Computation of Nigeria's Real Effective Exchange Rate Indices[1]

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The exchange rate is a useful macroeconomic indicator which aid policy makers to take informed actions to stimulate or sustain the economy on a long run growth path. Thus, several exchange rate indices (bilateral nominal/real exchange rate, nominal effective exchange rate, real effective exchange rate, purchasing power parity, etc) are computed for different policy information. In this paper, we computed Nigeria's real and nominal effective exchange rate (REER and NEER) indices using a pool of high frequency monthly data for the period 1996-2007. The paper observed that the REER index appreciated most of the period due to inflationary pressures in Nigeria, implying a loss in Nigeria's competitiveness relative to its major trading partners. The conclusion was that the naira was overvalued in real terms. The NEER also appreciated during the review period against the currency indices of the major trading partners, indicating a stronger naira. The paper advocated a basket approach to naira nominal exchange rate determination in which the relative macroeconomic developments in major trading partner economies are factored into the market exchange rate of the naira. A major shortcoming of the present study is that sub-regional effects of Nigeria's trade with its neighbors were not factored into the computations due to dearth of data. Current data indicate low level trade between Nigeria and its neighbors and other African countries

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I. Introduction

The real exchange rate is both an external and internal indicator of the competitiveness of an economy. As an external indicator, it is the nominal exchange rate adjusted for price differentials between countries, i.e. the ratio of aggregate foreign price levels or cost level, to the home country's aggregate price level or cost level measured in a common currency. The external real exchange rate derives from the concept of the purchasing power parity (PPP), which compares the relative value of currencies by measuring the relative prices of foreign and domestic consumption or production baskets in different countries. As a measure of domestic (internal) competitiveness, it is the ratio of the domestic prices of tradables to non-tradables in the home economy. The internal real exchange rate captures the internal relative price incentives in an economy, i.e. by allocating resources internally between the production and consumption of tradable and non-tradable goods. In this way, the real exchange rate serves as an indicator of the incentives for domestic resource allocation.

Each of the two broad categorizations of the real exchange rate gives rise to alternative formulations derived from different analytical approaches. For instance, three variants of the external real exchange rate can be identified based variously on the purchasing power parity, the Mundell-Fleming one-composite-good, and the law of one-price of internationally competitive traded goods approaches. Similarly, three variants of the internal real exchange rate are identifiable based on one-good, two-good or multi-good models. The differences in conceptualization and measurement adopted by the various approaches raise fundamental issues about the theoretical and empirical relationships among the resulting indices, the interpretation of differences in their behaviour and the appropriate measure to use in a given situation.

Conceptually, the multiplicity of the underlying theories of real exchange rate computation provides incredible problems of measurement and comparability of the emerging rates and indices. The reason is that the

underlying theories necessitate the use of different price and cost indices in the computation. Besides, the composition of the basket and weights for domestic and foreign goods enunciated in some of the theories display large ambiguity under empirical investigations, thus making comparability difficult. Although these problems are common in most countries, developing countries are particularly vulnerable due to the existence of large informal foreign exchange markets, smuggling and unrecorded cross border trade, shifts in trade policy, erratic volatility in the terms of trade and trade patterns; all of which create complexities that are not usually encountered when computing the real exchange rate for industrial countries. In addition to these, it is often difficult to find exact empirical measures of the desired indices in developing countries. In most developing countries therefore, the dearth of data has restricted the use of the empirical measures of the real exchange rate to CPI Indicators and GDP deflators even though in a number of cases, the underlying process that generated the data was fraught with substantial inconsistencies. These data related shortcomings notwithstanding, the real effective exchange rate has continued to be an important indicator of economic competitiveness across countries.

