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DEVELOPING INFLATION - AND - DEPRECIATION-ADJUSTED MODELS FOR COST AND PRICE UPDATE OF IN-COUNTRY MANUFACTURED PRODUCTS.

By
George C. Ogueji for

ABSTRACT

The local currency, the Naira has over the years undergone massive and steady depreciation. The national economy has experienced high inflation which persisted over several years. These two phenomena which have simultaneous occurrence have a great impact on the massive changes in the price levels. Therefore this paper exploits this dual-headed problem in addressing the development of an algebraic model for cost and price update aimed at ensuring a fairly accurate and realistic measure of the changes in price levels.

The main features of this model are:

- (1) The conceptual framework advocated by Economists that the value of money consists of two aspects namely the internal and the external values.*
 - (2) The rational basis provided by the depreciation of the Naira in the Foreign Exchange Market, FEM and the inflation in the domestic economy. This re-inforces the former feature as the depreciation in the FEM indicates the fall in the external value of the Naira, while the inflation in the domestic economy shows the decline in the internal value of the Naira. In developing the algebraic model, the concepts of cost, price and markup are explained; the depreciation in the exchange rates and the inflation in the domestic economy are reviewed; the exchange rate index is analysed; the price indices are emphasized; the algebraic model is derived and illustrated; and related issues are discussed. All of these are summarised and presented as this paper will show.*
- Given the emphasis of the algebraic model on the external and internal values of money, the test results are measures of the time value of the Naira.*

KEYWORDS: exchange-rate depreciation, domestic inflation, 'depreflation,' exchange-rate-index analysis, price-index emphasis, price-model derivation, model testing.

INTRODUCTION

Since the inception of the Structural Adjustment Programme, SAP in 1986, the massive depreciation of the Naira in the external sector of the national economy on the one hand, and the high inflation in the domestic economy on the other hand appear to be an over source of worry and top priority concern to virtually every interest group in Nigeria; the entrepreneurs, the product innovators, the manufacturers, the bankers, the government, the consumers, the workers, the professionals, the academics, and the micro-economic watchdogs. This is because the Naira foreign exchange rate and the domestic inflation rate represent critical measures of economic welfare for every Nigerian.

Therefore the costs and prices of products and services are adversely affected by the simultaneous depreciation and inflation phenomena in the national economy. If an acronym be coined for this simultaneous phenomena it may be called **DEPREFLATION** (ie depreciation plus inflation).

However, this work is stimulated by two major factors, namely.

- (1) The insight gained from the unstable costs/prices of engineering prototypes developed by the author for the purpose of engineering and technology pedagogy in Universities and Polytechnics in Nigeria. One of the engineering prototypes developed is the Process-Heat-Transfer Apparatus presented at the third Africa-USA international Conference on Manufacturing Technology held in Accra Ghana. [Oguejiofor et al, 179 - 192].
- (2) The experience borne out of the observation of some national economic indicators like the price indices, the inflation rate and the foreign exchange rate, all of which appear to show massive and persistent decline as the years progressed.
- (3) The intellectual framework put forward by Economists that the value of money is two dimensional - the internal and external values.

Therefore, to address precisely the topic of this paper, from the standpoint of cost engineering, the paper is broken up into the following objects. First, to briefly explain some basic concepts of cost and price. Second, to examine the depreciation in both the official and unofficial exchange rates of the Naira under the on going SAP, 1986 - 1995, with a view to developing a cost/price update model. Third, to examine the domestic price indices from the inception of SAP in 1986 to 1995, with regard to developing a cost/price-level adjustment model. Fourth, to review the relevant accounting framework for price-level changes. Fifth, to derive and illustrate the mathematical models that will incorporate the simultaneous inflation and depreciation adjustments. Finally, to make recommendations for application.

