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New perspectives on inflation in Nigeria

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NEW PERSPECTIVES ON INFLATION IN NIGERIA

By

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This study offers another perspective to the inflationary trend in Nigeria that incorporates monetarist, open economy and structural features of the economy. The main argument is that variation in the parallel market exchange rate was one of the determinants of price level behavior in Nigeria during the period, 1971-1995. A partial equilibrium model based on micro-foundations is solved for the price level and the solution estimated through Two Stage Least Squares (2SLS) instrumental variable method, using annual data. The results confirm the importance of parallel market exchange rate dynamics, in addition to the traditional monetarist variables in the period under review.

1. INTRODUCTION

The volatility of the price level in Nigeria since the advent of the oil boom has been subjected to various analyses. Some analyses are based on the effects arising from monetary factors such as the monetization of the budget deficit through the central bank, capital inflows (a majority of which came in mainly through the monetization of crude oil earnings) and excessive private domestic credit creation in the financial markets. Other studies emphasised the effects arising from real factors such as agro-climatic conditions, especially the famine at the Sahelian part of the country in the mid 1970's. However, one of the often-neglected sources of variations in the price level is the existence of a parallel market for foreign currency, which is relied upon for the finance of unofficial short-term trade in intermediate inputs and consumer durables. The effect of the parallel market exchange rate on prices arises from the fact that domestic prices are fully adjusted to the parallel market exchange

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rate rather than the rationed official exchange. Regardless of whether foreign currency used for the purchase of intermediate inputs is obtained from the official or parallel market, prices are set based on the parallel exchange rate. The implication of this assumption for inflation in Nigeria is the subject of this paper.

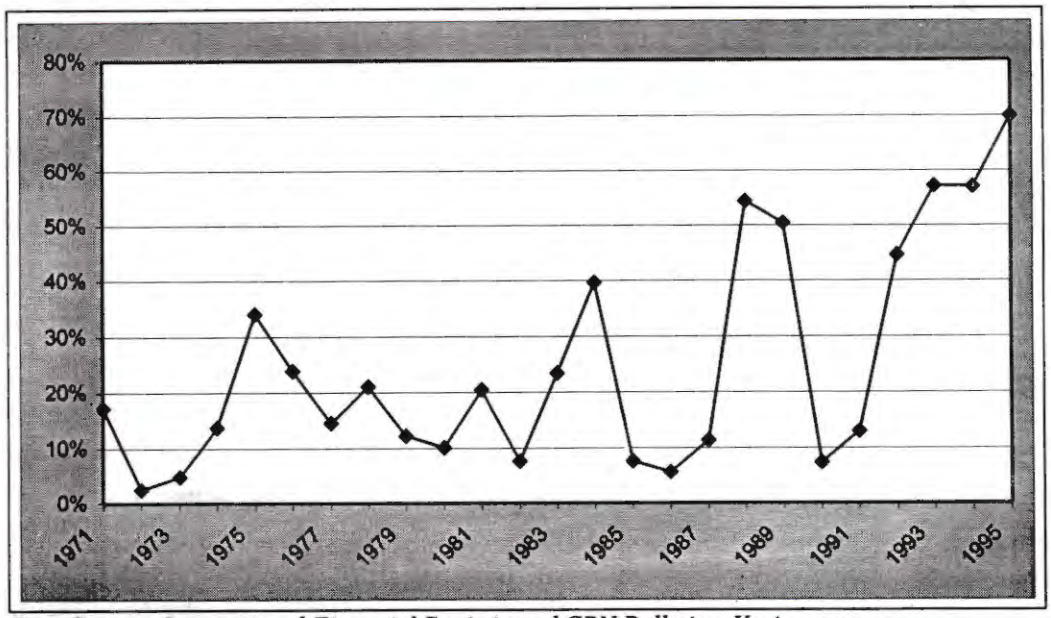
The rest of the paper is organized as follows: Section two reviews the various episodes of inflation in Nigeria since 1970; section three reviews relevant empirical literature, while section four specifies a partial equilibrium theoretical model of price level change. The derived solution for inflation is estimated and discussed in sections five and six.

2. INFLATIONARY TREND IN NIGERIA

Nigeria has experienced high volatility in inflation rates. Since the early 1970's, there have been four major episodes of high inflation, in excess of 30 percent. The growth of money supply is correlated with the high inflation episodes because money growth was often in excess of real economic growth. However, preceding the growth in money supply, some factors reflecting the structural characteristics of the economy are observable. Some of these are supply shocks, arising from factors such as famine, currency devaluation and changes in terms of trade. In addition, in the late 1980's, following the Structural Adjustment Program, the effects of wage increases created a cost-push effect on inflation. In the long run, it was the structural characteristics of the economy, coupled with the growth in money supply, that translated these into permanent increases.

In Figure 1, the first period of inflation in the 30 percent range was in 1976. One of the factors often adduced for this inflation is the drought in Northern Nigeria, which destroyed agricultural production and pushed up the cost of agricultural food items, a significant proportion of the average consumer's budget. In addition, during this period, there was excessive monetization of oil export revenue, which might have given the inflation a monetary character. In 1985, inflation peaked at 40 percent at a time of relatively little growth in the economy. At that time, the government was under pressure from debtor groups to reach an agreement with the International Monetary Fund, one of the conditions of which was devaluation of the domestic currency. The expectation that devaluation was imminent fuelled inflation as prices adjusted to the parallel rate of exchange. Over the same period, excess money growth was about 43 percent and credit to the government had increased by over 70 percent. In other respects, the cause of the inflation may also be adduced to the worsening terms of external trade experienced by the country at that time. It is possible therefore that Nigeria's inflationary episodes were preceded by structural or real factors followed by monetary expansion.