Given the policy relevance of the real exchange rate as a potent variable in economic analysis, policy evaluation, financial planning and economic forecasting, it becomes necessary for countries to consistently update their real exchange rate index to serve as a guide to exchange rate management. This is against the limitations of relying on the one currency based nominal exchange rate in a country with multiple trading partners. The limitations of using changes in dollar or euro based bilateral exchange rate to make policy decisions affecting other currencies has necessitated the need for developing an updated real effective exchange rate index that would more appropriately capture developments in one currency against the currencies of the other trading partners at a point in time. In this paper, therefore, we explore this possibility, limiting reference to the real exchange rate to the external real exchange rate. Consequently, the paper examines some of the methodological concerns involved in computing the real exchange rate and updated Nigeria's real exchange rate index for

the period 1996 to 2007. We benefited from the works of Mordi and Audu (1991), Obadan (1994) and Obaseki (2001), who had variously computed Nigeria's nominal/real effective exchange rate using different approaches.

The theoretical expose of the paper is anchored on the premise that an appropriate definition of the real exchange rate depends on a complicated interplay of the theoretical model of interest and much more on data availability. In computing the rates and indices for Nigeria, the period chosen covers two exchange rate regimes: a fixed official exchange rate regime (1996 and early 1999) and a market determined exchange rate regime (late 1999 to 2007). To achieve our objective, the paper examines some conceptual and common methodological concerns in Section II. In Section III, we employed the methodology we found most appropriate in the computations, while Section IV summarizes and concludes the paper.

II. Methodological Issues in the Computation of Exchange Rate Indices

II.1 Some Definitions

Nominal Exchange Rate

The nominal exchange rate is the number of foreign currency units per unit of home currency. In this case, we are looking at the bilateral exchange rate hence; only two currencies are involved in the transaction because a country with only one trading partner has between its currency and that of the trading partner only, to monitor. Consequently, only the nominal exchange rate or the bilateral real exchange rate would be needed to show the level of competitiveness between them. Changes in the nominal exchange rates could have important effects on the external trade of the countries concerned through the effects on the relative prices of goods, that is, the ratio of the price level of the home country to the price level in the trading partner country.

Nominal exchange rates can be measured either in terms of domestic currency (units of domestic currency per unit of foreign currency, E_{dc}) or in

foreign currency terms (units of foreign currency in terms of one unit of domestic currency, E_{fc}). Whichever definition is desired, the other becomes the inverse. This relationship is shown in equation (1) as:

$$E_{dc} = \frac{1}{E_{fc}} \quad \text{.....} \quad (1)$$

Where only one trading partner is involved, we define the exchange rate as:

$$R_i = \frac{R_i}{R_i^*} \text{ for all i = 1}$$

$$R_i = R_n \quad \text{for i = 1}$$

$$E_i = \frac{R_i^*}{R_n} = \frac{1}{R_i} \text{ for all i = 1} \quad \text{.....} \quad (2)$$

where:

$R_i =$ units of domestic currency per unit of the i[th] trading partner's currency

$R_n =$ units of domestic currency per unit of trading partner currency

$R_i^* =$ number of units of i[th] trading partner currency per unit of domestic currency

$E_i =$ units of the i[th] trading partner's currency per unit of domestic currency

The nominal exchange is important in determining the cost of imports and the level of revenue to the exporter.

Bilateral Exchange Rate

In a multilateral trading system where the country trades with several other countries, many different exchange rates and different price levels are involved. Consequently, where a country trades with many partners, the exchange rate is defined as units of home currency per unit of the currency of each trading partner, apiece. This then raises the issue of multilateral exchange rates commonly referred to as bilateral exchange rates. The bilateral exchange rate in a multilateral relationship is defined algebraically as:

$$E_i = \frac{R_i^*}{R_n} = \frac{1}{R_i} \text{ for all i = 1, 2, ...n} \quad \text{(3)}$$

$$R_i = R_n \text{ for i = n}$$

Where:

$R_i =$ units of domestic currency per unit of the i^{th} trading partner's currency

$R_n =$ units of domestic currency per unit of trading partner's currency

$R_i^* =$ number of units of i^{th} trading partner's currency per unit of domestic currency

$E_i =$ units of the i^{th} trading partner's currency per unit of domestic currency

In a multi-country trading relationship, it is often convenient and useful for policy and analytical expose to employ an index that reflects the relationship between the domestic currency and the currencies of the other trading partners. Consequently, we would measure the home country's competitiveness by the use of a bilateral exchange rate index, which approximates the ratio of the relative prices between the home country and the trading partners. However, the bilateral exchange rate has limited application to policy because of its inability to capture variations in the value of one currency against another due to changing economic fundamentals. Consequently, to make bilateral exchange rates useful in gauging changes in other currencies, the need to aggregate bilateral exchange rates in an index that would incorporate changes in the relative values of specified currencies against a base currency over a period of time becomes necessary.

