CONSTRUCTING EFFECTIVE EXCHANGE RATE (EER) INDICES: METHODOLOGICAL ISSUES AND AN APPLICATION TO NIGERIA*

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This paper reviews the major conceptual and methodological issues that confront an index designer with particular emphasis on the construction of effective exchange rate indices. In addition, the paper attempts to construct for the first time a nominal effective exchange rate (NEER) indices for Nigeria, for the period January 1960 to December 1990, as a means of providing a summary measure of the average external value of the nation's currency against those of her trading partners selected for the index.

Analysis of the indices constructed, showed how on average the external value of the country's currency has moved vis-a-vis the currencies of her trading partners. A comparison of our indices with that of the IMF showed very close correlation between them and generally moved in the same direction. On the whole, the indices have been on the downward trend since 1984 indicating the continuous depreciation of the naira vis-a-vis the currencies of the trading partners during the period. However, the depreciation was more rapid between 1985 and 1987, and gradual thereafter.

Central Banks of quite a large number of developed countries and few developing countries, as well as some private and multinational organisations have in the last two decades considered it necessary to construct and maintain effective exchange rate indices, as a means of gauging/monitoring the average international value of national currencies against other currencies.[1] The profound interest in the construction of exchange rate indices was motivated to a large extent by the breakdown of the Bretton Woods Agreement and the long-standing regime of fixed exchange rate, and the emergence of generalised floating exchange rate system in the early 1970s, which resulted in wide fluctuations in the movement of national currencies vis-a-vis other major currencies.

With the advent of generalised floating increased attention began to be focused on the need for countries to monitor what was happening to key economic variables as a result of exchange rate changes between domestic currency and various foreign currencies. This stemmed from the pervasive impact of exchange rate changes on the macro economy. Exchange rates are relevant to the valuation of commodities and financial assets. Furthermore, under the floating exchange rate regime, movements in the market rate of a domestic currency measured against only one foreign currency, cannot adequately represent the changes against all currencies because the fluctuations of most nation's currencies occur simultaneously. Thus, when the changes in

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1. Among such private and multinational organisations are the Morgan Guaranty Trust Company, World Bank, International Monetary Fund (IMF), European Economic Community (EEC), Organisation for Economic Cooperation and Development (OECD), and Bank for International Settlements (BIS).

value of various currencies vary from currency to currency, it is generally convenient to have a single index for each country that measures the average change of a country's exchange rate against all other currencies. This is what effective exchange rate indices attempt to capture.

The notion of nominal effective exchange rate was developed by Hirsch and Higgins(1970), but was subsequently extended by Artus and Rhomberg(1973), Black(1976) and Rhomberg(1976). These authors emphasised that indices could be developed to monitor the impact of exchange rate changes on various economic variables, but attention was mainly on the trade (or more generally the current account) balance and the impact of exchange rate-induced changes in relative prices on trade flows. In Nigeria as in most developing countries, no formal attempt had been made at constructing exchange rate indices as a way of summarising information about the external value of the Nigerian pound/naira.[2] The present study is, therefore, a pioneering effort in that direction and is intended to fill the existing gap. It is hoped that with this study, such indices would regularly be updated and maintained to assist in future exchange rate policy design.

The purpose of this study is to review the major conceptual and methodological issues (including the technical difficulties) involved in the construction of exchange rate indices. Also, we hope to apply the methodology to Nigeria with a view to constructing effective exchange rate indices for the country. For easy exposition, the remaining part of the paper is organised as follows: Section I defines some basic concepts germane to subsequent analyses in the paper. Section II provides the rationale for the construction of exchange rate indices and their uses. In Section III some of the major conceptual and methodological issues involved in the construction of many of the effective exchange rate indices currently published are reviewed. Section IV deals with the application to Nigeria, while Section V presents the results of our calculation and analyses the behaviour of the indices over time. The paper ends with some concluding remarks in Section VI.

I. DEFINITION OF SOME BASIC CONCEPTS

The Nominal Exchange Rate

The exchange rate is a key macroeconomic variable in the economic reform process. The exchange rate could be defined in several ways, but there are basically two alternative ways of defining the concept. The exchange rate may be defined as the price of a unit of domestic currency in terms of a foreign currency (for example, number of United States dollar per naira). Alternatively, it may be defined as the number of units of domestic currency per unit of foreign currency (for example, the number of naira per United States dollar). The interplay of demand and supply in the foreign exchange market leads to the establishment of a *nominal exchange rate* at which a currency is traded at a given point in time. As demand and supply in the foreign exchange market shifts, and depending on the country's exchange system, the exchange rate may

2. The only known exchange rate indices for Nigeria was recently constructed by the International Monetary Fund (IMF) and published for the first time in the July 1988 issue of the *International Financial Statistics*, (lines nec and rec) with a base of 1980, but now rebased to 1985. The period covered is 1980 — date.

change.[3] Generally, an increase in the rate (or price) is referred to as an appreciation with respect to the foreign currency, while a decrease is termed a depreciation. However, this depends on how the exchange rate is defined. As an illustration, let $E_{N\$}$ be the number of naira per U.S. dollar (say 10 naira to the dollar), then the nominal exchange rate (NER) is given as:

$$NER = E_{N\$}/\$1 = 10 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1a)$$

Alternatively, we could express the nominal exchange rate in units of the U.S. dollar to the naira as:

$$NER = E_{\$N}/₦1 = 0.1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1b)$$

A currency is said to depreciate (appreciate) whenever more (less) units of the currency are required to purchase a unit of foreign currency. In terms of the nominal exchange rate in equation (1a) above, therefore, higher values would indicate a depreciation while lower values would indicate appreciation of the naira. The reverse would be the case if we adopted equation (1b), i.e. expressing the nominal exchange rate on the basis of units of foreign currency per one Naira. From both equations, it is apparent that each is simply a reciprocal of the other.