2. SOME BASIC CONCEPTS OF COST AND PRICE

2.1 CONCEPT OF COST

Cost means different things to different people. To a buyer of a product, the cost is money sacrifice such as cash or liability incurred for a commodity or service. To the producer or seller of a commodity, cost means the product's cost plus a profit margin. The product's cost is the cost of services utilised in forming the product. Example, direct material cost, DMC plus direct labour cost, DLC and plus workshop overhead cost, WOC represent product cost, C_p . The mathematical expression for product cost or prototype cost may be:

$$C_p = \Sigma DMC + \Sigma DLC + \Sigma WOC \quad \dots(1)$$

A period cost is a cost that is largely identified with time interval and not with goods or services. Commercial costs are period costs which are made up of distribution, marketing, administrative and financial charges. The addition of commercial costs, CMC to product cost, C_p gives total cost of product, C_t ;

$$C_t = \Sigma DMC + \Sigma DLC + \Sigma CMC \quad \dots(2)$$

2.2 CONCEPT OF PRICE

Although price like cost has shades of meanings, for this work however, price is cost plus a markup on cost. A price is thus a factor that consists of cost and profit components. The components of a product price are direct material cost, direct labour cost, workshop overhead cost, commercial costs, and markup on cost, M_p . The product price, P_t may be mathematically expressed in the following from:

$$P_t = \Sigma DMC + \Sigma DLC + \Sigma CMC + M_p \quad \dots(3)$$

2.3 CONCEPT OF MARKUP

A markup is a profit margin often calculated as a percentage of price instead of cost. It is a simple matter to convert from one to the other by use of the following expressions [Pappas, Brigham and Hirschey, 1983:406]:

$$\text{Markup on price} = \frac{\text{Markup on cost}}{1 + \text{Markup on cost}} \quad \dots(4)$$

$$\text{Markup on cost} = \frac{\text{Markup on price}}{1 - \text{Markup on price}} \quad \dots(5)$$

3. DEPRECIATION IN THE EXCHANGE RATES

Under the Structural Adjustment Programme, SAP, a market-driven exchange rate policy was put in place in 1985 to check the overvaluation of the foreign exchange rate and the associated government subsidy.

The objectives were to liberalise the foreign exchange market so as to achieve a realistic naira exchange rate that would allocate resources more efficiently, and would specifically encourage non-oil export and capital inflow. The institutional arrangement for achieving those objectives came to be known as the Foreign Exchange Market, FEM [Oliadebe, 1996:33]

Table 1 shows the official exchange rate of the naira, while table 2 shows the unofficial exchange rate called the parallel market rate. The introduction of the liberalised exchange rate in 1986 resulted in the persistent depreciation of the Naira as the years progressed (tables 1 and 2). Example the average official exchange rate declined from \$1.0 = N0.8924 in 1985 to \$1.0 = N22.0654 in 1993 (Table 1). With the pegging of official exchange rate at \$1.0 = N21.8861 in 1994, the average official exchange rates for 1994 and 1995 recorded \$1.0 = N21.8861 (Table 1). Also, the exchange-rate index and the Naira purchasing power as shown in table 1 declined steadily from 1985 to 1993, after which the 1994 and 1995 values remained constant - a consequence of the pegging of the official exchange rate with effect from 1994 fiscal year. The rate of depreciation recorded massive devaluation of the Naira in 1987 with 182.95 percent depreciation and in 1992 with 74.57 percent depreciation (Table 1). The massive depreciation experienced in 1987 was caused by the government's abolition of dual exchange rates. Similarly, the staggering depreciation recorded in 1992 was a consequence of government's bid to eliminate the parallel market. As a result the exchange rate rose from N9,9095 to N17,2985 to \$1.0.

On the other hand, the parameters analyzed in table 2 such as the parallel market rate, the exchange rate index, and the Naira purchasing power showed similar falling trends as their counterparts in table 1. However, comparing the magnitudes of the values of the parameters in both tables 1 and 2 showed that the values in table 2 were higher - an indication that the official Naira exchange rate remained overvalued.

The parallel market rate is more accessible to users of foreign exchange than the official exchange rate and so the parallel market rate is a better representative of the activities in the national economy. Therefore data shown in table 2 and particularly the exchange-rate index, ERI is a preferable variable for application in the cost/price update model envisaged.

TABLE 1: Analysis of the Official Rate of the Naira under the ongoing Structural Adjustment Programme (SAP) 1986-1995.

