METHODOLOGICAL NOTES ON THE COMPUTATION OF CONSUMER PRICE INDEX, INFLATION RATE AND GDP DEFLATOR IN NIGERIA

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Introduction

The officially published inflation rates for Nigeria have tended to generate a lot of arguments, within the academia, the private and the public circles largely because of the feeling that the adopted methodologies for its computation tended to underestimate and or failed to indicate the true changes in real consumer price level. This note, attempts to review and compare the methodology for computing the major price indexes currently in use in Nigeria – (consumer price index (CPI) and Gross Domestic Product (GDP) Deflator or implicit price index (IPI) and the emergent inflation rates therefrom. It also discusses the problems and shortcomings of the methods, and proffer suggestions for evaluating both the statistical accuracies and interpretations of the outcome (inflation rate estimates) which emerge from them.

The paper is organised into three parts for ease of exposition. Part I explains the methodology for computing the CPI (old and new), the inflation rate and GDP deflator by the Federal Office of Statistics while part II analyses methodological and other problems of the indexes. Part III is the summary and conclusion of the paper.

Part I
DERIVATION OF THE CPI, GDP DEFLATORS, AND INFLATION RATES

(A) Consumer Price Index (CPI)

The computation of the major price indices is usually carried out by the FOS. The mathematical specifications cited below are the same as that in use by the FOS. The attempt in this section is to give a verbal exposition to the methodology in use. The consumer price index (CPI) measures the aggregate consumer price levels paid for goods and services consumed by the final consumers over a given period.

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1. Mathematical Derivation of the CPI

Its derivation by the FOS is based on the adapted version of the Laspeyres index number formula. This is an aggregate price relations, and/or level, derived mainly from a weighted average of simple relative for the major components of the consumer basket. The computation is done in two stages. Firstly, the sample or component index is computed for a particular period n, by dividing the current actual average price level for the component, by its level in the base year.

$$Psin = \frac{Pni}{Poi}$$

where: Psin = simple price index for the ith component in nth period.
Pni = average price level in ₦/unit for ith Component in nth period.
Poi = average price level for the ith Component in the base year.

Secondly, the aggregate or overall consumer price index Ini is computed as a weight average of the simple price relatives as follows:

$$In = \frac{\sum PsinWoi}{\sum Woi}$$

Where In = aggregate or overall consumer price index for period n,
and Woi is the weight for the base period for the ith components.

The weights, Woi are usually derived, based on the results of a consumer expenditure survey carried out during the base year. In principle, the weights, usually reflect the share of each consumer item in total household comsumption expenditures for that period.

Such that

$$Woi = \frac{Poiqoi}{\sum Poiqoi}$$

where qoi = quantity of the ith item consumed in the base period.

This formula yields similar results as the original Laspere's rendered as

$$In = \frac{\sum PniWoi}{\sum PoiWoi}$$

2. FRAMEWORK FOR THE CPI

(a) Data Collection

The FOS trained enumerators collect data on prices of consumer goods and services from markets, departmental stores and selected local shops. The data from various sources are aggregated to obtain a single price for the particular item. The local measures which are often used are converted using conversion factor to change them to standard units such as kilograms, litres, etc. For instance, a market woman knows how many "olodos" of rice there are in a 50kg of rice or how many bottles of oil there are in a tin of oil.

(b) Sample Design

The Federal Office of Statistics conducts national household consumer survey in a chosen year called the base period to provide weights for the computation of the aggregate consumer price index. The weight that was used up to August, 1990, was derived from the household consumer survey of 1974/75 while the new weight was derived from the national consumer survey 1985/86. The urban consumer expenditure survey has three stage sample design – the urban centres, enumerating areas (EAS) and household – while the rural consumer survey has two stage sample design – enumerating areas and the households.

(c)

(i) Commodity Weights (Old)

From the household consumer survey of 1974/75, the following commodity weights were derived for both the urban and rural areas (See Table I). For instance, the urban and rural weights of each component of the consumer basket is derived as the relative share of that item in total expenditure for the period. The all items weights are derived as weighted average using the relative share of rural and urban population in total. From the 1963 population census, the population weights for the rural (0.877) and urban (0.1230) were derived. This implies that 87.7 per cent are located in the rural centres while 12.3 per cent are found in the urban areas. The population weights as shown above were applied to commodity weights for urban and rural centres to obtain the all-items weight e.g.