The Real Exchange Rate

The real exchange rate (RER) attempts to measure the rate at which goods and services are exchanged between the domestic economy and the rest of the world. It is obtained by adjusting the nominal exchange rate (NER) to differentials in prices at home and abroad. The real exchange rate (RER) for a currency is defined as the bilateral ratio of currencies deflated by their respective price indices. In our two-country example, the rate would be expressed as:

$$RER = \{E_{N\$}/P_D\} \,/\, \{\$1/P_{US}\} \text{ or } E_{N\$}^{*}\,(P_{US}/P_D) \quad \ldots\ldots\ldots \quad (2a)$$

The alternative expression using the dollar to one naira rate is:

$$RER = \{E_{\$N}/P_{US}\} \,/\, \{₦1/P_D\} \text{ or } E_{\$N}^{*}\,(P_D/P_{US}) \quad \ldots\ldots\ldots\ldots \quad (2b)$$

where:

$E_{N\$}$ = the nominal exchange rate (Naira per US \$)
$E_{\$N}$ = the nominal exchange rate (US \$ per one naira)
P_D = the price deflator for the domestic currency (naira)
P_{US} = the price deflator for foreign currency (US dollar)

Effective Exchange Rate

The domestic exchange rate defined in terms of a single foreign currency represents

3. A discussion of the determinants of exchange rate is outside the scope of the present study. However, suffice it to mention that movements in the exchange rate reflect relative economic conditions between countries, that in turn, influence the demand and supply of the currencies. Changes in expectation about future economic conditions, relative price levels, differences in countries' relative economic activity, differences in interest rates across countries, and changes in money growth, all determine the nominal exchange rate.

a bilateral rate. However, with increased exchange rate flexibility since the mid-1970s, the construction of exchange rate indices designed to measure the average change of a country's exchange rate against a number of currencies during a particular period has become prevalent. This concept of the average relationship between a currency and a set of other currencies is often referred to as the *effective exchange rate (EER)*. The *effective exchange rate index* is thus an average of bilateral exchange rates. EER indices are always based on *weighted* basket of currencies, the weight being determined by the purpose for which the index is to be used. Effective exchange rate could be nominal or real. The *nominal effective exchange rate (NEER)* for a country is the value of the currency in terms of a weighted basket of currencies, where the weights represent the relative importance of each currency to the domestic country. The *real effective exchange rate (REER)* of a currency, on the other hand, is defined as the nominal effective exchange rate adjusted for relative price movements in both the domestic country and the other countries. Movements in the effective exchange rate indicate either appreciation or a depreciation of the domestic currency vis-a-vis the set or basket of other currencies. Movements in the index are referred to as effective appreciation or depreciation.

II. THE RATIONALE FOR/USES OF EXCHANGE RATE INDICES

For a country with only one trading partner, the relationship of the domestic currency vis-a-vis the currency of the trading partner is traced through the movements of the exchange rate between the currencies. However, when a country trades with n other countries, there are n exchange rates. In such a case, it is convenient and at the same time useful for both analytical and policy making purposes to employ an index that reflects the relationship between the domestic currency and all other currencies.

When a currency appreciates or depreciates in a floating exchange rate regime, it does so against numerous currencies with varying rates of change against those currencies. Simply looking at a variety of bilateral exchange rate movements will not capture fully many and diverse substitution possibilities that the currency appreciation or depreciation would entail. Thus, a change in a bilateral exchange rate is of only limited use in exploring the consequences of a currency-value change on international competitiveness. It was this limitation that informed analysts to form an aggregation of exchange rates in the form of an index that incorporates changes in the relative values of specified currencies against a base currency over some relevant time period.

Effective exchange rate indices are used in economic analysis, policy evaluation and financial planning and forecasting. Because these indices are weighted averages of a number of exchange rates, their use avoids the mistaken generalisations about the value of a currency that may arise by simply looking at fluctuations in a single exchange rate. A multilateral weighted exchange rate is said to be more useful than any single bilateral exchange rate in assessing the value or changes in the value of a currency. See Ott(1987), Black(1976), Hooper and Morton(1978), Maciejewski(1983), Dutton and Grennes(1985), Belongia(1986), Cox(1986) and Rosensweig(1986).

With respect to the practical use of effective exchange rate indices, a number of countries (e.g. the U.S.) view these indices as a convenient summary measure or indicator of the performance of their currency against all other currencies. Some other countries, such as Sweden, Norway and Finland use the effective exchange rate as a

policy guide for purposes of exchange market intervention. On the whole, exchange rate indices summarise information contained in many bilateral exchange rates that apply to a particular currency in order to gauge the average value of that currency against the others. Exchange rate indices are useful tools in analysing or forecasting the influence of a currency's international value on important macroeconomic variables or policy objectives, such as international trade volumes and values, asset demands, and prices. [Hooper and Lowrey(1979), Whitt, Koch and Rosensweig(1986)]. Effective exchange rate indices measure one of the important determinants of a country's international transactions and provides a useful summary statistic to help in assessing the overall impact on the domestic price level of diverse bilateral exchange rate movements (Hooper and Morton, 1978).

III. REVIEW OF CONCEPTUAL AND METHODOLOGICAL ISSUES

Constructing EER indices is not an easy exercise, for it requires addressing a number of theoretical and statistical issues. In fact, as noted by Belongia(1986), "constructing a multilateral exchange rate index is a difficult marriage of theory and practice."[4] In order to construct an EER index, several questions must be answered and several important decisions must be taken. These include:

(i) what number and selection of countries/currencies should be included in order to obtain a reliable index?

(ii) what weighting scheme, that is, the relative importance that should be attributed to each currency in the index? Closely related to this are:— which economic variable would be most appropriate to determine the relative importance of the individual currencies? what representative time period should be used for the weights?, and which base period should be used for the index?

(iii) what type of averaging formula should be adopted? and

(iv) should the index be nominal or real?

Since theory does not offer any practical guide to resolving these issues, it has been commonly argued that answers to each of these questions and/or decisions on them depend upon the purpose(s) of the analysis, that is the use(s) to which the EER would be applied. Such decisions have important implications for what the indices measure. Thus, according to Hervey and Strauss(1987) "the worth of any index depends upon the appropriateness of its construction and the trustworthiness-of-measure of its individual components." A discussion of each of the issues highlighted above now follows.