YEAR	Average Official Exchange Rate (N/\$)	Exchange Rate Index, ERI	Purchasing Power of Naira	Annual Rate of Depreciation (%)
1980	0.5469	n.a	n.a	n.a
1981	0.6048	n.a	n.a	n.a
1982	0.6731	n.a	n.a	n.a
1983	0.7235	n.a	n.a	n.a
1984	0.7642	n.a	n.a	n.a
1985	0.8924	100.0	1.0000	-
1986	1.2713	142.5	0.7018	42.46
1987	3.5971	403.2	0.2480	182.95
1988	4.5065	505.1	0.1980	25.28
1989	7.3855	827.8	0.1208	63.89
1990	7.9422	890.2	0.1123	7.54
1991	9.9095	1110.7	0.0900	24.77
1992	17.2985	1938.9	0.0516	74.57
1993	22.0654	2473.2	0.0404	27.56
1994	21.8861	2453.1	0.0408	-0.81
1995	21.8861	2453.1	0.0408	0.0

Source: Analyzed from the Central Bank of Nigeria (CBN) Data

TABLE 2: Analysis of the Parallel Market Rate of the Naira under the ongoing SAP 1986 -1995

YEAR	Average Parallel Market Rate (N/\$)	Exchange Rate Index, ERI	Naira Purchasing Power	Annual Rate of Depreciation (%)
1980	0.9009	n.a	n.a	n.a
1981	0.9259	n.a	n.a	n.a
1982	1.1364	n.a	n.a	n.a
1983	1.8182	n.a	n.a	n.a
1984	3.2500	n.a	n.a	n.a
1985	3.7900	100.0	1.0000	-
1986	4.1700	110.0	0.9091	10.03
1987	5.5500	146.4	0.6831	33.09
1988	6.0500	159.6	0.6266	9.01
1989	10.5300	277.8	0.3600	74.05
1990	9.6067	253.4	0.3946	-8.77
1991	13.4254	354.1	0.2824	39.75
1992	20.3396	536.5	0.1864	51.50
1993	36.1527	953.6	0.1049	77.75
1994	60.7608	1602.7	0.0624	68.07
1995	83.6756	2207.1	0.0453	37.71

Source: (i) Average Parallel Market Rate (N/\$) 1980 - 1987, First Bank of Nigeria, FBN.
(ii) Average Parallel Market Rate (N/\$), 1988 - 1995, Central Bank of Nigeria, CBN.

(iii) Other parameters analyzed from CBN and FBN Data.

4. INFLATION IN THE DOMESTIC ECONOMY

Table 3 shows the comparative analysis of domestic price indices 1986 - 1995 for:

- (a) all items urban consumer price index, UCPI
- (b) all items rural consumer price index, RCPI
- (c) all items retail price index, RPI
- (d) all items composite consumer price index, CPI

The figures for the UCPI, RCPI, RPI and CPI indicated persistent rising trends which were demonstrative of steady inflationary trends and the associated loss in the Naira purchasing power in the domestic economy. Example, data from table 3 showed that the average all-items composite Consumer Price Index, CPI in 1995 stood at 2040.4 (1985 = 100). This implied an inflation rate of 72.8 percent $(\frac{2040.4 - 1180.7}{1180.7} \times 100\%)$ compared

with 57 percent in 1994.

The increase in the prices of petroleum products by the government in 1994 was largely responsible for high inflation rate recorded in 1994 and 1995 (table 3). Thus the domestic price index is a parameter to be used in the cost/price adjustment model envisaged.

Table 3: Comparative Analysis of Domestic Price Indices under the ongoing SAP 1986 - 1995

Year	Urban Consumer Price Index, UCPI (All items)	Rural Consumer Price Index, RCPI (All items)	Retails Price Indices of selected consumer items in Lagos Area, RPI (All items)	Composite Consumer Price Index, CPI (All items)	Annual Rate of Inflation (%)
1986	100.00	100.0	100.0	100.0	0.0
1987	119.1	104.7	113.8	105.4	5.4
1988	117.8	115.9	122.2	116.1	10.5
1989	176.5	182.2	164.0	181.2	38.3
1990	270.2	273.3	258.0	272.7	40.9
1991	291.9	293.4	284.4	293.2	7.5
1992	345.7	328.3	348.9	330.9	13.0
1993	514.7	471.4	513.1	478.4	44.6
1994	830.1	736.7	854.0	751.9	57.2
1995	1317.1	1154.2	1222.6	1180.7	57.0
1995	2134.9	2022.0	1725.9	2040.4	72.8

Sources: Compiled from: (i) Central Bank of Nigeria, CBN Statistical Bulletin.
(ii) Federal Office of Statistics, FOS Annual Abstract of Statistics

5. EXCHANGE RATE INDEX AND PRICE INDICES

Because foreign exchange rates and domestic prices may change considerably over time due to changes in economic conditions, some homegrown method of adjusting for the time value of money must be developed for updating cost/price data applicable at a past date to costs/prices that are representative of conditions at the present time. This can be done by the use of foreign exchange-rate index (tables 1 and 2) and domestic price indices (table 3).

