. *Income and Inflation in Nigeria*. Ikeja: Longman.
- IMF. 2003. "The move to inflation targeting". *IMF Finance and Development*, June. Vol. 40 (2) International Monetary Fund, Washington, D.C.
- Johansen, S. 1988. "Statistical analysis of cointegration vectors". *Journal of Economic Dynamics and Control*, 12: 231–54.
- Johansen, S. 1991. *A Statistical Analysis of Cointegration for I(2) Variables*. University of Copenhagen, Copenhagen.
- Kenny, G. and D. McGettigan. 1999. "Modelling traded, non-traded and aggregate inflation in a small open economy: The case of Ireland". *The Manchester School*, 67(1): 60–88.
- Khan, M.S. 2003. "Current issues in the design and conduct of monetary policy". IMF Working Paper No. 03/56, March. International Monetary Fund, Washington, D.C.
- Kilindo, A.A.L. 1997. *Fiscal Operations, Money Supply and Inflation in Tanzania*. AERC Research Paper No. 65. African Economic Research Consortium, Nairobi.
- King, M. 1997. "The inflation target five years on". *Bank of England Quarterly Bulletin*, 33: 434–42.

- Moser, G.G. 1985. "The main determinants of inflation in Nigeria". *IMF staff Papers*, 42(2): 271–89.
- Onitiri H.M.A. and K. Awosika. eds. 1982. *Inflation in Nigeria*. Proceedings of a National Conference convened by the Nigerian Institute of Social and Economic Research, Ibadan.
- Osakwe, J.O. 1983. "Government expenditures, money supply and prices 1970–1980". *CBD Economic and Financial Review*, 21(2): 4–18.
- Oyejide, T.A. 1972. "Deficit financing, inflation and capital formation: An analysis of the Nigerian experience, 1957–1970". *Nigerian Journal of Economic and Social Studies*, 14(1): 27–43.
- Rutasitara, L. 2004. *Exchange Rate Regimes and Inflation in Tanzania*. AERC Research Paper No. 138. African Economic Research Consortium, Nairobi.
- Sowa, N.K. and J.K. Kwaye. 1993. *Inflationary Trends and Control in Ghana*. AERC Research Paper No. 22. African Economic Research Consortium, Nairobi.
- Uchendu, O.A. 2000. "Inflation targeting: A monetary policy management framework for the attainment of price stability in Nigeria". *Central Bank of Nigeria Economic and Financial Review*, 38(2, June): 1–16.
- Vinals, J. 1998. *Monetary Policy and Inflation: From Theory to Practice*. Discussion Paper No. 1821, Centre for Economic Policy Research .

Appendix

Table A1: Summary statistics of variables

Sample: 1970–2003

| | Lcpi | lexinf | Lfisc | lgdp | |
|----------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Mean | 5.285902 | 2.681071 | 1.399810 | 11.38748 | |
| Median | 4.706107 | 2.644730 | 1.712877 | 11.40400 | |
| Maximum | 8.709936 | 4.001934 | 2.745988 | 11.86530 | |
| Minimum | 2.379546 | 1.147360 | -2.995732 | 10.89949 | |
| Std. dev. | 2.102544 | 0.748892 | 1.178089 | 0.234756 | |
| Skewness | 0.269469 | 0.058832 | -2.115818 | 0.053030 | |
| Kurtosis | 1.656664 | 2.070911 | 7.883610 | 2.226773 | |
| Jarque-Bera Probability | 2.967924 0.226738 | 1.242491 0.537275 | 59.15488 0.000000 | 0.862932 0.649556 | |
| Sum | 179.7207 | 91.15640 | 47.59353 | 387.1744 | |
| Sum sq. dev. | 145.8828 | 18.50767 | 45.80052 | 1.818638 | |
| | lint | lmss | lpet | lrain | lrer |
| Mean | 2.557417 | 10.09795 | 4.752213 | 7.216534 | -0.370500 |
| Median | 2.565688 | 9.551304 | 3.790024 | 7.238132 | -1.550687 |
| Maximum | 3.586293 | 14.01891 | 8.799949 | 7.458186 | 5.574135 |
| Minimum | 1.791759 | 6.410668 | 2.680552 | 6.792344 | -4.470377 |
| Std. dev. | 0.560257 | 2.280528 | 2.001435 | 0.149096 | 3.797175 |
| Skewness | 0.063487 | 0.069690 | 0.581666 | -0.699467 | 0.429483 |
| Kurtosis | 1.547765 | 1.958601 | 1.796276 | 3.211025 | 1.539144 |
| Jarque-Bera Probability | 3.010573 0.221954 | 1.563913 0.457510 | 3.969911 0.137387 | 2.835527 0.242255 | 4.068558 0.130775 |
| Sum | 86.95217 | 343.3302 | 161.5752 | 245.3622 | -12.59700 |
| Sum sq. dev. | 10.35832 | 171.6266 | 132.1895 | 0.733578 | 475.8116 |