4. A comprehensive discussion of the theoretical and statistical issues on the construction of exchange rate indices is contained in Dutton and Grennes(1985). Goolsby and Roberson(1985) also offered similar discussion with particular emphasis on agricultural trade indices. We thank Professor Grennes and the U.S. Department of Agriculture for making these papers available to us.

Countries/Currencies

As has been recognised in the literature, the selection of a sample of countries/currencies to include in the construction of an exchange rate index is perhaps the most critical issue in nominal index design. For an open economy trading with a large number of countries, the decision on what number of countries and thus the selection of currencies to include is not an easy one. As observed by some writers, there is no universally accepted view among researchers with respect to the number of countries/currencies to include in an index. In fact, it has been argued that there is a diversity of views that is nearly as broad as the number of aggregate indices that have been developed (Hervey and Strauss, 1987). The primary issue is whether the number of currencies/countries matters? A question for which theory offers no guidance whatsoever.

The views/arguments put forward in the literature runs as follows: all convertible currencies and all currencies of countries with which the country constructing the index trades should be included; the broader the coverage the more accurately the weighting scheme will represent the importance of the various countries in the international activities of the base currency; a sufficient number of countries must be represented to mirror trade accurately; currencies of countries with either a significant share of world trade (in the case of multilateral index) or a country's trade (in the case of bilateral index) should be included; the index should encompass countries whose assets are widely traded in financial markets; countries included should have a well-developed foreign exchange market; currencies linked directly to currencies in the index may be omitted; and the need for one to confront the inflation problem and its impact on exchange rate and trade. [See Koch(1984), Hervey and Strauss(1987), Rosensweig(1987) and Paul(1987) for details].

In view of the above, it is undeniably obvious that the index designer has a herculian task, since no group of currencies can be ideal for all purposes. In practice, however, it is very common to work only with a limited number of currencies/countries which represent a large percentage of the total of weights and to ignore many other currencies with small weights. The choice generally has been governed by striking a compromise between completeness of the set of trading partners and data availability. Most indices have tended to use the principal industrial economies' currencies.

Averaging Formula

There are different averaging formula or techniques but the two most commonly discussed are the arithmetic and geometric averages. Of the two options, analytical arguments strongly favour the latter. In fact, it has been argued that regardless of the weights employed, the EER indices are influenced by whether the indices are calculated as arithmetic or geometric averages. In this regard too, the definition of exchange rate adopted matters, since calculated effective exchange rate index will in general, be sensitive to which definition is employed.

A geometric average of a set of n numbers is the nth root of the product of those numbers. While an arithmetic average is their sum divided by n. Thus, the two formulae for calculating the index value at time t can be written as:

$$\text{Arithmetic Mean} = 100 \sum_{i=1}^{n} w^*_i \, E^*_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$\text{Geometric Mean} = 100 \prod_{i=1}^{n} (E^*_{it})^{w^*_i}$$

$$= 100 \exp \sum_{i=1}^{n} w^*_i \log E^*_{it} \quad \ldots\ldots\ldots\ldots \quad (4)$$

where:

w_i^* = weight assigned the currency of country i

E_{it}^* = value at time t of the domestic currency in terms of currency i divided by its value in the base period

$\prod_i$ = the product over all i

$\sum_i$ = sum over all i

log = logarithm (either $\log_e$ or $\log_{10}$)

exp means " take the anti-log."

From equations (3) and (4), we can see that the arithmetic mean is a single sum of a currency values (E_i) weighted by each currency's weight (w_i) in the index. The geometric mean on the other hand, averages the percentage changes in the individual exchange rates to determine the percentage change in the index. As is obvious from above, the form of the index carries implications for the comparative importance of absolute versus percentage changes. Geometric averages emphasises proportional changes, rather than absolute changes.

The two averaging techniques possess a number of distinguishing features that have influenced their usage in practice. First, a geometric average is independent of the definition of the exchange rate adopted, while an arithmetic average is sensitive to the definition used. Therefore, an arithmetic index will yield different results if exchange rates are defined in reciprocal terms, say naira per dollar rather than dollar per naira. On the other hand, the reciprocal of a geometrically averaged index derived from reciprocal currency values equals the original index. Second, a geometric index treats depreciating and appreciating currencies symmetrically, that is, responds to proportional exchange rate movements. An arithmetic index on the other hand, gives asymmetric treatment to depreciating and appreciating currencies and further results in an upward bias. That is, it gives larger weight to those currencies that change more than other currencies in the index.[5] Finally, a geometric index satisfies the time reversal test — that is, given two different points in time, with different data, indices constructed from both periods will show the same percentage change.[6] Thus, unlike arithmetic

average, geometric index yields the same percentage change in an index even if the base period of the index is changed, and even if the exchange rates in the index are defined in reciprocal terms.

Thus, for any set of bilateral exchange rate changes between domestic currency and its trading partners, the arithmetic and geometric indices are likely to differ substantially. It is therefore, principally because of the advantages of the geometric index over the arithmetic index that the former is favoured and its use has gained in popularity in recent years (Hooper and Morton (1978), p. 700; Dutton and Grennes (1985), pp. 20—27 and Belongia (986), p. 9).

Nominal or Real Indices

The choice between a nominal or real index becomes of interest when the issue of relative changes in price levels between countries is being addressed particularly in hyper-inflationary cases. It is of particular interest in countries with floating exchange rate since such indices give an indication as to whether exchange rate development follows the underlying real economic forces. In the short-run, a change in the relative price between two currencies may not necessarily reflect an equal change in the economic relationship between the two countries. When the price relationship between currencies is changing the relationship between other economic variables — real and nominal — are also changing, but not necessarily in tandem. Thus, an understanding of the real economic impact of a change in exchange rate demands for an understanding of what is happening in the real sectors.

In the light of the above, it is only by sheer coincidence that an observed change in the nominal exchange rate would manifest in a proportional change in relative inflation for any two countries during any given period of time. Therefore, a measure of the 'real' economic consequences of a relative change in the exchange rate calls for an adjustment of the nominal exchange rate to take account of the differences in real developments.