5.1 Foreign Exchange Rate Index

Tables 1 and 2 show the exchange-rate index, ERI analysed from the foreign-exchange-rate data. The ERI measured the changes in the external value of the Naira over the specified time frame relative to the 1985 base year (1985 = 100).

5.2 Domestic Price Indices

The varieties of locally available price indices (UCPI, RCPI, RPI, and CPI) compiled from the CBN and the FOS shown in table 3 were measures of the changes in the internal value of the Naira over the years on the basis of 1985 = 100.

On the basis of the foregone discussion, it is clearly evident that the national economy is bedeviled by the simultaneous occurrence of exchange rate inflation on the external section of the national economy on one hand and domestic price inflation on the internal sector of the economy on the other hand.

Therefore any attempt to develop a simple method for a fairly accurate adjustment or updating of costs and prices must take account of these two factors - the exchange-rate index and the price index.

6. DERIVING THE SIMPLE ALGEBRAIC MODEL FOR PRICE UPDATE

6.1 Re-inforcement Framework

The International Accounting Standards Committee, IASC recognises the historical cost, current cost, realisable value and present value measurement bases for accounting for changes in price-levels. In this connection however, the relevant International Accounting Standards, IASs that provide insights and recognition into cost and price update are:

IAS 15 Information Reflecting the Effects of Changing Prices (Effective 1 January 1983)

IAS 21 The Effects of Changes in Foreign Exchange Rates (Revised 1993, effective 1 January 1995)

IAS 29 Financial Reporting in Hyperinflationary Economies (Effective 1 January 1990)

The insights gained from these bodies of international standards re-inforced the earlier framework discussed in the foregone sections of this paper.

6.2 Algebraic Model Derivation

If the cost at some time in the past is known, the equivalent cost at the present time can be determined by multiplying the historical cost (original cost) by the ratio of the present index value to the index value applicable when the original cost was obtained [Peters and Timmerhaus, 1981 : 160] The following expression represents this definition:

$$\text{Present cost} = \text{original cost} \frac{(\text{index value at present time})}{(\text{index value at time original cost was obtained})}$$

[Peters and Timmerhaus, 1981 : 160]

Representing this expression with symbols for the domestic price index using the composite consumer price index, CPI the current cost C_2 becomes,

$$C_2 = C_1 \times \frac{(CPI)_2}{(CPI)_1} \quad \dots(6)$$

where:

$$\frac{(CPI)_2}{(CPI)_1} = \text{domestic cost escalation factor, } F_D$$

$(CPI)_2$ = current consumer price index

$(CPI)_1$ = original consumer price index associated with the original cost.

C_1 = original or historical cost

Also, the current price, P_2 becomes:

$$P_2 = P_1 \times \frac{(CPI)_2}{(CPI)_1} \quad \dots(7)$$

Moreover, the other domestic price indices such as RPI, UCPI and RCPI may be put in the places of $(CPI)_2$ and $(CPI)_1$ to obtain any other formulae desired.

In a manner similar to the use of domestic price index, the present foreign exchange cost, C_2 and the present foreign exchange price, P_2 may be obtained as follows:

$$C_2 = C_1 \times \frac{(ERI)_2}{(ERI)_1} \quad \dots(8)$$

and

$$P_2 = P_1 \times \frac{(ERI)_2}{(ERI)_1} \quad \dots(9)$$

where:

$$\frac{(ERI)_2}{(ERI)_1} = \text{foreign exchange rate escalation factor, } F_F$$

$(ERI)_2$ = Present exchange rate index

$(ERI)_1$ = original exchange rate index associated with the original cost.

According to Economists, the value of money is of two types;

- (1) The internal value of money referring to the purchasing power of money over domestic goods and services, and
- (2) The external value of money which refers to the purchasing power of money over foreign goods and services.