All items = Urban Commodity Weight (population weight) + rural commodity weight

(pop. weight)

= 560.5 (.123) + 740.2 (0.877)

= 68.94 + 649.16 = 718.1 (see Table I)

From the result shown in table I below, we found, for instance, that the rural populace spend 74.0 per cent of their income on food, urban dwellers 56.0 per cent while at the national level, 71.8 percent of income was spent on food.

Table I
Commodity Weights

	Commodity Group	All-Items	Urban	Rural
1.	Food	718.1	560.5	740.2
2.	Drinks	43.6	56.9	41.8
3.	Tobacco and Kola	20.8	18.2	21.1
4.	Accommodation, fuel and Light	40.5	115.6	30.0
5.	Household goods and other purchases	48.2	60.1	46.5
6.	Clothing	57.9	84.1	54.3
7.	Transport	41.9	63.3	38.9
8.	Other Services	29.0	41.3	27.2
	Total	1000.0	1000.0	1000.0

Source: Federal Office of Statistics, Lagos

(c)

(ii) Commodity Weights (new)

In the new CPI with 1985 as base year, the average expenditure on a commodity group was obtained and multiplied by the total number of households in the sector (Urban or rural) of a State. This is added together for all the States to get total expenditure on a commodity. In the same way, the total consumption expenditure on a commodity group for the States and the country as a whole were obtained. The commodity group weights for each sector of the State (urban, rural) is found by dividing the expenditure on the commodity group in the sector of a State by the total consumption expenditure on the commodity group in a sector of the Country. The weights, so obtained, are used to combine the urban and rural group indices to derive the composite group index. For example, weight for food in the rural areas is 0.841 while it is 0.159 in the urban centres.

(d) Income Groups and Population Weight (old CPI)

The urban centres with population weight of 0.123 are further classified into six income groups and their respective population weights are shown in Table II below.

Table II
Income Groups and Population Weights

	Income Group	Weight
1.	Low income wage earners (LIWE)	0.311
2.	Low income self employed (LISE)	0.588
3.	Middle income wage earners (MIWE)	0.055
4.	Middle income self employed (MISE)	0.028
5.	Upper income wage earners (UIWE)	0.011
6.	Upper income self employed (UISE)	0.007

The rural centres with population weight of 0.877 are categorised under the low income group.

In the new CPI, the survey listing were done on sectorial basis in each State. The FOS felt that the definition for the various income groups as in 1975 were no more relevant to the prevailing economic circumstances and as such discarded them.

(e) Zonal Weights (old)

In the old CPI, the country was divided into five zones with the following Sates under each zone.

Table III

	Zone	State
1.	Lagos	Lagos State
2.	South-West	Ogun, Ondo, Oyo and Bendel
3.	South-East	Anambra, Imo, Rivers, Cross Rivers and Akwa-Ibom
4.	North-East	Benue, Plateau, Bauchi, Gongola and Borno
5.	North-West	Kano, Kaduna, Katsina, Niger, Sokoto and Kwara

From the 1963 population census, the zonal weights were derived. The zonal weights imply, for instance, that in Lagos zone, 15.4 per cent of total urban dwellers and 4.0 per cent of total rural dwellers are found there (see Table IV).

Table IV
Zonal Weights

Zone	Urban Weight	Rural Weight
Lagos	0.154	0.004
South-West	0.359	0.151
South-East	0.164	0.312
North-East	0.035	0.294
North-West	0.238	0.239
Total	1.00	1.00

In the new CPI, with the weight computed on sectoral basis, the zonal weights became irrelevant.

(f) Price Relative

$$\text{Price relative which is designated (rn)} = \frac{\textit{average current price}}{\textit{base period average price}} \times 100$$

Calculation of Consumer Price Index

Price surveys are done weekly by enumerators employed by the Federal Office of Statistics (FOS). As a result, four batches of weekly price data are collated monthly. The average prices for each week are calculated and then transfered to the monthly summary sheet. Here too, the average prices for all the items are calculated and transferred into the consumer price index file for the computation of consumer price indices. To make the calculation more manageable, the group indices for the broad expenditure group is calculated. For instance, under food we have sub-head such as staples, protein, oil & fats, vegetables and other food (processed food). The average prices of these sub-heads are multiplied by the respective item weights, summed together and divided by the sum of the weights. *Example*: Let us take a hypothetical weights and prices of the food sub-heads.