In summary, a nominal measure of a change in exchange rate may be misleading or distortionary. However, as long as the relative price conditions between economies remain stable, whether the index is nominal or real is immaterial. In this case, a nominal index is a satisfactory proxy for a real index. For analytical purposes, however, many countries construct and employ various types of real and nominal exchange rate indices.

Base Period

The choice of a base period encompasses the choice of a base for the index, as well

5. For example, an EER index based on an arithmetic average of n countries' exchange rate will in general show larger variations than an index based on geometric average of the same countries' currency if some countries currency values change by much larger amount than the others (and the differences is particularly great in connection with extreme exchange rate movements). Thus, even if two indices are constructed from the same currencies and the same trade weights, the method used to calculate the index can produce different measures of changes in the currency value.

6. The time reversal test was defined by Fisher(1922) ". . . ., the formula for calculating an index should be such that it will give the same ratio between one point of comparison and the other point, no matter which of the two is taken as the base". For an algebraic test see in particular pp. 118—119.

as a base for the weights employed to construct the index. What constitutes an ideal base period remains an unresolved issue.[7] It is practically impossible to find a year that satisfies the necessary criteria. The worrisome nature of this issue has its origin in the perennial index number problem of the reliability of an index when the underlying economic structure of the index is changing but the weighting mechanism is fixed in time.

The questions that arise in making a choice include: should an index employ fixed weights or ones that are constantly updated to reflect current developments? If fixed weights, should they come from one recent year or an average over a few years? If one year, which one? Answers to these questions are as diverse as available indices. Thus, some indices are based on a single year and others on either an average of several years or moving base year.

The views with respect to the choice of an appropriate base year runs as follows:

(a) choose a base period that adequately reflect current economic development and periodically update the base to maintain a 'realistic' weight;

(b) choose a base period that is cyclically neutral, and in this respect it is preferable to have several years as base period; and

(c) the base period should roughly be in the middle of the time period covered by the index. However, whichever procedure is adopted, it is pertinent to bear the following points in mind. First, employing changing weights could lead to confusion and wrong interpretation with respect to changes due to exchange rate shifts and changes due to shifting weight in the index. Second, if there have been shifts in the structure of the economy, fixed weights from an earlier period may become misleading over longer periods of time. Third, when using fixed weights from one period, if significant structural shifts has occurred, then a fairly current period may be more suitable, although care should be taken not to be too current since very recent data are likely to be substantially revised. Finally, a single recent year should be used only if it is indicative of the structure over longer periods of time, otherwise use of a simple average of a number of years is preferable.

Weighting Scheme[8]

The issue of weighting scheme and choice of weights are of fundamental importance in the construction of EER indices, and decision on them is obviously dependent on the purpose of the indices and on how far one is prepared to accept the method as only an approximation to a theoretical ideal. As observed by Crockett and Nsouli(1977) and Solheim and Sporastøyl(1984), the most theoretically ideal method of assigning weights should incorporate the following features — trade and payments structure,

7. Deephouse(1985) has noted that the reference base could be interpreted as a period when the currency held its "proper value", but further stated that ". . . .the base period is unimportant because any index can be rebased to any period simply by dividing its reference series by the value in that period". Batten and Belongia(1986) and Belongia(1986) on their part observed that "in theory absolute purchasing power parity (PPP) should hold in the base year and the countries used to construct the exchange rate index should consume identical commodities". Absolute PPP requires an exchange rate that equates the price levels between countries.

including the price and cost effects generated by exchange rate changes, the own and competitors' elasticities for different commodities and in the various market with respect to price, demand, supply and substitution, the competitive relationships of a country's exports in foreign markets, the pattern of bilateral trade, and the effects on capital flows, as well as other exogenous factors influencing exchange rate other than direct measures by the authorities. However, in real life such a model is non-existent. The closest approximation is the famous Multilateral Exchange Rate Model (MERM) of the IMF. Artus and Rhomberg(1973), Black(1976), Rhomberg(1976) and Koch(1984) contain extensive review of MERM. Given the complexity of such a procedure in addition to the question of the reliability of some of the underlying assumptions, its wide application is limited.

Since a weighted average reflects the relative importance of a group of values in a statistical sense, it has been argued that it is reasonable to weight those factors that have the greatest impact on the variables in question. Until recently, trade accounted for the bulk of the international transaction, so naturally the plethora of existing indices use trade variables as weights — exports, imports, or total trade. However, since the last decade or so the rapid increase in international capital flows has challenged the preponderance of trade as a determinant of exchange rate. Trade weights are intuitively more appealing in view of the importance of trade-related questions in the use of EER indices. Data availability may also have influenced the use of trade weights.

Several types of trade weights can be used in constructing effective exchange rate indices, although two in particular have been dominant — *bilateral* and *multilateral*. In a *bilateral weighting scheme*, a country's weight in a bilateral index is the share of its total trade (sum of exports and imports) with the domestic country in relation to the total of the domestic country with the countries included. Thus, the weight is derived from direct trade between the local nation and other countries. For example, the weight of country i is determined by its trade with the domestic country as a share of total trade between domestic country and the various countries included in the index,[9]

$$W_i = \frac{\text{domestic country exports to } \textit{plus} \text{ imports from country i}}{\text{sum of domestic country exports to } \textit{plus} \text{ imports from all the countries included.}}$$

In a *multilateral weighting scheme* on the other hand, the weights are based on each country's share of total worldwide trade conducted by all the countries in the index. Thus, using a multilateral approach, the weight for each country "i" is calculated as:

$$W_i = \frac{\text{worldwide exports } \textit{plus} \text{ imports of country i}}{\text{sum of the worldwide exports } \textit{plus} \text{ imports of all the countries included.}}$$

Each alternative, however, has its merits and demerits, and there is no *a priori* way

8 Because of the diverse and extensive nature of the issues involved in the choice of weighting scheme, only a partial review is attempted here. Most of the literature cited contain detailed discussions of the problem. The interested reader is advised to consult them and in addition Honohan(1979), Artus and McGutrik(1981), Morgan Guaranty(1986) and Wickham(1987).