Figure 1: Percentage Rates of Change of CPI, 1971 - 1995



Data Source: International Financial Statistic and CBN Bulletins, Various years

The third high inflation episode started in the last quarter of 1987 and accelerated through 1988 and 1989. This episode is related to the fiscal expansion that accompanied the 1988 budget. Though initially the expansion was financed by credit from the CBN, it was later sustained by increasing oil revenue (- occasioned by oil price increase following the Persian Gulf War) that was not sterilized. In addition, with the debt conversion exercise, through which "debt for equity" swaps took place, external debt was repurchased with new local currency obligations. However, with the drastic monetary contraction initiated by the authorities in the middle of 1989, inflation fell, reaching one of its lowest points in 1991.

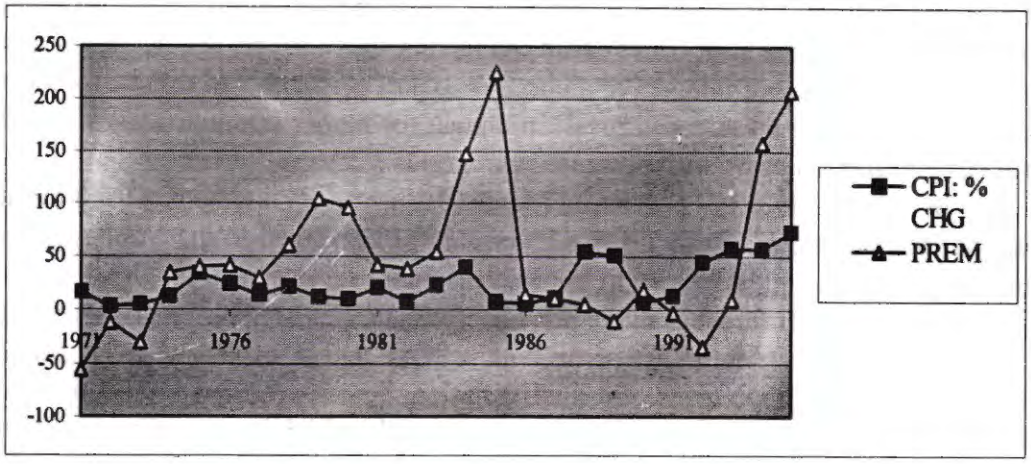
The fourth inflationary episode occurred in 1993, and persisted through the end of 1995, the last period of this study. Though inflation gathered momentum towards the tail end of 1992, it reached 60 percent by the end of 1993, the highest rates since the eighties, and by the end of 1995, it was 70 percent. As with the third inflation, it coincided with a period of expansionary fiscal deficit and money supply growth. The authorities found it too difficult to contain the growth of private sector domestic credit and bank liquidity; and by the end of 1992, money supply growth was 70 percent.

Structural factors have proven to be important in the inflation spiral. Reduction in oil revenue (a supply shock) led to a reduction in real income, with serious distributional implications. As workers pushed for higher nominal wages, while

producers increased mark-ups on costs, an inflationary spiral followed. In addition to these factors, the government also had a transfer problem in order to meet debt obligations, with the devaluation increasing its debt obligations in local currency value.

Figure 2 presents the graphical detail of 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's to the mid 1980's. Indeed this was the period of widest divergence between the official and parallel market exchange rate. As can be seen from the chart, peaks and throughs almost always go together, thus confirming the initial assumption that the parallel market exchange rate was significantly correlated with inflation rate. This assumption will be more formally tested in sections 5.

Figure 2: Inflation and the Exchange Rate Premium: 1971 - 1995



Data Source: International Financial Statistics

The episodes reviewed so far suggest that inflation in Nigeria is driven from both the demand and the supply side. The demand side pressures arise from changes in monetary aggregates while the supply side pressures arise from salient structural characteristics of the economy. Some of these are the climatic conditions, the structure of production, which is favourably disposed to the reliance on imported inputs and the availability of huge foreign currency, which is rationed. In order to explain properly how these jointly determine price level changes; a theoretical model is built in section four and the solution estimated in section five. However, before that, a review of literature is undertaken in the next section.

3. THEORETICAL BACKGROUND AND LITERATURE REVIEW

Traditional monetarist approaches to the study of inflation stress the importance of the link between money supply and inflation. Monetarists see inflation as "always and everywhere a monetary phenomenon". (Friedman, 1956) argued that inflation has a monetary character because it results from the rise in the quantity of money, though the change in prices may not show up at the same time as the rise in the quantity of money. This concept of inflation, which models money supply as an exogenous variable with causality running from money supply to prices, characterises the works of Cagan (1956) and Harberger (1963), among others.

The monetarist position is in stark contrast to the structuralist school, which sees financial factors as forces propagating inflation rather than causing it. The main structuralist point is that inflation can result from a number of special problems in developing countries, and not just from excessive money growth. Their search for explanations of inflation usually centers around "structural" problems such as supply bottlenecks or high dependency on imported intermediate goods. Inflation could also arise from the cost side. Costs could change through a supply shock, an increase in local earning power arising from a boom in export earnings, (in this case oil), or devaluation. Any of these could result in a push for higher nominal wages, which drive up production costs and increases final goods prices.

In a study of OECD countries, Maynard and van Ryckeghem (1975) found that the long-run trend of rising price levels can be attributed to differences in the rates of growth and productivity in the industrial and service sectors. Other causes of rising prices are differences in the prices and elasticities between the two sectors, a uniform growth in nominal wages in both sectors, and price and wage rigidities. The result of these problems is cost-push inflation. Post-Keynesian perspectives on the causes of inflation take a conflict theory approach, which is generally consistent with a structuralist framework. The conflict theory regards inflation as the outcome of struggles by economic groups over income shares (Rowthorn, 1977, Rosenberg and Weisskopf, 1981). The assumption here is that capitalists and workers each have target real incomes, which may or may not be consistent with each other. If total claims for real income by all groups are not greater than the actual real output produced, then price stability is possible. But if total claims exceed real output available, then inflation ensues. The main determinant of inflation is then the rate at which the money wage rises in excess of the growth of average labor productivity. Since in the manufacturing sector of the economy prices are cost determined as a mark-up over unit labour costs, if nominal wage increases exceed productivity growth, then workers are claiming a higher share of output and the price increases that result are the effort of firms to prevent that.