Table V

	Weight	base period average price	Current Price price	Relative	Weight Multiplied by price relative
Food					
(a)					
Staple	5	200	750	375	1875
Protein	3	200	450	225	675
Oil & Fat	1	200	500	250	250
Vegetables	1	100	250	250	250
Other food	2	200	650	325	650
Total	12				3700

From the table we obtain the price relative and multiply it by the corresponding weight, sum it and divided by sum of weights to obtain food index, e.g.

$$\text{Food group index} = \frac{3700}{12} = 308.3$$

We do the same thing to all other items.

After calculating items indices for all items in the basket, we use the various indices to calculate the all-items index for a centre. To do this we multiply the group indices by the group weights, then sum together and divide by total weight index for that particular item.

Table VI

Example

Calculation of all-items index for a centre

Components	Group Weight (1)	Group Index (2)	Product of (1) & (2)
Food	525	308.3	161,857.5
Drinks	60	236.4	14,184.0
Tobacco & Kola	45	115.0	5,175.0
Accommodation fuel and light	150	209.3	31,395.0
Household goods and other purchases	60	161.0	9,660.0
Clothing	60	250.0	15,000.0
Transport	55	290.0	15,950.0
Other services	45	212.0	9,540.0
	1000		262,761.5

$$\text{All items index for the centre} = \frac{262{,}761.5}{1000} = 262.8$$

Then the computation is broken into urban and rural.

(A)

(i) Urban Index Computation (old)

In the old system, the indices from the urban centres are further classified into two – low income and "middle" and upper income group. For the lower income group (LIWE and LISE) a simple aggregation is done for all centres in the zones that are within the urban classification to obtain zonal indices for this grade of people. Then the zonal weights are applied to obtain an index on the extreme right corner of table VII (attached).

The zonal weight is applied to show the proportion of the population that this represents. For the second urban group – middle and upper incomes – simple average of all commodity indices in all centres are used to obtain all-items indices for these categories of people. The various income weights are applied to all income groups and summed to obtain the urban indices. A table showing various income groups and weights as one below is used.

TABLE VIII
All-Urban Index

Income Group	LIWE	LISE	MIWE	MISE	UIWE	UISE
Weights	0.311	0.588	0.555	0.028	0.011	0.007

(ii) Rural Index Computation (old)

For the rural areas in the old system, everyone is classified under low income group. So we simply apply the items weights across the board to obtain item indices as shown on the left half of Table VII. Then apply the zonal weights and aggregate to obtain the rural index on the extreme right of table VII

(B) Computation of New Urban and Rural Indices

In the case of the new CPI, each State is classified into Urban and Rural Sectors. The calculation of both all-urban and all-rural price indices follow the same process. Firstly, a simple average of each sector's average prices is calculated for each State. Then the relative price for such an item is derived by dividing the current average price of the item by the average index for that particular item. The indices of all the items under such a commodity group is summed by applying their respective weights to obtain a single index for the commodity group. Then all the commodity and services group indices are summed by applying their weights to derive the all-items Urban or all-items rural indices.

(C) Composite Index Computation

The population weights are applied to both the all-rural and all-urban indices for a particular component and summed-up to obtain the composite index (see Table IX). The same method is applied to all other components to obtain composite consumer price index table. In the new CPI, the sectoral weighs are applied to the all-urban and all-rural indices to obtain the composite index.

Table IX
Consumer Price Index

Time	Component	All-Urban	All-Rural	Composite
Nov.'89	Food	1311.7	1125.1	1148.0

$$\begin{aligned}\text{Composite} &= 1311.7(0.123) + 1125.1(0.877)\\ &= 161.3 + 986.7\\ &= 1148.0\end{aligned}$$

4. Calculation of Inflation Rate

The composite Consumer Price Index (CPI) is used for calculating inflation in Nigeria. The inflation rate is derived from the percentage increase in the composite price index between two successive periods. These periods may be on month-by-month, quarterly, annually or longer period basis.

The month-by-month or quarterly rates of inflation contains a lot of noise and as such can not give a good signal of inflation. A very long period say, five or ten years may be important and interesting to study but may be too long for most economic problems. As such, annual rates are usually preferred because it enables monetary authorities to take appropriate macro-economic policy measures, aimed at combating inflation through budgetary measures.

In measuring inflation on annual basis, we obtain a twelve month moving average of the composite consumer price index (CPI) for the consecutive periods, divide the latter period average by the earlier period's and multiply by 100 minus 100.