9. Some writers have argued that rather than total trade, total exports or total imports should be used in a bilateral index. See Crockett and Nsouli(1979) pp. 131—132 for a discussion of the arguments in favour of import-weighted index for less developed countries.

to choose between them on conceptual grounds. The main advantage often cited in favour of multilateral weighting scheme is that third-country effect (or substitution possibilities) is taken into account, and this is considered preferable if third market effect seem crucial.[10] The major criticism against multilateral weight is that it gives extraordinary weights to geographical regions within which a great deal of inter-country trade takes place. This implies that undue emphasis is placed on countries that happen to trade primarily with each other, thus overstating the importance of third-market competition.

Bilateral weights on the other hand, have been commended for their simplicity and their emphasis on trade between two countries, which is considered close to actually measuring the importance of individual trading partner to the economic activity of the home country. Another advantage is that they are considered most useful for short-run policy analysis, in that it probably captures the short-run effects of changes in the currency on a country's trade and inflation. The major disadvantage of bilateral weighting scheme which is often cited is that third-country markets are ignored. To counter this some writers have adopted the double-weighting scheme or a combination of bilateral and global weights.

Generally, and despite their imperfections, bilateral weights have universal applicability owing to their simplicity. Some central banks and private and multinational organisations maintain indices based on the two weighting schemes.

IV. EER INDICES: AN APPLICATION TO NIGERIA

The steps taken in applying the concept of effective exchange rate indices to Nigeria can be summarised as follows:

(i) choose a base date for the indicators.

(ii) calculate exchange rate indices vis-a-vis each of the countries in question. The index value at the base date is usually set at 100.

(iii) each country is assigned a weight based on its relative importance for Nigeria; the combined weight is normalised to 1, that is, adds up to 1.

(iv) employing these weights, a weighted average of the exchange rate indices is calculated, giving a nominal effective exchange rate index (NEER).

Before proceeding with the steps outlined above, we have had to contend with the problem of non-availability of exchange rate data in terms of the Nigerian currency for all the currencies selected. Since data on exchange rates of partner currencies are available in terms of a *numeraire* currency (i.e. the U.S. dollar), it was necessary to compute the *cross-rates* before proceeding. To clarify this point, assume that Nigeria trades with 10 countries and that exchange rates of nine (9) of her trading partners, labelled R_1', R_2',... R_9', as well as the pounds/naira, labelled R_n, are expressed in terms

10. Rosensweig(1986) has argued that this is largely a superficial and theoretical one that does not apply in practice. On the same issue, Hervey and Strauss(1987) observed that the statistical gain from the inclusion of third-country effects should be sufficiently great to offset the increased cost and complexity associated with their inclusion.

of one unit of the currency of the U.S., that is the dollar. Cross rates can be computed through the following relationships:[11]

$$\begin{aligned} R_i &= R_n/R_i' \text{ for } i = 1,2,...9 \\ E_i &= R_i'/R_n \text{ for } i = 1,2,...9 \quad \ldots\ldots\ldots\ldots (5) \\ R_i &= R_n \qquad \text{for } i = n \end{aligned}$$

where:

R_i = naira per unit of the ith trading partner's currency;
R_n = naira per unit of U.S. dollar;
R_i' = the number of units of the ith trading partner currency per unit of U.S. dollar;
E_i = unit of the ith trading partner's currency per naira.

In constructing our index, we selected 10 Nigeria's trading partners (mainly the G-10 countries) which control the bulk of Nigeria's trade with the outside world. This apart, these countries have well-developed foreign exchange markets, in addition to most of the currencies being convertible. These countries are: Belgium, France, Italy, Japan, Netherlands, Spain, Switzerland, West Germany, United Kingdom and the United States of America.[12] These countries together controlled on the average over 70 per cent of Nigeria's total trade between 1980 and 1985. (See Table 1). The selection of currencies/countries is seemingly biased against African countries (and developing countries in general) due to the absence of developed foreign exchange market where rates are determined by market forces. This apart, their currencies are tied to at least one of the included currencies. Trade between them is also minimal as they produce identical primary commodities, and where trade is substantial as in ECOWAS sub-region, the incidence of border trade and smuggling distorts published trade figures.

With respect to the choice of base year, we chose 1985 as base year. Our choice was informed by the need to be as current as possible, as well as because 1985 marks a watershed in our economic management. Also we chose the base to afford us the opportunity of comparing our indices with those recently published by the IMF. The base for the weights was 1980—1985, and in particular a simple average of the trade figures for the years to take account of any shifts that may have occurred in the most recent past not captured by an earlier date.

Coming to weighting scheme and choice of a measure of relative importance, as is generally common, we employed total trade and utilised the bilaterial weighting scheme. The appropriate weights (that is, a measure of relative importance for each currency in the index) are contained in Table 1.

Finally, for the averaging technique we have employed the geometric in view of the overwhelming argument in its favour.[13] After computing the cross rates according to equation (5) above, the indices were computed according to the geometric mean formula as follows:

11. Adapted from a lecture material from IMF Institute. Data generated from this exercise is so voluminous that space constraint precludes us from attaching it. They are, however, available from the authors on request.

12. Except for Spain and Switzerland, the rest are members of the G-10 countries.

$$NEER = 100 \prod_{i=1}^{n} (E_{it})^{w_i^*}$$

$$= 100 \exp \sum_{i=1}^{n} w_i^* \log E_{it}^* \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

where:

$w_i^* = (w_i / \sum_{i=1}^{n} w_i)$ = average share of country i's total trade in Nigeria's total trade with the countries included.

$E_{it}^* = (E_{it}/E_{i0})$ = the index of home currency in terms of the ith trading partner's relative to the base year.

$n = 10$

The weights used are bilateral trade weights (w_i^*'s) and represent average total trade for the period 1980—1985, so that

$\sum_{i=1}^{n} w_i^* = 1$. The countries/weights are: Belgium (0.0242559), France (0.1481199), Italy (0.0981114), Japan (0.0500239), Netherlands (0.0922248), Spain (0.0286457), Switzerland (0.0137635), West Germany (0.1439383), U.K. (0.1243577) and U.S.A. (0.2765588).

Base year exchange rate (E_{i0}) is 1985 average for the respective currencies.