With regard to the above definitions, equations 6 and 7 are algebraic formulae representing the current internal value of the Naira, while equations 8 and 9 are algebraic representations of the current external value of the Naira. By exploiting the Economists' proposition about the value of money equation 6 and 8 are combined to obtain the simultaneous inflation-and - depreciation-adjusted cost model as shown below:

$$C_2 = C_1 \frac{(CPI)_2}{(CPI)_1} + \frac{C_1 (ERI)_2}{(ERI)_1} \quad \dots(10)$$

$$C_2 = C_1 \left[\frac{(CPI)_2}{(CPI)_1} + \frac{(ERI)_2}{(ERI)_1} \right] \quad \dots(11)$$

Also, by pairing equation 7 and 9 together the simultaneous inflation-and-depreciation-adjusted price model is arrived at;

$$P_2 = P_1 \frac{(CPI)_2}{(CPI)_1} + \frac{P_1 (ERI)_2}{(ERI)_1} \quad \dots(12)$$

$$P_2 = P_1 \left[\frac{(CPI)_2}{(CPI)_1} + \frac{(ERI)_2}{(ERI)_1} \right] \quad \dots(13)$$

It is important to recall the difference between cost and price discussed in section 2. Price is cost plus markup on cost. By recalling equations 2 and 3 from sections 2.1 and 2.2 respectively, the concepts of cost and price from the standpoint of a producer or manufacturer may be highlighted.

$$\begin{aligned} C_1 &= \Sigma DMC + \Sigma DLC + \Sigma WOC + \Sigma CMC \\ P_1 &= \Sigma DMC + \Sigma DLC + \Sigma WOC + \Sigma CMC + Mp \end{aligned}$$

$$\text{Markup on price} = \frac{\text{Markup on cost}}{1 + \text{Markup on cost}}$$

Markup or profit margin is often expressed as a percentage.

C_1 and P_1 shown above can be substituted into equations 11 and 13, however for simplicity this paper would not undertake it.

$$\text{Recalling that } F_D = \frac{(CPI)_2}{(CPI)_1} \text{ and } F_P = \frac{(ERI)_2}{(ERI)_1}$$

and putting them into equation 11 and 13, the following simplified models are obtained:

$$C_2 = C_1 (F_D + F_P) \quad \dots(14)$$

and

$$P_2 = P_1 (F_D + F_P) \quad \dots(15)$$

7. ILLUSTRATIVE EXAMPLE

Owing to the SAP constraints resulting in the unaffordability of equipment for pedagogy in engineering and technology in the tertiary educational institutions in the country, the Process-Heat-Transfer Apparatus was developed. At the time of commissioning in 1990, the total cost of this prototype teaching apparatus was N19,405.10 (US \$2,020.00), and the price on a 50 percent markup on total cost was N29,107.65 (US \$ 3030.00). Given the prevailing macro economic conditions, it is required to produce price and cost adjustments from 1991 to 1995.

Basis of the cost and price update calculations

(1) ERI data taken from table 2

ERI value for 1990 = (ERI)₁ = 253.4
 ERI value for 1991 = (ERI)₂ = 354.1

(2) CPI data taken from table 3

CPI value for 1990 = (CPI)₁ = 293.2
 CPI value for 1991 = (CPI)₂ = 330.9

(3) Values taken from the illustrative example

Original cost (historical cost) = C₁ = N19,405.10 (\$2020.00)
 Original price (historical price) = P₁ = N29,107.65 (\$3030.00)

$$C_2 = \frac{(CPI)_2 + (ERI)_2}{(CPI)_1 + (ERI)_1} \times C_1 = 19,405.10 \left[\frac{330.9 + 354.1}{293.2 + 253.4} \right] = N49,017.28$$

$$P_2 = \frac{(CPI)_2 + (ERI)_2}{(CPI)_1 + (ERI)_1} \times P_1 = 29,107.65 \left[\frac{330.9 + 354.1}{293.2 + 253.4} \right] = N73,525.92$$

The changes in the levels of the costs and prices of the home-developed prototype are arranged below.