Symbolically, it is written as:

$$I_t = 100\left[\frac{\bar{P}_t}{\bar{P}_{t-1}}\right] - 1$$

where I_t is the inflation rate at time t.

$\bar{P}_t$ and $\bar{P}_{t-1}$ are the twelve month price index moving average for time t and t - 1.

So,

$$\bar{P}_t = \frac{1}{12}\sum_{i=1}^{12} Pi_t$$

$$\bar{P}_t = \frac{1}{12}\sum_{i=1}^{12} Pi_{t-1}$$

$$I_t = 100\left[\frac{\frac{1}{12}\sum_{i=1}^{12} Pi_t}{\frac{1}{12}\sum_{i=1}^{12} Pi_{t-1}}\right]$$

We shall illustrate this with real data on table X below:

Table X
Composite Consumer Price Index 1989 (old series)

Period	YEAR 1986	1987	1988	1989
January	468.1	541.5	611.4	931.6
February	478.2	540.7	631.2	969.7
March	473.2	542.1	662.0	1041.8
April	476.2	542.8	715.6	1066.5
May	497.7	549.0	745.4	1142.3
June	506.6	552.3	784.2	1190.7
July	523.6	563.0	824.7	1192.2
August	539.4	567.2	873.7	1130.8
September	542.0	576.7	863.5	1118.9
October	534.8	582.9	852.1	1105.4
November	537.5	590.2	874.4	1112.1
December	538.5	590.8	879.3	1124.7
Average	509.7	561.6	776.5	1093.9

Source: Federal Office of Statistics (FOS), Lagos.

Inflation Rates for 1987 and 1988 are calculated as follows:

$$1987 = 100\left(\frac{561.6}{509.7} - 1\right)$$
$$= 100\,(1.1018 - 1)$$
$$= 10.2 \text{ per cent}$$

$$1988 = 100\left(\frac{776.5}{561.6} - 1\right)$$
$$= 100\,(1.383 - 1)$$
$$= 38.3 \text{ per cent}$$

Since CPI is released on monthly basis, it has been conventional to calculate inflation rate on a twelve month moving average ending on a particular month. For instance, the inflation rate as at end of November, 1989 is calculated as follows:

$$\text{Nov., 1989} = \frac{100\,[\text{12 month Average (Dec. 1988 - Nov. 1989}]}{[\text{12 month Average (Dec. 1987 - Nov. 1988}]}$$
$$= 100\left(\frac{1073.4}{752} - 1\right)$$
$$= 100\,(1.427 - 1)$$
$$= 42.7 \text{ per cent}$$

The yearly (1979-1989) changes, in average price indices or the inflation rates using the 1975 base year are shown in Table I. The introduction of the new series with 1985 as base year, in August, 1990, brought some moderate improvement as could be seen from the inflation rates derived from the old and new series, which were 16.2 and 19.5 per cent, respectively.

(B) GDP DEFLATOR OR IMPLICIT PRICE INDEX

The Gross Domestic Product Deflator or the Implicit Price Index (IPI) measures price behaviour with reference to the GDP as purchased by the consumers, business enterprises and governments. In terms of the GDP Deflator, inflation is indicated when national income (nominal GDP) is rising faster than the national real income (real GDP). The GDP deflator is obtained by dividing the GDP at current prices (nominal GDP) by GDP at constant price (real GDP) multiplied by 100.

$$\text{i.e. GDP Deflator (IPI)} = \frac{(Nominal\ GDP)}{(Real\ GDP)} \times 100$$

It is conventional to multiply by 100 to obtain an index number that takes on the value 100 for the base year (for which nominal GDP equals the real GDP).

$$\text{IPI}_{1989} = \frac{254{,}810}{151{,}400} \times 100$$

$$= 286.43 \text{ (See Table XI)}$$

In this example, the price of the average item increased by 186.43% on the basis of 1984 prices. On annual basis the price increase between 1989 and 1988

$$= \left(\frac{286.43}{183.45} \times 100\right) - 100$$

$$= (156.1 - 100)$$

$$= 56.1 \text{ per cent.}$$

Table XI
GDP DEFLATOR (1981 - 1990)