Sources of Data

(i) Exchange rate data used to derive the cross-rates were obtained from various issues of the International Monetary Fund's *International Financial Statistics*, as well as the supplementary issue on Exchange Rate published in 1985.

(ii) Trade data for the weights came from various issues of IMF's, *Direction of Trade Statistics Yearbook*.

V. PRESENTATION OF RESULTS AND ANALYSIS

The results of our application for the period 1960—1990, are contained in Table 2. These have been graphed and presented in Chart I.

A cursory examination of the Table and Chart reveals some general and interesting patterns. For the period 1960—1972 which coincided with the fixed exchange rate regime, the indices were relatively stable, while in 1973 the indices declined with the advent of the floating exchange rate system, indicating the depreciation of the Nigerian currency in tandem with what happened to most of the major international currencies during the year. Between 1973 and 1976, the naira on the average appreciated against all the currencies of the trading partners included in the index. This may be attributed to the first oil price shock between 1973 and 1975, which saw the terms of trade in favour of Nigeria. Between 1976 and 1979, the naira once again depreciated against

13. In the more comprehensive paper, we employed two base years — 1980 and 1985, two averaging techniques — arithmetic and geometric, and three bilateral weighting schemes— trade-weighted, export-weighted and import-weighted.

TABLE 1: *TOTAL TRADE OF NIGERIA WITH MAJOR TRADING PARTNERS 1980—1985 (BILATERAL)*
(US $Million)

Year/ Country	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*Total (1980—85)*	*% Share of Total*	*Average (1980—85)*	*% Share of Total*
Belgium	1,054	486	554	252	42	756	3,144	2.43	524	2.43
France	4,211	3,186	3,407	3,075	3,160	2,160	19,199	14.81	3,199.833	14.81
Germany	4,766	3,970	3,186	2,297	1,774	2,664	18,657	14.39	3,109.5	14.39
Italy	1,611	1,784	2,331	3,038	2,113	1,840	12,717	9.81	2,119.5	9.81
Japan	1,761	2,986	9	856	488	384	6,484	5.00	1,080.666	5.00
Netherlands	3,666	2,821	1,636	1,272	1,725	834	11,954	9.22	1,992.333	9.22
Spain	534	865	377	580	547	810	3,713	2.86	618.8333	2.86
Switzerland	540	371	251	154	147	321	1,784	1.38	297.3333	1.38
U.K.	3,399	3,999	3,101	1,932	1,555	2,133	16,119	12.44	2,686.5	12.44
U.S.A.	11,736	8,540	6,078	3,553	2,371	3,569	35,847	27.66	5,974.5	27.66
Total	33,278	29,008	20,930	17,009	13,922	15,471	129,618	100	21,603	100
DOTS World Total	43,436	38,257	27,470	21,068	17,730	22,781	170,742		28,457	
Ratio of Total to DOTS Total	76.6	75.8	76.2	80.7	78.5	67.9	75.9		75.9	

Source: IMF, Direction of Trade Yearbook.

TABLE 2: *NOMINAL EFFECTIVE EXCHANGE RATE INDICES (TRADE-WEIGHTED)*
(Base: 1985 = 100)

	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Average*
1960	98.0	98.0	98.0	98.0	98.0	98.0	97.9	97.9	97.9	97.9	98.0	98.0	98.0
1961	98.0	98.1	96.9	96.9	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.2
1962	97.0	97.0	96.9	97.0	96.9	96.9	97.0	97.0	97.0	97.0	97.0	97.0	97.0
1963	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0
1964	97.0	97.0	97.0	97.0	97.0	97.1	97.1	97.1	97.1	97.0	97.0	97.0	97.0
1965	97.0	97.0	97.0	96.9	97.1	97.1	97.1	97.2	97.1	97.1	97.1	97.1	97.1
1966	97.2	97.2	97.2	97.3	97.2	97.1	97.1	97.1	97.2	97.2	97.2	97.2	97.2
1967	97.2	97.2	97.2	97.1	97.1	97.1	97.1	97.1	97.1	97.1	99.2	99.3	97.5
1968	99.4	99.4	99.4	99.4	99.5	99.7	99.7	99.7	99.6	99.6	99.6	99.6	99.6
1969	99.6	99.7	99.8	100.3	99.8	99.8	99.8	100.8	101.3	100.4	100.1	100.1	100.1
1970	100.2	100.1	100.0	99.9	99.8	99.8	99.8	99.8	99.8	99.7	99.7	99.8	99.9
1971	99.6	99.5	99.5	99.5	99.0	99.0	98.8	98.1	105.4	104.8	104.6	103.3	100.9
1972	101.6	100.6	100.2	100.4	100.3	100.3	100.8	101.3	101.1	101.5	101.8	101.7	101.0
1973	101.8	98.3	95.3	95.8	94.9	92.3	89.6	91.3	91.3	90.7	93.8	95.9	94.3
1974	100.2	98.6	96.7	95.5	101.0	102.2	101.9	103.1	104.4	103.0	102.0	100.7	100.8
1975	98.8	97.9	97.1	98.4	97.7	98.5	101.8	103.6	103.7	102.1	102.1	103.1	100.4
1976	103.3	104.2	106.0	107.2	107.6	108.0	107.8	107.7	120.3	107.6	107.1	106.4	107.8
1977	106.3	106.5	105.2	102.7	102.4	102.3	101.6	102.0	102.2	101.0	100.0	98.4	102.6
1978	99.1	97.1	100.4	101.6	102.1	102.2	101.3	102.2	101.6	101.9	101.6	101.2	101.0
1979	90.4	107.2	91.9	95.3	96.8	97.7	97.8	99.7	101.1	100.7	100.0	100.0	98.2
1980	101.7	103.9	109.5	105.9	102.6	104.5	104.1	105.2	106.9	108.6	111.3	111.2	106.3
1981	113.7	115.6	110.8	107.9	112.3	117.1	118.0	107.8	104.6	104.1	104.9	107.9	110.4
1982	107.8	108.2	108.2	108.7	106.1	109.6	110.6	110.9	111.3	111.5	112.9	112.5	109.9
1983	111.6	110.2	109.8	110.0	110.4	109.1	107.7	109.4	109.5	108.2	110.2	112.0	109.8
1984	113.7	111.4	108.7	109.9	112.7	111.9	113.1	114.1	117.5	118.0	113.0	114.4	113.2
1985	114.5	113.8	110.5	104.0	103.3	101.7	98.2	95.8	94.9	89.9	88.4	83.8	100.0
1986	79.4	77.0	75.3	74.3	72.2	66.5	57.7	54.0	15.4	15.1	17.2	18.6	51.9
1987	16.5	16.1	15.4	15.2	14.3	14.8	15.6	14.6	14.1	13.8	13.1	13.1	14.7
1988	13.6	13.6	13.3	13.5	13.9	13.9	13.1	13.2	12.9	12.4	11.3	10.9	13.0
1989	9.3	8.8	8.6	8.7	9.0	9.2	9.2	9.1	8.9	8.8	8.6	8.3	8.9
1990	8.2	8.1	8.1	8.1	8.0	8.0	7.8	7.6	7.6	7.4	7.0	6.7	7.7