For both structuralists and post-Keynesians, an endogenous money supply is

assumed. Whereas monetarists believe that excess aggregate demand caused by excess supply of money causes inflation, structuralists hold that the inflation rate can increase regardless of aggregate demand, making stagflation possible (Taylor, 1993). Inflation also occurs because of cost-push factors. Since the increase in money supply follows a prior price increase, structuralists believe in the endogeneity of money.

The above broad overview can be briefly compared to what obtains in the Nigerian economy. In addition to excess money supply, key aspects of the economy such as supply bottlenecks, dependence on imported intermediate goods and the struggle for real income which makes rent-seeking activities so pervasive also affect the price level.

Some attempts have been made to study the character of inflation in Nigeria. Asogu (1991) undertook an empirical investigation based on ten different specifications that covered monetary, structural and open economy aspects of inflation. Variables used in the regressions include money supply and its lagged value, real GDP and its lagged value, aggregate domestic credit to the economy and its lagged value, government expenditure and its lagged value. Others are industrial production index, import price index and the official exchange rate. All variables were expressed in terms of their rate of change. In all the models estimated, the character of inflation seems to be well captured. Real output had the right signs in all the models, but was significant in only one case. Money prices and exchange rates were significant in all the equations where they featured. In summary, the results of the estimations suggested that real output, especially industrial output, net exports, current money supply, domestic food prices and exchange rate changes were the major determinants of inflation in Nigeria. The study therefore confirms the importance of the structural character of the economy, open economy and monetary aspects of inflationary trend in Nigeria.

In another study, Moser (1995) identifies the main determinants of inflation in Nigeria; presents both a long run model and a dynamic error correction model, and discusses the policy implications of the results[1]. All the coefficient estimates had their expected signs. The monetary effect was quite large, and significant at the one percent level, while real income and the exchange rate were also significant at that level. Rainfall, on the other hand, had no significance in the long run. In addition to the above estimates of the structural parameters in a long run relationship, Moser also estimated a dynamic version specified as an error correction model[2]. The model utilises information in the error term of the long-run model to approximate deviations from the equilibrium and represents the short-run response necessary to move the system back towards its equilibrium.

In another study of inflation in Nigeria, Fakiyesi (1996) argues that inflation is dependent on growth in broad money ($M2$), the rate of exchange of the naira vis a vis the dollar (E), the growth of real income (Y), the level of rainfall (R), and the

level of anticipated inflation which is based on the previous year's level of inflation (P_{t-1}). Based on a functional form that assumes that the lagged value of broad money and prices were the relevant series for consideration, the lagged value of prices and money were estimated.

The broad inference to be drawn from these studies of inflation is that the explanations of changes in price level can benefit from the inclusion of parallel market exchange rate dynamics. The fact that the official exchange rate is marginal to price determination has been well established in other studies[2]. Prices tend to fully adjust to the parallel market rate, while the official exchange rate just serves as a measure of rents. It is therefore necessary to incorporate (or control for) the parallel market exchange rate in a study of inflation in Nigeria. This study proposes to complement existing ones by using an approach that takes into consideration the salient features of production in the economy, while at the same time recognizing the role of monetary policies in inflationary outcome. The next section presents the model.

4. A MODEL OF PRODUCTION AND PRICE CHANGE

The model that follows describes production and price change in an open economy with an active parallel market for foreign exchange. The goal is to obtain a price level change equation directly from the model, solve and estimate it using data from Nigeria. The model of the parallel market for foreign currency presented is based in part on earlier works by Dornbusch et al (1986) and Pinto (1989). However it differs from their work in several important respects. In the first place, their models are based on the assumption that the demand for parallel market foreign currency is an asset motive demand. Domestic residents are assumed to demand for foreign currency as a means of portfolio diversification, especially at periods of high inflation when the domestic currency is loosing value. The model presented here on the other hand is based on the presence of a transaction motive, which fuels demand for foreign currency for the purpose of trade finance and purchase of consumer goods. Therefore, the Pinto model is modified to incorporate both official and unofficial importation of intermediate goods, arising from a transaction motive for demand of foreign currency. In addition, the model presented unlike the Pinto model makes the assumption that there is a cost to smuggling unofficial exports. The complete model follows.

Consider a small open economy with three classes of economic agents: the government sector, private sector firms and private individuals. The private sector produces exports, X, which are traded goods, and home goods N, which are non-traded, with the foreign price of exports P_X, taken as exogenously given. Home goods are produced using labor and imported inputs and sold at the price P_N. The

world price of traded goods is normalised to unity. Trade in exports and the imported component of home goods is carried out through both official and unofficial channels, requiring currency transactions in both official and unofficial (parallel) foreign exchange markets. Capital transactions are prohibited.

The government sector participates in the official foreign exchange market by supplying foreign currency to be traded at each auction session after meeting its own foreign exchange needs. This currency is partly accounted for by the revenue from sales of crude oil, the price of which is exogenously determined and accrues to the government in the first instance. The balance comes from aid, grants and non-oil export proceeds.

The private sector firms participate in both the official and unofficial markets for foreign exchange. In the official market, the rate of exchange is e, which is exogenously determined by the monetary authorities as part of some broad policy objectives. For official exports, as explained above, foreign currency earnings are subject to surrender in exchange for local currency, also at the rate e. Though participation in the unofficial market is illegal, it is carried out extensively. Commercial purchases from the market are mainly by firms whose transactions are not eligible for the official market, those whose transactions are eligible but who are unsuccessful, and those who are avoiding the large local currency requirement for participation in the official market. Private citizens also buy foreign currency for the purpose of acquiring consumer durable such as automobiles and electronic goods and for the purpose of tourism. Supply in the market comes from those who are redirecting the rents that accrue from privileged access to the official market, exporters avoiding the official market due to the overvalued exchange rate (which means they get less local currency), international workers' remittances and presumably some illegal activities. The rate of exchange in this market is b, which is freely determined by the conditions of demand and supply for that currency, with $b \geq e$.

I consider the implication of this regime for production and price level changes.