Real Exchange Rate

The real exchange rate broadly defined, is the ratio of foreign currency to domestic currency based on some broad based price indices such as the CPI or GDP deflator, and expressed in a common currency by using the nominal exchange rate to convert the price level in one country to the currency of the other. In the context of developing countries, the real exchange rate is seen analytically either as the relative price of traded goods in terms of non-traded goods (the two-good internal real exchange rate), or as the relative price of exports and imports in terms of non-traded

goods(the three-good internal real exchange rates). Irrespective of the price or cost indicator used, the real exchange rate of a country can be defined in relation to one trading partner or to an average of all the major trading partners or competitor countries.

The bilateral real exchange rate is useful both as a bilateral and general indicator of the real exchange rate in conditions where a country is a member of a currency zone or has one dominant trading partner. The bilateral real exchange rate ($BRER_{dc}$) between the domestic economy (d)and a foreign trading partner country (f) can be defined as shown below:

$$BRER_{dc} = \frac{E_{dc} * P_{Gf}}{P_{Gd}} \quad \text{.....} \quad (4)$$

where:

E_{dc} is the index of the nominal exchange rate of the domestic currency, P_{Gf} and P_{Gd} are the foreign and domestic general or aggregate price indexes, respectively.

The subscript *dc* indicates that the bilateral real exchange rate is defined in terms of the domestic currency. A decline in the index of the RER_{dc} (which corresponds to a real exchange rate appreciation), reflects an increase in the prices of goods and services relative to that in the foreign country.

The inverse of the bilateral real exchange rate index in foreign currency terms is also defined as indicated in equation (5).

$$BRER_{fc} = \frac{E_{fc} * P_{Gd}}{P_{Gf}} = \frac{1}{BRER_{dc}} \quad \text{.....} \quad (5)$$

A change in the index of the bilateral nominal/real exchange rate is referred to as an appreciation or depreciation of the home currency in relation to the trading partner currency with respect to an underlying equilibrium exchange rate. A misalignment in the nominal/real effective exchange rate indicates a condition in which a country's actual nominal/real exchange rate deviates from the implicit or ideal nominal/real exchange rate.

Effective Exchange Rate

The effective exchange rate has developed due to the existence of multiple trading partners to capture the relative trade weights of the numerous trading partners with the home country in computing the nominal or real exchange rate. Consequently, when the various trade weights of the major trading partners are taken into account, the emerging exchange rate is the nominal effective exchange rate, while taking care of the relative trade weights and price differentials between the countries produces the real effective exchange rate. Thus, the effective exchange rate could be nominal or real, and both are potent tools for economic analysis, policy evaluation, financial planning and forecasting, amongst other uses.

Nominal Effective Exchange Rate

We define the nominal effective exchange rate as a product of the weighted average of the bilateral nominal exchange rates between the home country's currency and that of its trading partners. The nominal effective exchange rate could be computed for individual trading partners and for all the trading partners. When the nominal effective exchange rate is used to compute the real effective exchange rate, it creates the possibility for separately analyzing the effects of movements in nominal exchange rates and foreign prices. It also allows a further decomposition of the nominal effective exchange rate to express its movements in terms of changes in the exchange rate between the home currency and a reference currency, and in the nominal effective exchange rate relative to the reference currency as indicated in equation (6) below.

$$NEER_{dc} = E_{dc} * \frac{NEER_{dc_b}}{E_{dc_b}} \quad \text{.....} \quad (6)$$

where:

E_{dc_b} is the nominal exchange rate with the base or target currency.