the partner countries' currencies. This period coincided with the downturn in economic activity that characterised the international economy, largely in response to the oil price crash during the period. The period 1979—1980, saw the second round of the oil price shock, culminating in an appreciating naira between 1979 and 1984. This was the period during which the general belief (in both domestic and international circles) was that the naira had been grossly overvalued and the country was losing her international competitiveness, given the precarious economic situation that the country found itself then, which could not sustain such high value of the naira. The sharp and rapid depreciation between 1984 and the adoption of the Structural Adjustment Programme (SAP) in 1986 to ameliorate the economic crisis, was as a result of the managed float exchange rate system adopted then to re-align the value of the naira with that of her major trading partners.

The sharp depreciation noticed between 1986 and 1987 was a consequence of the SAP which sought to find a realistic exchange rate of the naira through the introduction of a market-oriented foreign exchange market. From 1987 onwards, the depreciation has been gradual. This is in sharp contrast to the general perception when a single bilateral nominal exchange rate of the naira vis-a-vis the U.S. dollar is used to measure the value of the naira between 1986 and 1990. The implication is that, even though the naira on average had depreciated against the currencies of the trading partners, it has done so with varying degrees. Therefore, using a single bilateral rate may not give a true picture of the extent of overall depreciation.

To test the robustness of our computations, we compared our results with the indices computed by the IMF, subjecting them to simple correlation analysis (in level form) and test of differences.[14] Both indices are presented to Table 3 and graphed in Chart 2. Generally, our indices are highly correlated with the IMF-computed indices with a simple correlation coefficient of about 99.3 per cent. Also, there was no significant statistical difference either in means or variances between them. From Chart 2 between 1980 and 1985, the IMF index was below our indices, but from 1986 the reverse was the case, although they moved in tandem with each other. Also, both indices were generally closer to each other from 1985. The differences may not be unconnected with the conceptual issues reviewed in Section III.

VI.. CONCLUSION

This paper has set out to review the technical difficulties involved in the construction of EER indices and to apply the methodology to Nigerian data. In all modesty, this objective has been accomplished in the paper. Our empirical application revealed some general patterns and differences often found in similar studies.

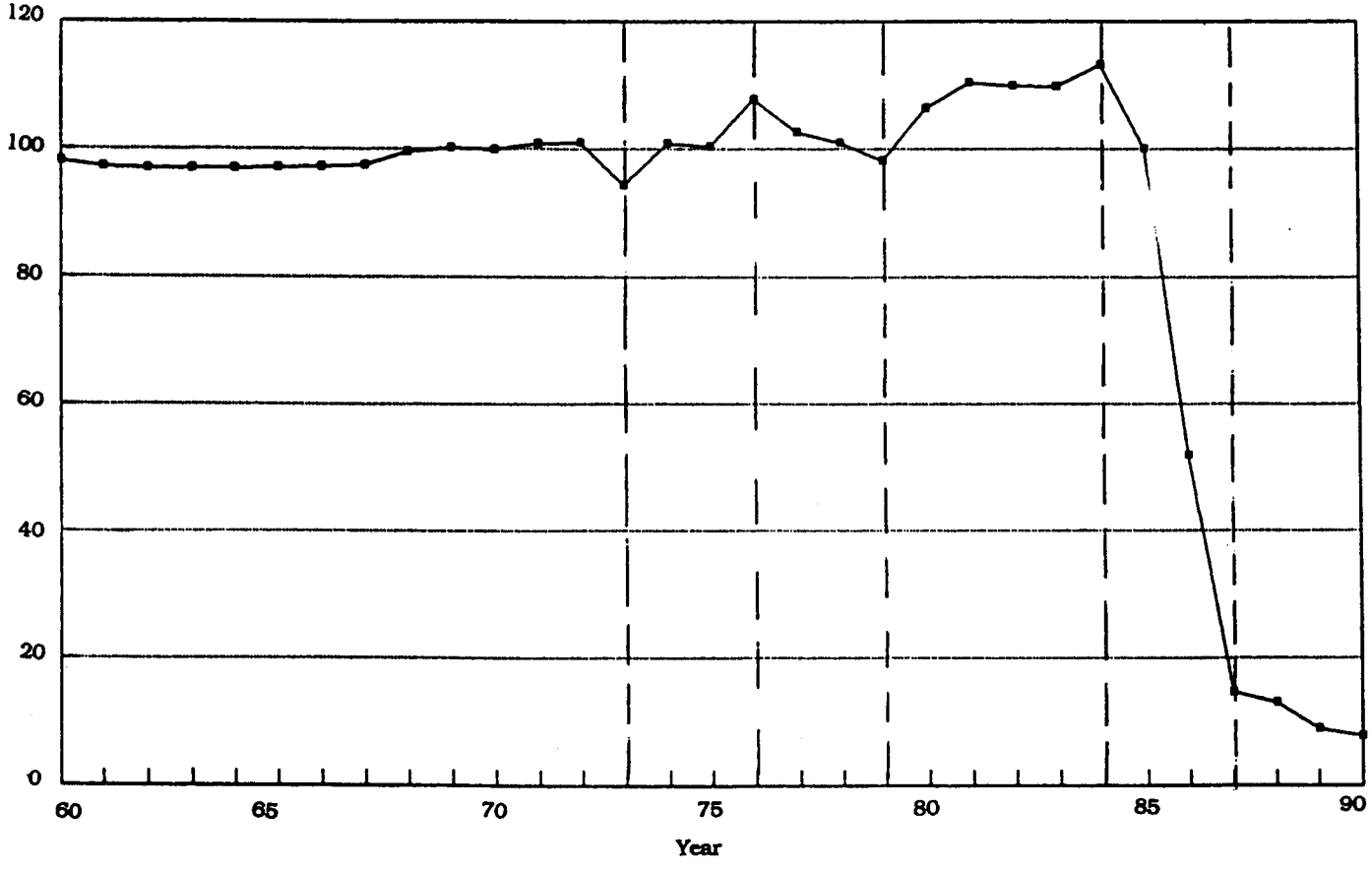
Our results are, however, tentative even though it compared very well with the only known existing exchange rate indices for Nigeria computed by the IMF. This is so, because no single index can be acclaimed to be ideal for all purposes, since it depends on the choice of base year, choice of currencies/countries, averaging technique, and choice of weights/weighting schemes.