Real Output and Prices

Consider a competitive open economy that produces home goods, N through a Cobb-Douglas technology, using only imported inputs I and labour L. In the official foreign exchange market, available foreign currency is rationed through import licensing and transactions are at the official exchange rate of e units of naira to the dollar. The government's choice of sale of foreign exchange for imports is based on a rationing policy, which seeks to preserve external reserves at a target level. The rationed level of official imports is much lower than the demand at the official exchange rate. Therefore, a residual amount of imports exists as the difference between total import

demand and official imports $(I - Io)$. Exports are produced, using fixed coefficients technology, with the input-output coefficient normalised to unity so that $X = L$. All production of the export good is either sold through the official market, where the foreign exchange earnings are valued at e, or smuggled through the parallel market, where the currency floats freely at the parallel market exchange rate, b. With the binding constraints on official imports and a higher parallel exchange rate, the incentive to smuggle exports and to supply foreign currency to importers is hindered only by the costs of smuggling.

Private sector firms purchasing intermediate goods are assumed to maximize the following profit function:

$$\Pi = P_N I^{1-\alpha} L_n^{\alpha} + bP_X L_u + eP_X L_o - bC_1(L_u) - eI_o - b(1+c_2)(I - I_o) - w(L_n + L_o + L_u) \quad (1)$$

$\text{Max}_{\{I, Ln, Lo, Lu\}} \Pi$

Subject to:

$N \leq I^{1-\alpha} L_n^{\alpha}$	(Production Function for home goods, with	(1a)
$\underline{L} > L_n + L_o + L_u$	(Labour endowment greater than or equal to labour utilised)	(1b)
$I, L_i > 0$	$i = n, o, u$ (Positive inputs)	(1c)
$X_i \leq L_i$	(Fixed coefficients normalised to unity)	(1d)
$I_o < R$	(Official imports less than or equal to official reserves)	(1e)
$I = I_o + I_u$	(Total imports equals official and unofficial imports)	(1f)

Where

α	=	coefficient of labour
b	=	the black market rate of exchange,
e	=	the official rate of exchange
PN	=	Price of Non-Traded goods
P_I	=	World Price of Imports (normalized to unity)
P_X	=	World Price of Export
I	=	Total Imports
I_o	=	Imports through the official channel (exogenously given)
I_u	=	Imports through unofficial channel
X_u	=	Unofficial exports
$C_1(X_u)$	=	Cost of smuggling unofficial exports (function)
c_2	=	Cost of smuggling imported inputs (assumed constant)
L_n	=	Labour employed in the production of home goods
L_o	=	Labour employed in the production of official exports
L_u	=	Labour employed in the production of unofficial exports
R	=	Official reserves

The first order conditions for an interior solution are:

$$\frac{\partial \Pi}{\partial L_n} = 0 \Rightarrow \alpha P_N I^{1-\alpha} L_n^{\alpha-1} = w \qquad (2)$$

Using (1a), (2) implies that:

$$\alpha P_N N L_n^{-1} = w \quad \text{or} \quad w = \alpha P_N N / L_n \quad \text{or} \quad wL_n = \alpha P_N N \qquad (3)$$

Therefore, wL_n, the marginal cost is equal to $\alpha P_N N$, the marginal returns.

$$\frac{\partial \Pi}{\partial L_u} = 0 \Rightarrow bP_X - bC_1^{'}(L_u) = w \quad \text{or} \quad w = b(P_X - C_1^{'}) \qquad (4)$$

Recall the assumption that exports are produced using only labour; therefore the marginal cost of producing unofficial exports, which is the wage rate, w, must be equal to the marginal net revenue, which is the value of unofficial exports less the cost of smuggling $b(P_X - C_1^{'})$.

$$\frac{\partial \Pi}{\partial L_o} = 0 \Rightarrow eP_X = w \qquad (5)$$

For official exports, the marginal cost is the same as that of unofficial exports, w, since the goods are perfect substitutes. However, the marginal returns are different based on the fact that one is valued at the official exchange rate while the other is valued at the black market exchange rate. In addition, there is a cost of smuggling C_1 involved in X_u.

From the above, since $w = \alpha P_N N / L_n = eP_X = w = b(P_X - C_1^{'})$ it is clear that labour is allocated among the three activities so as to equate the marginal returns and marginal costs in all three. Defining this in terms of $P_N N$ yields:

$$P_N N = \frac{wL_n}{\alpha} = \frac{eP_X L_n}{\alpha} = \frac{L_n b(P_X - C_1^{'})}{\alpha} \qquad (6)$$

For total imports, the change in Π with respect to I is:

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$$\frac{\partial \Pi}{\partial I} = (1-\alpha)P_N I^{-\alpha} L_n^{\alpha} - b(1+c_2) = 0 \qquad (7)$$

(7)

$$\Rightarrow (1-\alpha)P_N N I^{-1} = b(1+c_2) \qquad (8)$$

Combining with $\frac{\partial \Pi}{\partial L_n} = 0$ The equality of marginal returns and marginal cost yields:

$$P_N N = \frac{w}{\alpha} L_n = \frac{eP_X L_n}{\alpha} = \frac{bI(1+c_2)}{1-\alpha} \tag{9}$$

The above profit maximisation function of the private sector says that from total labour endowment $\overline{L}$, L_n is devoted to the production of home goods, using imported inputs. L_o is devoted to the production of exports that go through the official channel, while L_u is the labour devoted to the exports that pass through the unofficial channel.