This decomposition is useful where a peg or protected exchange rate exists. Consequently, such an exchange rate becomes typically a policy (target) variable while the nominal effective exchange rate relative to the

peg currency is an exogenous variable for the country using the peg. An important property for exchange rate index analysis is the attention on determining not only the level of the index at any material time but also the rate of appreciation and depreciation of the index over time.

Real Effective Exchange Rate

The real effective exchange rate is the nominal effective exchange rate adjusted for relative price differentials between the home country and its trading partners. It is defined in terms of the domestic currency in two ways: as a weighted geometric mean of the exchange rate of the trading partners and their relative price levels, or as a weighted arithmetic mean. If we define the effective real exchange rate as a geometric weighted average, it is shown as in equation (7).

$$REER_{dc} = \prod_{i=1}^{m}\left[E_{dc_1} P_{Gi}\right]^{\omega_{id}} * \frac{1}{P_{Gd}} \quad \text{.....} \quad (7)$$

where:
m is the number of trading partners of the domestic economy, Π denotes the product of the real exchange rate (the bracketed term) over all the trading partners, ω_{id} is the appropriate trade weight for each of the trading partners *i(i=1, 2, ..., m)* with the domestic economy. The trade weights of the trading partners sum to 1 as indicated in equation (8) below.

$$\sum_{i=1}^{m} \omega_{id} = 1 \quad \text{.....} \quad (8)$$

When the real effective exchange rate is defined in foreign currency terms, it is expressed as in equation (9).

$$REER_{fc} = \prod_{i=1}^{m}\left[\frac{E_{fc_i}}{P_{G_i}}\right]^{\omega_{id}} * P_{Gd} = \frac{1}{REER_{dc}} \quad \text{.....} \quad (9)$$

Two alternative methods for computing the real effective exchange rate are often employed. However, the statistical information generated by the two methods differs. For instance, the methods decompose the components

of the real effective exchange rate differently, but give additional information which is found useful in analyzing the resultant indices. In the first method, the real effective exchange rate is computed as a geometric weighted average of the bilateral real exchange rates of the home country with each major trading partner. This real effective exchange rate of the domestic economy is computed as shown in equation (10)

$$REER_{dc} = \prod_{i=1}^{m} BRER_{dc_i}^{\omega_{id}} \quad \text{.....} \quad (10)$$

where:

$BRER_{dc_i}$ is the bilateral real exchange rate of the domestic economy.

When the effective real exchange rate is computed as in equation (10), information on calculations of bilateral real exchange rate indices for individual countries can be made available. Where a country pegs to a major currency, it is useful to express the domestic effective real exchange rate in terms of changes in the domestic country's bilateral real exchange rate with the peg currency caused by differences in inflation at home and the peg countries. Also, it can be analyzed with respect to changes in the home country's real effective exchange rate relative to the bilateral real exchange rate with the peg currency caused by inflationary differences and exchange rate movement in third country currencies as demonstrated in equation (11)

$$REER_{dc} = BRER_{dc} * \frac{REER_{dc}}{BRER_{dc_b}} \quad \text{.....} \quad (11)$$

where:

$BRER_{dc_b}$ is the bilateral real exchange rate with the base or target currency.

In the second method, the real effective exchange rate is computed as the product of the nominal effective exchange rate and the effective relative price index. Thus, we rewrite equation (4) as shown in equation (12)

$$REER_{dc} = \frac{NEER_{dc} * EP_{Gf}}{P_{Gd}} \quad \text{.....} \quad (12)$$

where:

$$NEER_{dc} = \prod_{i=1}^{m} E_{dc_i}^{\omega_{id}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

and

$$EP_{Gf} = \prod_{i=1}^{m} P_{Gi}^{\omega_{id}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

But:

$NEER_{dc}$ is defined as the nominal effective exchange rate in terms of the currency of the domestic economy and its trading partners. EP_{Gf} is the geometric weighted average (or effective) of foreign aggregate price index for the home country's trading partners.