In conclusion, we state that the paper is meant to stimulate interest in this relatively

14. The results are not presented here, but are available on request. It is also possible to carry out the tests in growth rate or percentage changes.

CHART 1

NIGERIA: NOMINAL EFFECTIVE EXCHANGE RATE INDEX (1960—1990) Base: 1985 = 100



unexplored area of empirical research in Nigeria. Furthermore, research in this area is worth the effort given the type of statements from both practitioners and theoreticians regarding movements in the value of the naira since the adoption of SAP. In addition, computing a multilateral exchange rate indices for the country is considered appropriate, if not for any other purpose, at least to enable one compare it with the bilateral index. Most Central Banks maintain such information.

Finally, in a follow-up paper to this, we intend to address the issue of real effective exchange rate indices for Nigeria.

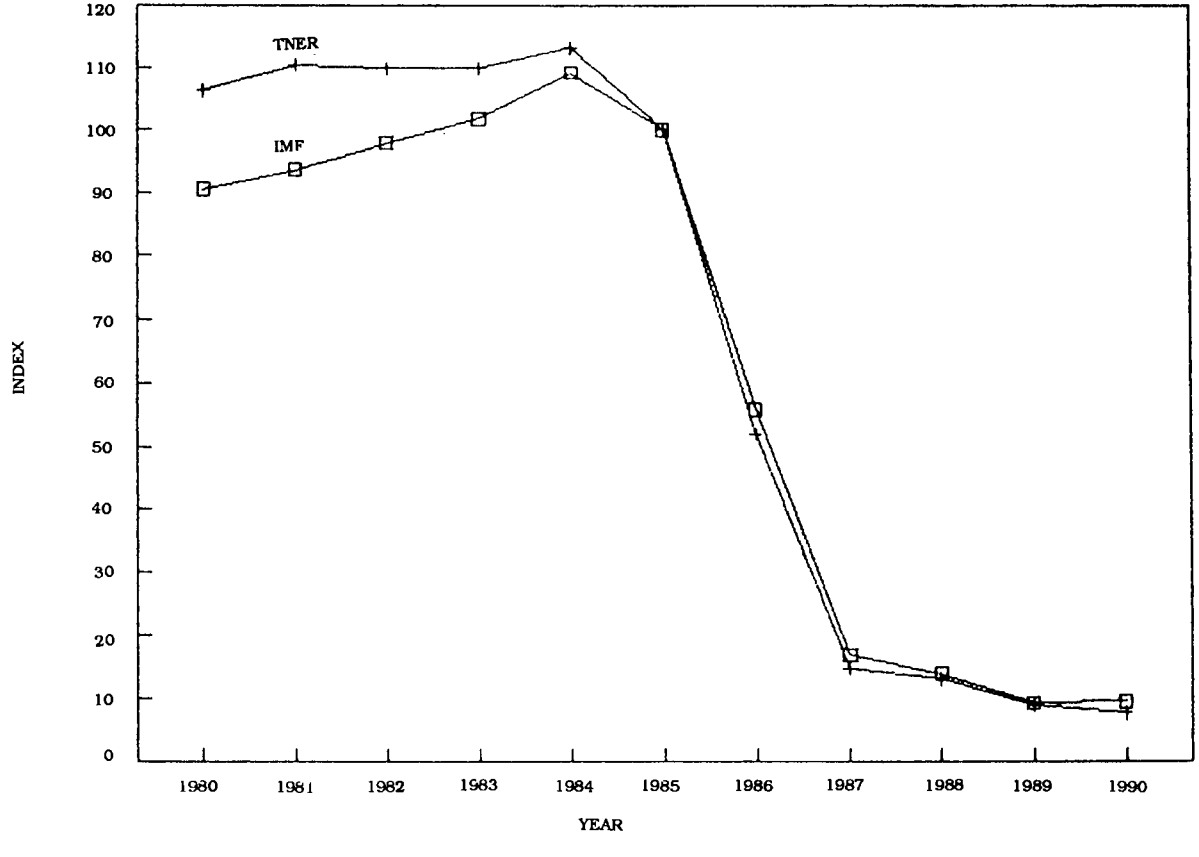
TABLE 3: *COMPARISON WITH IMF NEER INDICES 1980—1990 (1985 = 100)*

Year	*IMF85*	*TNER85*
1980	90.6	106.3
1981	93.7	110.4
1982	98.0	109.9
1983	101.8	109.8
1984	109.1	113.2
1985	100.0	100.0
1986	55.8	51.9
1987	16.8	14.7
1988	13.8	13.0
1989	9.2	8.9
1990	9.4	7.7

Notes: IMF85 = IMF indices
TNER85 = Our own trade-weighted indices.

CHART 2

COMPARISON WITH IMF NEER
(1985 = 100)



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