**Table A2: Unrestricted cointegrating coefficients (normalized by $b^*S11*b=I$)
(PT-matrix of the beta coefficients from the Johansen cointegration analysis)**

| lcpi | lexinf | lfisc | lgdp |
|-----------|-----------|-----------|-----------|
| -1.685727 | 4.661348 | 0.980852 | -5.597585 |
| 13.12522 | 2.614074 | 0.337612 | 16.26374 |
| -0.474287 | 0.728176 | -0.268690 | 1.312433 |
| 1.535720 | 0.225542 | 0.051478 | 7.250615 |
| 16.41058 | 0.189201 | 1.999192 | 14.54010 |
| -8.353432 | -1.801213 | 0.542974 | -1.696941 |
| -3.013705 | -1.867638 | 0.642954 | -6.276865 |
| -4.047991 | 0.822163 | -0.028618 | 3.113739 |
| -0.491784 | -0.930290 | 0.304337 | 6.984960 |

| lint | lmss | lpet | lrain | lrer |
|-----------|-----------|-----------|-----------|-----------|
| -1.945258 | -0.066707 | 0.962983 | -2.677258 | 1.000579 |
| 1.601519 | -8.229406 | 0.574644 | -3.607427 | -3.760710 |
| 2.011234 | 0.207172 | -3.148010 | -8.004076 | 1.493306 |
| 0.981792 | 0.041933 | 5.361872 | -7.038379 | -4.296897 |
| 0.372955 | -9.255549 | 2.171017 | -6.159340 | -5.553452 |
| -0.455362 | 2.489657 | -0.872949 | -1.767749 | 3.696234 |
| -6.324742 | 1.912052 | -1.692911 | -1.254889 | 2.511833 |
| 0.239294 | 2.057481 | -3.703460 | 4.889083 | 2.726000 |
| 0.291630 | 0.179303 | -1.830270 | 1.787072 | 1.070234 |

The first cointegrating equation (std. error in parentheses)

| lcpi | lexinf | lfisc | lgdp |
|-----------|-----------------------|-----------------------|------------------------|
| -1.000000 | 2.765187 (0.16988) | 0.581857 (0.06151) | -3.320577 (0.43792) |

| lint | lmss | lpet | lrain | lrer |
|------------------------|------------------------|-----------------------|------------------------|-----------------------|
| -1.153958 (0.20118) | -0.039571 (0.07984) | 0.571257 (0.21558) | -1.588192 (0.37268) | 0.593559 (0.13761) |