Undervalued/Overvalued Exchange Rate

An exchange rate is undervalued when it is more depreciated than the equilibrium exchange rate, and overvalued when it is more appreciated than the implicit exchange rate. An appreciation/depreciation in the real exchange rate is an increase/decrease in the value of the domestic currency relative to a foreign currency. An appreciation is an increase (upward movement) in the real exchange rate in foreign currency terms, representing a decrease (downward movement) in the index in domestic currency terms since this is the inverse of the foreign currency index. When a currency appreciates or depreciates, it does so against n-other currencies with varying degrees of change. A real exchange rate appreciation in the face of high inflation may lead to a deterioration of the current account position. Since real effective exchange rate indices are normally weighted averages of a number of exchange rates, their use avoids the wrong generalizations about the value of a currency that may arise by merely observing the fluctuations in the bilateral nominal or real exchange rate.

To know by how much a currency is overvalued/undervalued, we compare what the value of the domestic currency should be given domestic and foreign trading partner price levels with what it currently exchange for. If the real exchange rate dictates that the naira should exchange at x3.00/ US$1 given domestic and foreign price levels, but the current exchange rate of the naira is x5/US$1, then we say the naira is undervalued by x2

because we are paying more naira for dollar when indeed the fundamentals indicate that we should pay less. If however, the fundamentals indicate that we should pay x10/US$1, and the official exchange rate is x8/US$1, then, we say that the naira is overvalued by N2 since we are paying less naira per dollar when we should be paying more.

Exchange rate misalignments have varying degrees of influence on the behaviour of economic aggregates. In particular, an exchange rate overvaluation could hinder the pace of economic growth, while an undervaluation is thought to provide an enabling environment for growth. In the real sense, however, both over-valuation and undervaluation are inimical to growth. However, unless the ideal exchange rate is clearly specified, an effective nominal or real exchange rate misalignment remains largely an abstraction. An ideal real exchange rate, therefore, is expected to achieve price competitiveness, while a weak domestic currency in real terms makes it easier to sell domestically produced goods abroad. In addition to achieving cost competitiveness, it takes account of the percentage mark-up in the price that compensates for labour productivity and rewards entrepreneurship. In this case, the real exchange rate is the nominal rate adjusted by wages and productivity levels and closely appears as a measure of competitiveness. Thus, as productivity level rises/falls, the real exchange rate appreciates/depreciates.

II.2 Some Methodological Issues

Choice of Weights

The first step in computing the real effective exchange rate is the choice of countries that constitute the major trading partners of the home country. This, however, is subject to the availability of trade data between the countries. Where a country, perceived to be a major trading partner, lacks adequate or reliable trade data, it could be replaced by less important countries that have adequate and reliable data. For instance, substantial trade exists between Nigeria and most of the countries in West Africa, but this trade is unrecorded and, therefore, the countries are excluded in the basket of Nigeria's major trading. Also, low inflation in major trading

partners not covered in a sample in preference to high inflation countries included in the sample could distort the emerging index. One guiding principle is that it serves no useful purpose to include many countries in the basket if better results could be produced with fewer countries. For instance, if Nigeria accounts for 60 per cent of trade with Benin Republic, and France accounts for 25 per cent, it serves no useful purpose to include a list of 15 countries that would make no difference in computing Benin's real effective exchange rate. Consequently, we settle for just two countries in computing the country's real effective exchange rate.

Weighting Criteria

Choice of Goods and Services

Closely associated with the choice of trading partners is the choice of goods and services to be included in the basket. The nature of goods and services in the basket significantly influence the choice of weights. For instance, the weight of West African countries with very large agricultural sector will be very weak if the index was made up mainly of manufactures. It would be higher if; however, the index took mainly agricultural raw materials into account. One approach is to choose a basket of goods and services that are comparable across countries because the tradable goods sector is the one most often exposed to shifts in the real exchange rate. Consequently, it is advisable that raw materials should be excluded from the basket of goods and services included in the computation. As is the practice, trade data on all goods and services exposed to international competition is preferred. The strength of this approach is that changes in the real exchange rate influence economic activity primarily through their impact on competitiveness in the tradable goods and services sector.