The first order conditions (FOC) for the production of home goods have the usual implication that $\alpha P_N N$, the marginal, return is equal to the wage multiplied by labour used, the marginal cost, a typical Cobb-Douglas outcome. For production of X_u, exports smuggled through unofficial channels, the FOC implies that the marginal benefit of smuggling bP_X, is equated with the marginal cost which is the wage rate and the export smuggling cost (e.g. bribery, rent seeking, moral hazard). For a given w, b and P_X, the firms produce unofficial exports up to the point where the rising marginal cost of smuggling eliminates the net gain, i.e. where $bP_X - w - bC_1' = 0$. If such costs were zero, exporters would not export through the official channel since bP_X would be more than eP_X at the same wage rate. On the import side, the initial assumption of the model is that official imports are sold in the domestic market where prices are fully adjusted to the parallel market rate. This gives official importers an arbitrage opportunity that amounts to $b > e$. Since (7) assumes that official and unofficial imports are perfect substitutes. the black market rate has to be inversely proportional to the cost of smuggling imports, and will therefore determine the choice of I_u in a firm's production function. Indeed the parallel market premium is an important link between imports and exports. The capacity to import through the unofficial market is constrained only by the availability of parallel market dollars (from unofficial exports). In the presence of a binding short to medium term constraint on available foreign exchange, policies that discourage export production ultimately reduce the supply of foreign currency for import of intermediate goods.

Price Determination

In order to solve for price, recall that by equation (1a), $N = I^{1-\alpha} L_n^{\alpha}$, assuming the constraint is binding. Then using equation (9) and replacing N in equation with (1a) yields:

$$P_N = \frac{bI(1+c_2)}{(1-\alpha)I^{1-\alpha}L_n^{\alpha}} = \frac{b(1+c_2)}{(1-\alpha)}\left(\frac{I}{L_n}\right)^{\alpha} \tag{10}$$

Defining the premium over the official exchange rate, b e as ϕ, where

$b = e\phi = e(b/e)$ then, by equation (9), $\alpha\phi(1+c_2) = \frac{P_N L_n(1-\alpha)}{I}$ The above can be rewritten as:

$$P_N = \frac{b(1+c_2)}{(1-\alpha)} \cdot \left(\frac{(1-\alpha)P_A}{\alpha\phi(1+c_2)} \right)^{\alpha} \tag{11}$$

Cross multiplying and collecting terms and using, gives:

$$P_N = \frac{(1+c_2)^{1-\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \; b\phi^{-\alpha} P_N^{\alpha} \tag{12}$$

This gives the solution for the price of non-traded goods as:

$$P_N = \left(\frac{(1+c_2)^{1-\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \right) \cdot e\phi^{1-\alpha} P_A^{\alpha} \tag{13}$$

It follows that the price of non-traded goods is a function of the official real exchange rate, the parallel market premium, the cost of smuggling imported inputs and the share of imports in total goods available in the domestic economy. Since inflation is the proportionate change in domestic prices, equation (13) can be restated in terms of the inflation rate to capture the link between the parallel market rate and inflation:

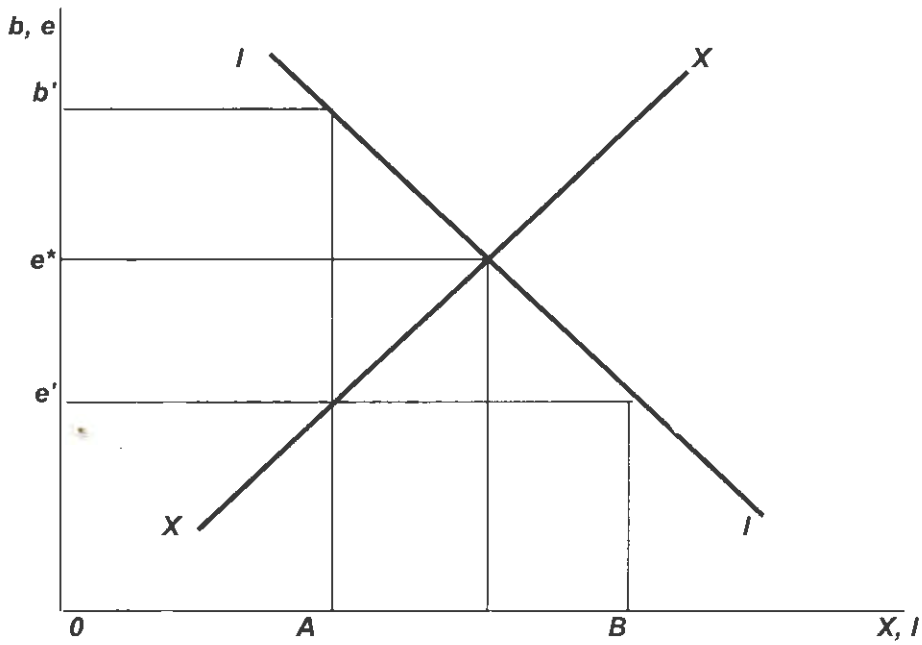
$$\pi \equiv \hat{P}_N = \hat{e} + (1-\alpha)\hat{\phi} + \alpha\hat{P}_N \tag{14}$$

assuming that α and c_2 are constants. The above equation implies that the inflation rate is equal to the sum of the rate of increase in the official exchange rate plus the weighted average of the rates of increase in the premium and the price of exports, with the weights dependent upon the relative shares of imports and labour in home goods production.

The above formulation of the growth rate of domestic prices has important implications for the model presented here. All the three variables: $\hat{e}$, $\hat{\phi}$ and $\hat{P}_N$ enter into the inflation equation positively. The effect arises from the fact that when government exchanges foreign currency for the naira at the Central Bank, e fixes the domestic component of the money stock. In addition, changes in the premium affect the rate of inflation in the same direction. The parallel market exchange rate will be one of the determinants of the domestic price level, regardless of the presence of smuggling function, as long as official foreign exchange is rationed. Consider a

situation where the cost of smuggling ($1+c_2$) is so high as to make it impracticable, but where imports are still rationed as part of some reserve target objective. There will still be an excess demand for imports, and official imports will be sold at a premium.

Figure 3: Parallel Market Exchange Rate in the Absence of Unofficial Transactions.



In Figure 3, import demand is represented by the downward sloping schedule *II*, while official exports are represented by the upward sloping schedule *XX*. At the official exchange rate of *e'*, the demand for imports is *OB* and if it was fully satisfied, the amount *AB* of reserves would be sold. But due to the rationing of official foreign exchange, official imports are restricted to *OA*. Imports are therefore equated with available export proceeds, and official reserves kept at their target level, so that no sale of reserves is necessary. But because there is still excess demand for imports, the market does not clear, and imports are sold at a premium price of *b'*. So in the absence of parallel market transactions, domestic prices are still fully adjusted to a "shadow" price which reflects excess demand for imports. However, if the exchange rate were allowed to float, it would settle at the rate of *e** which would clear the market.