Year	Current (Nominal) GDP (₦ Million)	Constant (Real) GDP (At 1984 Prices) (₦ Million)	Deflator
1981	56,602.20	77,826.60	72.73
1982	60,483.14	78,197.01	77.35
1983	63,293.40	74,955.55	84.34
1984	69,950.25	69,950.25	100.00
1985	78,775.84	75,453.65	104.40
1986	79,740.4	77,899.53	102.36
1987	110,576.01	79,283.53	139.47
1988	151,400.00	82,530.00	183.45
1989	245,810.00	85,820.00	286.43
1990	336,070.00	88,990.00	377.65

Apart from the aggregate deflator, FOS publishes deflators for the various activity sectors such as agriculture, mining, manufacturing, building and construction, etc. (See Table 2). Since the aggregate deflator represents average of items, the breakdown into activity sectors enables sectoral analysis of price movements.

Part II
METHODOLOGICAL PROBLEMS

(a) Consumer Price Index (CPI)

A major problem with the computation of CPI is associated with the selection of appropriate base year, the "market basket" (which is most representative of sampled goods and services), commodity group "weights" and the adopted aggregation formulae.

With regard to weights, the extent to which consumer behaviour approximates normal situation in the base year will affect the values of the weights used for price aggregation. As was alluded to in the text, the old CPI was adjudged defective because the old base year weights were no longer truly representative of current consumer behaviour. This is more so with the rapid changes in consumer behaviour which characterised the Nigerian consumer market as a result of the frequent emergence of new products, which were often not reflected in weight baskets, used for the computation.

The use of the adopted Laspeyer's formula tended to overstate changes in the aggregate index. This problem has often been tackled through adjustments of the outcome of computation based on this formula. One major problem which remain outstanding is the determination of the extent of adjustment that is desirable and consistent with expectations.

In a situation where the composition of the "market basket" and "weight" remain unaltered for long periods of time (a decade or more), the underlying validity of CPI becomes very questionable. There is therefore the need for regular update of the sample of goods and services comprising the "market basket". Because of the considerable amount of time and money required to establish and conduct National Consumer Expenditure Survey, the general practice in most countries is to use a fixed set of weights for a period extending up to 10 years.

In Nigeria, the CPI "market basket" and "weights" were based on (NCES) of 1975. The Federal Office of Statistics conducted a NCES in 1985 in order to update the sample of goods and services comprising the market baskets and establish appropriate "weights". The result of the survey was not made public until later part of 1990. However, it has been observed that commodity group weights derived from the census were not significantly different from the weights obtained in 1975.

Using 1963 census figure, which says that only 12.3 per cent of the population of the country is urbanised is misleading as such could affect the correctness of an index derived from such a data.

Classifying everybody in the area which was designated as rural in 1963 as low income earners in 1990 is a misnomer. This is because, with the creation of 21 states structure, many villages have grown into towns while many towns have grown into cities.

The structure of the zonal weights must have also been seriously altered and hence will distort indices derived by using the 1963 zonal weights.

(b) GDP Deflator

GDP Deflator will share from the methodological problems of compilation of gross domestic (national) product. This include the problem of double-counting as the products of some sectors will be intermediate products or raw materials of other activity sectors.

Unless a process of value-added is adopted the value of the gross output may be overstated. Besides, the scope of coverage of GDP is very broad and extensive. This causes a considerable time lag in procurement of data. GDP figures are only available on annual basis. The practical use of GDP Deflator as a measure of inflation will be limited until FOS can derive quarterly or monthly series of GDP data.

In addition to the above-stated conceptual and statistical problems associated with CPI and GDP Deflator, other factors which hampers the computation of the two indexes include:

(i) Manpower Constraints

The FOS requires a large number of professionals as well as clerical staff to be able to collect monthly series of data and conduct national surveys at regular intervals. The staff strength of the organisations seems to be inadequate. Besides FOS has been known to be experiencing a high rate of staff turnover probably due to poor conditions of service.

(ii) Equipment and Infrastructure

The level of equipment and infrastructure at FOS is not adequate for the wide array of data and the process of aggregation required. There is need for increased computer application in some areas to minimise manual compilation/processing of routine data. This will make for greater accuracy and timeliness.

(iii) Timeliness of Data

Following irregular returns from enumerators in the zones, inadequate level of equipment and infrastructure, high rate of staff turnover and other problems of logistic, delays are associated with the release of data. Between the years 1985 and 1987, FOS was several months in arrears. However, following the re-organisation of FOS in 1988 with the appointment of a Sole Administrator and