Table A3: The general/over-parameterized EC model

| Dependent variable: Δlpci | | | | |
|--|-------------|-----------------------|-------------|-----------|
| Variable | Coefficient | Std. error | t-statistic | Prob. |
| C | 0.027066 | 0.192521 | 0.140589 | 0.8971 |
| $\Delta \text{lpci}(-1)$ | 0.664530 | 0.568925 | 1.168044 | 0.3272 |
| $\Delta \text{lpci}(-2)$ | 0.415688 | 1.199998 | 0.346408 | 0.7519 |
| Δlexinf | 0.181330 | 0.106824 | 1.697461 | 0.1882 |
| $\Delta \text{lexinf}(-1)$ | 0.102456 | 0.175437 | 0.584003 | 0.6002 |
| $\Delta \text{lexinf}(-2)$ | 0.031402 | 0.074316 | 0.422543 | 0.7011 |
| Δlfisc | 0.023764 | 0.029635 | 0.801915 | 0.4812 |
| $\Delta \text{lfisc}(-1)$ | 0.015007 | 0.050612 | 0.296514 | 0.7862 |
| $\Delta \text{lfisc}(-2)$ | 0.020212 | 0.061786 | 0.327130 | 0.7651 |
| Δlgdp | 0.120266 | 0.362957 | 0.331351 | 0.7622 |
| $\Delta \text{lgdp}(-1)$ | -0.169890 | 0.760902 | -0.223275 | 0.8377 |
| $\Delta \text{lgdp}(-2)$ | -0.052071 | 0.341706 | -0.152386 | 0.8886 |
| Δlrint | -0.058312 | 0.323714 | -0.180134 | 0.8685 |
| $\Delta \text{lrint}(-1)$ | -0.036835 | 0.208257 | -0.176871 | 0.8709 |
| $\Delta \text{lrint}(-2)$ | -0.068969 | 0.214231 | -0.321938 | 0.7686 |
| Δlmss | -0.114287 | 0.424230 | -0.269398 | 0.8051 |
| $\Delta \text{lmss}(-1)$ | -0.053120 | 0.410115 | -0.129525 | 0.9051 |
| $\Delta \text{lmss}(-2)$ | -0.024356 | 0.485621 | -0.050155 | 0.9632 |
| Δlpet | 0.056267 | 0.174659 | 0.322156 | 0.7685 |
| $\Delta \text{lpet}(-1)$ | 0.054305 | 0.200520 | 0.270818 | 0.8041 |
| $\Delta \text{lpet}(-2)$ | -0.016636 | 0.154685 | -0.107550 | 0.9211 |
| Δlrain | -0.166821 | 0.369304 | -0.451718 | 0.6821 |
| $\Delta \text{lrain}(-1)$ | -0.118171 | 0.158672 | -0.744750 | 0.5105 |
| $\Delta \text{lrain}(-2)$ | 0.073968 | 0.191389 | 0.386479 | 0.7249 |
| Δlrer | 0.075896 | 0.138572 | 0.547698 | 0.6220 |
| $\Delta \text{lrer}(-1)$ | -0.179450 | 0.341347 | -0.525712 | 0.6355 |
| $\Delta \text{lrer}(-2)$ | 0.083120 | 0.223576 | 0.371775 | 0.7348 |
| $\text{ecm}(-1)$ | -0.277803 | 1.715190 | -0.161966 | 0.8816 |
| R-squared | 0.983134 | Mean dependent var | | 0.198474 |
| Adjusted R-squared | 0.831341 | S.D. dependent var | | 0.144563 |
| S.E. of regression | 0.059369 | Akaike info criterion | | -3.338999 |
| Sum squared resid | 0.010574 | Schwarz criterion | | -2.043785 |
| Log likelihood | 79.75449 | F-statistic | | 6.476814 |
| Durbin-Watson stat | 2.088693 | Prob(F-statistic) | | 0.074056 |

Note: Δ represents the first difference operator; lpci = Consumer price index; lexinf = Expected inflation; lfisc = Fiscal deficits/GDP; lgdp = Gross domestic product; lrint = Interest rate; lmss = Money supply; lpet = Oil prices; lrain = Average rainfall; lrer = Real exchange rate (ALL IN LOGS).

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