In the next section, an empirical estimation of equation (14) is undertaken.

5. EMPIRICAL ESTIMATION: THE MODEL

The purpose of this estimation is to find out whether the model of price level change implied by equation (14) holds. Recall that equation (14), the inflation rate for non-traded goods, was derived as:

$$\pi = \hat{P}_N = \hat{e} + (1-\alpha)\hat{\phi} + \alpha\hat{P}_X$$

As explained earlier, this equation implies that inflation is equal to the sum of the growth rate of the official exchange rate and the weighted average of the parallel market premium and the price of exports, with the weight depending upon the relative shares of imports and labour in the production of non-traded goods. This specification captures the salient character of the economy, which impacts on changes in the price level. Based on the above formulation, prices could change as a result of changes in the official exchange rate, the parallel market premiun , imported inflation and changes in labor costs. Differencing the variables and log-linearising so that coefficient effects are expressed in terms of elasticity, and using foreign prices as the price of exports give:

$$\pi = \Delta \log e_t + (1-\alpha)\Delta \log(b_t / e_t) + \alpha \Delta \log P_t^f \qquad (15)$$

The official exchange rate, the premium and foreign prices all have positive effects on the inflation rate. The effect arising from the official exchange rate has both a monetary and a structural component. In the first place the rate at which foreign currency is exchanged for naira impacts on the stock of money and therefore prices, though the impact is negligible. Second, though prices are fully adjusted to the parallel market exchange rate, import tariff and excise duties are set based on the official exchange rate. Therefore, changes in the rate affect the real cost of imports.

The inflation rate is also positively related to the parallel market exchange rate. As argued in the theoretical model, due to official foreign currency rationing, the excess demand is satisfied at a premium price, b/e. Since imported goods are valued at this premium price, regardless of the source of the foreign currency, changes in domestic prices mirror changes in the parallel market exchange rate. Foreign prices also have a positive effect on the inflation rate. This is as a result of the dependence on intermediate inputs, which brings about imported inflation.

In order to specify a functional form for the equation, it is necessary to build in the role of expectations. A model based on rational expectations is ruled out because the assumptions are too strong to hold in the Nigerian economy. Adaptive expectations, based on the assumption that expectations are based on previous periods' values which are revised accordingly, is preferred. Since it is based on past values, the lagged value of the price level is used as a proxy to capture the expectations of

economic agents, P^e:

$$\Delta \log P_t = c_0 + c_1 \Delta \log e_t + c_2 \Delta \log b_t + c_3 \Delta \log P_t^f + c_4 \Delta \log P^e \qquad (16)$$

The first coefficient c_0 is the constant, which is expected to be zero under the assumption that the above specification fully explains inflation. The second coefficient is the total elasticity of inflation with respect to official devaluation, and by comparing (15) with (16), we can see that $c_1 = 1 - (1 - \alpha) = \alpha > 0$. Thus, official devaluation should have a positive effect on inflation equal to the share of labour in the production function for non-traded goods. This third coefficient is $c_2 = 1 - \alpha > 0$. This is the elasticity of domestic inflation with respect to the parallel exchange rate which should be positive and should equal the share of imported inputs in the production function for non-traded goods.[4] The third coefficient on foreign price inflation is $c_3 = \alpha > 0$, which should thus be the same as the coefficient c_1 on the official exchange rate under the assumptions of the model. Finally, c_4 is the coefficient on the lagged value of the changes in the price level proxies for the role of expectations. It is expected to be positive, as expectations are expected to move in the same direction as changes in the actual variable. Thus, testing the restrictions that $c_0 = 0$, $c_1 > 0$, $c_2 > 0$, $c_3 > 0$, $c_4 > 0$, $c_1 + c_2 = 1$ and $c_1 = c_3$ will provide evidence for the validity of the inflation model derived here.

The specification of inflation derived in equation (16), though based on alternative micro-foundations of production, is similar to more traditional specifications in some respects. Indeed, apart from the parallel market exchange rate variable, all other variables are common in estimations of the price level. With the exception of the parallel market exchange rate, all the variables in the regressions have entered into equations specified by Aghevli and Khan (1976), Asogu, Moser and Fakiyesi, in one form or the other. Results are not expected to depart radically from received thinking, rather it is expected that explanations of inflation will be enhanced.

Figure 4: Alternative Specifications for the Inflation Equation

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Model 1: *The derived model*

$$\Delta \log P_t = \alpha_0 + \alpha_1 \Delta \log e_t + \alpha_2 \Delta \log b_t + \alpha_3 \Delta \log P_{Mt} + \alpha_4 \Delta \log P_{t-1}$$

Model 2: *The derived model with monetary variables*

$$\Delta \log P_t = \alpha_0 + \alpha_1 \Delta \log e_t + \alpha_2 \Delta \log b_t + \alpha_3 \Delta \log P_{Mt} + \alpha_4 \Delta \log P_{t-1} + \alpha_5 \Delta \log M_t + \alpha_6 \Delta \log Y_t$$

The derived estimable form of the equation provides us with a general framework on which to build an alternative specification of the model. The alternative model adds money and output variables in the equation. The monetarist assumption is that the rate of change of domestic prices is set in the money market where an excess supply of money means that there is an excess demand for both traded and non-traded goods. The two models are presented in Figure 4.

For the purpose of estimation and consistency, all data are annual data from the tapes of the *International Monetary Fund's International Financial Statistics (IFS)* and *Direction of Trade Statistics* (DOT), except the parallel market exchange rate, which is from *Pick's Currency Yearbook.* The short span of available data limits the estimation to the period from 1971 to 1995. This coincides with the first oil boom and the end of the first phase of the structural adjustment program in Nigeria, and it was also the period of widest divergence in the parallel and official exchange rates.