**Table 4: Process-Heat-Transfer Apparatus
 Cost And Price Update 1990-1995**

Year	UPDATED COST		UPDATED PRICE	
	Nigerian Naira (N)	US Dollar(\$)	Nigerian Naira(N)	US Dollar(\$)
1990	19,405.10	2,020.00	29,107.65	3,030.00
1991	49,017.28	5,102.52	73,525.92	7,653.78
1992	72,749.72	7,572.98	109,124.58	11,359.47
1993	122,795.47	12,782.56	184,193.21	19,173.84
1994	200,881.60	20,911.04	301,322.39	31,366.56
1995	304,058.51	31,651.38	456,087.77	47,477.07

Given the emphasis of the model on the changes in the external and internal value of money, the results of the illustrative example shown in table 4 suggested responsiveness to inflationary pressures which prevailed in both the domestic and external sectors of the national economy. Therefore the costs and prices in table 4 measured potentially the time value of the Naira at the corresponding years and these values show signs of consistence with the skyrocketing prices of goods in the domestic economy.

8. DISCUSSION

The Structural Adjustment Programme, SAP put in place to cure the nation's economic ailment has so far achieved mixed results - disappointing and fair results.

Disappointing results

The price indices and the exchange rate index derived from the economy in which the SAP operates experienced steady and drastic annual increases in costs and prices for the period studied, 1986 - 1995 (table 4). The massive depreciation of the local currency the

Naira (tables 1 and 2), the high inflation rate (table 3) and the perennial rising costs and prices (table 4) produced widespread poverty. Example, the impact of the steady loss in the Naira purchasing power were:

- (1) Steady and drastic decline in the disposable incomes be it corporate, individual or government.
- (2) Steady reduction of the market sizes for most businesses with its associated lay-off of employees.
- (3) Liquidation and winding up of some business enterprises with its subsequent job losses. With regard to these, industrial relations worsened as workers agitated for improved conditions of services so as to contain the havoc and hardship inflicted by SAP. For instance, in 1995, a total of 196 trade disputes were declared, out of which 124 resulted in strikes involving 1,546,328 workers and giving rise to the loss of 235,069,010 man-days (table 5). These strikes involved workers in the educational and health sub-sectors.

Table 5: Industrial Relations

Description	1991	1992	1993	1994	1995
Trade Disputes	198	185	160	175	196
Work Stoppages	95	92	90	103	124
Workers Involved	403,412	127,546	880,244	1,537,890	1,546,328
Man-days Lost	1,957,074	396,619	6,192,167	234,299,461	235,069,010

Source: Central Bank of Nigeria, CBN Annual Report and Statement of Accounts, December 31, 1995.

Fair results: On the other hand, SAP stimulated the struggles for and pursuit of technological self-reliance. The widespread hardship and havoc wrecked by SAP which made imported goods unaffordable and at most times unavailable stimulated the struggles for survival thus giving rise to:

- (1) self-reliance innovations
- (2) homegrown creative ingenuity
- (3) local sourcing of raw materials
- (4) local substitution of foreign components of imported equipment.

This paper is part of the pursuit of self-reliance initiative aimed at developing the homegrown model for cost/price update of in-house teaching apparatus developed by the author and his students.

However, the homegrown research and development have their obvious limitations - scarcity of funds and lack of sponsorship.

9. CONCLUSION

The model development is suitable for the nation's depressed economy in that:

- (1) It has potential to determine the time value of money as the illustration problem showed.
- (2) It fairly proved the validity of the Economists' assertion which was exploited in developing the model that emphasised the following variables;
 - (a) that the change in the exchange-rate index meant the change in the external

value of the Naira, and,

- (b) that the change in the domestic price indices implied the change in the internal value of the Naira.

The model will be a useful and applicable tool for cost/price update in economies experiencing exchange-rate depreciation and domestic inflation. Also, the model will be suitable for economies where the IMF induced economic restructuring programme, called the SAP.

The model will ensure a fairly accurate and realistic cost and price update for any form of manufacturing and business transaction requiring foreign input.

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ACRONYMS

CPI	=	Consumer price index
(CPI) ₁	=	Original consumer price index associated with the original cost
(CPI) ₂	=	Present consumer price index
Depreflation	=	Depreciation plus inflation
(ERI) ₁	=	Original exchange rate index associated with the original cost
(ERI) ₂	=	Current exchange-rate index
FEM	=	Foreign exchange market
RCPI	=	Rural consumer price index
RPI	=	Retail price index
SAP	=	Structural adjustment programme
UCPI	=	Urban consumer price index