Estimation is carried out using a two-stage least squares (2SLS), single-equation instrumental variables method. The choice of an instrumental variable method is because of the possibility that output is endogenous, since it may be jointly determined with prices. The choice of instruments was based on the convention of using all exogenous and all lagged endogenous variables, though recognizing the endogeneity of real output. In addition, the variable industrial production index was added to the list of instruments. Figure 5 provides a definition and classification of the variables and instruments used.

The results of the estimation are as shown in Table 6. Below the coefficients are the t-statistics in parenthesis. The estimations are subsequently subjected to a battery of tests to confirm model adequacy, with tests of auto- and serial correlation, heteroskedasticity and overall goodness of fit.

Auto- and Serial Correlation: An important assumption of the classical linear model is that there is no autocorrelation or serial correlation among the disturbances. In the presence of autocorrelation, the variances and standard errors of the estimates are underestimated and the computed *t* and *F* statistics give misleading conclusions about the true statistical significance of the estimated coefficients. To test for autocorrelation, the residuals are subjected to visual inspection in a correlogram. In addition, the Ljung-Box Q-statistic is obtained by testing the residuals of the regression for serial autocorrelation. The Q-statistics confirm that all of the autocorrelations are zero; that is, the series is white noise. In addition, the Breusch-Geoffrey test, a serial correlation LM test which is more powerful, also confirms the absence of autocorrelation.

Figure 5: Definition of Variables and Sources

Variable	Description	Source
Δ	First Difference Operator	
log	Natural logarithm	
Endogenous		
P_t	The Domestic Price Level	Line 64, IFS
Y_t	Gross Domestic Product	Line 99b, IFS
Predetermined (Exogenous and all lagged endogenous)		
e	Official exchange rate	Line ae, IFS
$\log b_t$	Parallel market exchange rate	Pick's Currency Yearbook
P^e	Expected rate of inflation, formed at t based on information available at t-1	Lagged value of Line 64, IFS
P^*	World Price of Traded Goods	Direction of Trade Statistics
IPI	Industrial Production Index	Line 66, IFS

Heteroskedasticity and overall model adequacy: The assumption that the variances of the disturbances are constant is another classical linear regression model assumption that might be violated, resulting in heteroskedasticity. This biases the estimates of the variance, and as in autocorrelation, results in misleading estimates of the true significance of coefficients. In order to minimise the bias in estimates of standard errors, the equations were first estimated in a *White's Heteroskedasticity-Consistent Standard Errors & Covariance*[6] framework. As a result, standard errors were lower, and test statistics more significant than when this restriction was not imposed.

Subsequent examinations of the residuals do not exhibit any systematic pattern. In addition, the ARCH[7] LM test and a White's test were carried out. In addition to testing for the presence of heteroskedasticity, both tests serve as general tests of model adequacy, since the null hypotheses underlying the tests assume that the errors are both homoskedastic and independent of the regressors and that the linear specification of the model is correct. Again, the result confirms the adequacy of the model.

Figure 6: Results of Estimation of the Price Inflation Equation Models

		Model 1	Model 2
Variable	Parameter	Coefficients	Coefficients
Constant	c_0	-0.02	-0.04
		(-.19)	(-.85)
Official Exchange rate	c_1	0.01	0.03
		(0.94)	(0.97)
Parallel Exchange Rate	c_2	0.41	0.33
		(3.26)*	(3.16)*
Foreign Prices	c_3	0.79	0.02
		(0.65)	(0.35)
Price Level (lagged)	c_4	0.56	0.63
		(3.37)*	(3.8)*
Stock of Money	c_5		0.37
			(2.5)*
Income Level	c_6		-1.00
			(-2.05)*
R^2		0.52	0.62
SSE		0.25	0.21
SE		0.12	0.11
Q(1)		0	0.00

** Denotes significance at the 1% level.*

Note: All variables are measured in log differences. t-statistics are in parenthesis.

6. INTERPRETATION OF RESULTS

In both models, the coefficient of the constant term is negative and not significantly different from zero. So the restriction that $c_0 = 0$ is confirmed. The official exchange rate is positive in both models, confirming the restriction that $c_1 > 0$. However, it is not significant at conventional levels. A positive effect equal to the share of labour in the production function for non-traded goods is expected. However, since these coefficient values are not significantly different from zero, it can be reasonably concluded that the inflationary effect of the official exchange rate are negligible, which confirms the initial assumption that prices are fully adjusted to the parallel exchange rate.

The parallel market exchange rate is significant at the one percent level in the two models estimated. The restriction that $c_2 > 0$ is confirmed, and the hypothesis that domestic prices are fully adjusted to the parallel market exchange rate is also confirmed. The large coefficient confirms that the share of imported inputs in the

production function for non-traded goods is large.

The role of expectations is one of the key causes of inflation in a structuralist framework. In Section 1, the expectation of devaluation was identified as one of the main causes of the inflationary episode of the mid-1980's. The expectations of changes in the price level resulted in a cost-push effect on prices, as prices were marked up, based on previous period's information. In the two models presented, the coefficient on expectations, c_1 is large and significant at the 1% level.

The change in the stock of money variable, which represents the monetarist explanation of inflation, is significant at the one percent level in model 2. Though it is not as strong as the parallel market exchange rate coefficient, it does confirm that the monetarist model is not completely irrelevant. Adding the money stock reduces but does not eliminate the significant positive effect of the parallel market exchange rate.

The output variable is significantly negative, confirming the negative effect of inflation on real output. The coefficient of foreign prices is also as expected, positive in the two models. However, since it is not significantly different from zero, it can be assumed that the effect of imported inflation on the domestic price level is not significant.

These results give broad confirmation to the hypothesis that price determination and the rate of inflation do not follow a strictly monetarist model. The positive and significant coefficient of $\Delta Logb$ is robust in the two models, and the official exchange rate and export prices are not significantly positive. The model of inflation postulated in section 3 is supported by the fact that adding the monetary variables does not eliminate the positive coefficient on $\Delta Logb$, even though money supply also has a positive effect.

The restrictions on the coefficients in (16) discussed earlier are all confirmed, however. The restriction that $c_0 = 0$ is accepted, as it is found to be insignificantly different from zero. Also c_1 and c_3 are positive, but not significantly so, which is expected if their role in price level change is marginal. In addition, using the Wald Test for joint coefficient restrictions, we cannot reject the null hypothesis that $c_1 + c_3 = 1$. Neither can we reject the null hypothesis of $c_1 = c_3$ based on the Wald coefficient test.

Figure 7: Actual Fitted and Residuals of the Inflation Rate Estimation

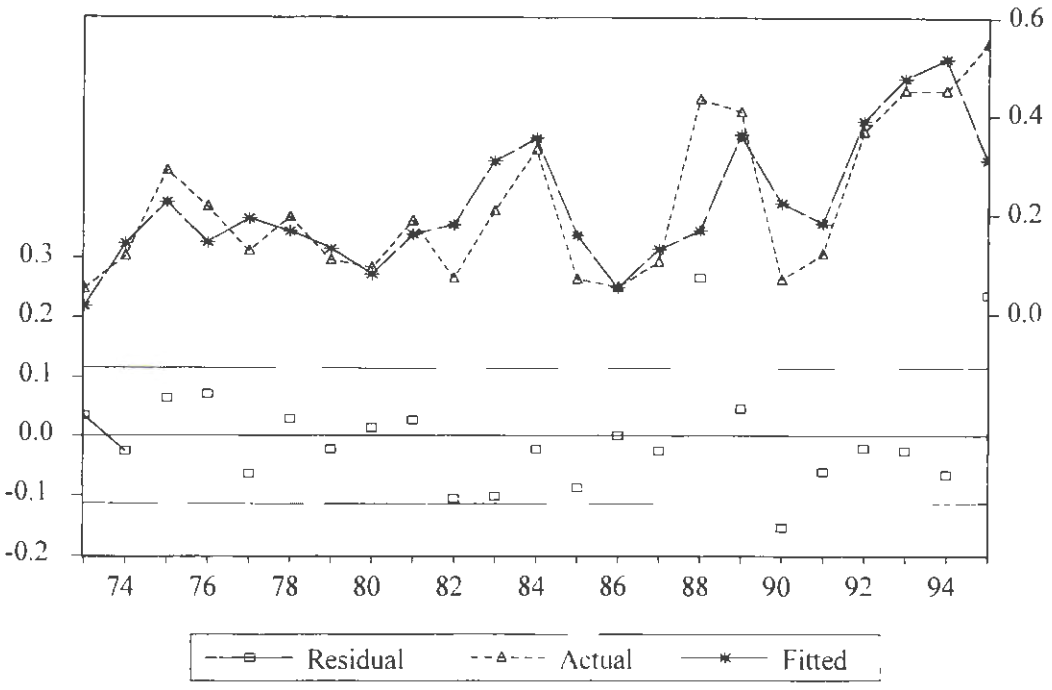

Figure 7 is a plot of the actual and forecast values of the inflation rate, based on the derived model. Fitted against historical data, the forecast was close to the actual in most of the years. Indeed, peaks and throughs almost always move together, sometimes closely, and sometimes with some margin. However, in four instances, (1977, 1982, 1991 and 1995), the movement predicted by the model was in the opposite direction from the actual. In some of these periods, isolated events not captured by the model were important determinants of price level change. In conclusion, there is strong evidence that the parallel market exchange rate is a major determinant of the price level. The structuralist model of inflation postulated is confirmed by some of the results. However in addition to this, the importance of the stock of money is clear. Furthermore, the role of expectations is important and relatively stable in both models.

The new insight into the relative importance of the paralled market exchange rate in the inflationary process in Nigeria makes it imperative for official policy to accommodate developments in that market in economic programmes. If this is not done, the achievement of macro-economic stability on a sustainable basis may not be easily realised.

CONCLUSION

In the foregoing analysis, a model of inflation was specified and the derived equation estimated, using annual data from Nigeria. Compared to previous works of the issue, the result of the estimation imply that in addition to conventional determinants of price level change, the cost-push effect of the parallel market exchange rate on production is significant for price level change in Nigeria. This has important implications for prices, productivity and export competitiveness.

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ENDNOTES

[1] The following result was obtained from the long run relationship:

$P_t = 3.028 + 0.0689M_t - 0.561y_t + 0.245e_t + 0.191Z_t + u_t$

(1.967) (30.132) (9.241) (7.644) (1.153)

Sample: 1960-1993 R^2=0.9996 SE=.095 CRDW=1.24

where P_t is the consumer price index, M_t is broad money, y_t is gross domestic output, et is the *N/US$* exchange rate index, Z_t is a measure of agro-climatic conditions (rainfall) meant to capture the relationship between agricultural production and rainfall. The structural model derived by Moser includes foreign prices and the expected nominal foreign interest rate. However, they were dropped from the long run equation because the results were not significant.

[2] $\Delta P_t = 0.019 + 0.356\Delta M_t \quad 0.294\ \Delta y_t - 0.191\ \Delta e_{t-1} \quad -0.230\ \Delta Z_{t-2} + 0.333\ P_{t-1}$

$0.508EC_{t-1}$ (0.025) (0.082) (0.102) (0.064) (0.107)

(0.118) (0.153)

$R^2 = 0.691$ SE = 0.075 DW = 2.342

[3] See Pinto (1991), Kharas and Pinto (1989) and Agenor (1993)

[4] This also implies the restriction $c^1 + c^2 = 1$.

[5] The Ljung-Box Q-Statistic is used in place of the DW statistic, which tends to be biased when lagged value of the dependent variable is a regressor in the equation.

[6] Halbert White, "A Heteroskedasticity- Consistent Covariance Estimator and a Direct Test for Heteroskedasticity", Econometrica, vol. 48, pp. 817-838, 1980.

[7] (See R. Engle, "Autoregressive Conditional Heteroskedasticity, with Estimates of the Variance of United Kingdom Inflations", Econometrica, 50, 987-1008.)