The Averaging Method

Geometric Averaging Method used here is often preferred over the arithmetic method even though the latter is simpler to calculate. This is because the geometric method has certain properties of symmetry and consistency that an arithmetic method does not possess. Although the

logarithm of a geometric average is the arithmetic average of the logs of the bilateral exchange rates, the geometric average method evaluates movements in exchange rate symmetrically, thereby avoiding the undesired properties associated with arithmetic averages. A geometric index gives real exchange rate levels for which the percentage change between two periods is not influenced by the choice of the base year and may; therefore, be readily rescaled to have a different base year. In a geometric average, currency depreciation and appreciation are treated in an entirely symmetric manner[2]. The geometric average is also indifferent to the definition of exchange rate adopted, and its index responds proportionally to depreciating and appreciating currencies. As shown by Mordi and Audu (1991), the geometric based index satisfies the time reversal test.

Although the geometric method is theoretically preferable, it is sometimes criticized for complicating the process of calculating the monthly and quarterly average real effective exchange rate indices. To derive the average value of the index over a quarter, daily readings of the index could be taken (calculated as a geometric average across all the bilateral exchange-rate pairs) from which the arithmetic average of these readings could be formed over the quarter. On the other hand, one could form the arithmetic average over the quarter of each bilateral real exchange rate, and then generate the geometric average across these quarterly average bilateral pairs. These two approaches do not generally yield the same results. For the same reason, constructing the real effective exchange rate index cannot be done by simply deflating the bilateral nominal exchange rate index by the ratio of the relative domestic price level. Rather, the use of the geometric averaging procedure is more generally accepted as capturing relative trade weights with the major trading partners.
The **Arithmetic Averaging Method** is presented in equation (15).

$$REER_A = \sum_{i=1}^{n} \propto^{i} \frac{\left(\frac{E_{it}^{pr}}{P_{it}^{pr}}\right)}{\left(\frac{E_{10}^{pr}}{P_{10}^{pr}}\right)} * 100 \quad \text{.....} \quad (15)$$

[2] *For further properties of the Geometric Average method, see Brodsky (1982) and Maciejewski (1983).*

Where:

$REER_A$ = real effective exchange rate calculated by the Arithmetical Average Method;

E_{it}^{pr} and E_{10}^{pr} are the ratios of the bilateral exchange rates of the ith trading partner country to the reporting country at time t=1 and time t=0, respectively. P_{it}^{p} and P_{10}^{pr} price index of the ith foreign country at time t relative to the base period and the price index of trading partner country at time t=1 and time t=0, respectively; ∞_i = weight assigned to the ith foreign currency.

Differences may occur in the percentage movements using the arithmetic method depending on whether the bilateral rates are expressed as units of home currency per foreign currency unit or not. Also, using the arithmetic method, exchange rate indices can be distorted when the base period is changed. In an arithmetic index, the percentage changes between any two periods depend on the base year used in computing the index so that rescaling (or rebasing) the index from the original base year to a different base year affects the percentage changes in the index. Also, an arithmetic index gives larger weights to currencies that have appreciated or depreciated to a significant extent relative to the domestic currency.

II.3 Import Competitiveness Indicator

The use of import-competitiveness indicator measures a country's competitive position at home, while an export-competitive indicator measures its competitiveness in the export markets. A useful real effective exchange rate index takes into account the global performance of the economy. Indices can thus be constructed using bilateral or multilateral trade weights. Using the bilateral approach, weights are computed based on the level of trade between the home country and individual trading partners. However, because this approach does not take account of competition between home country products in third markets, it tends to understate the degree of competition facing the home country in foreign markets. For instance, while Nigerian farmers may not be exporting cocoa to Ghana, they must compete with Ghanaian Cocoa producers in European

markets. This possibility is often overlooked in assigning weights and so does not reflect in ascertaining an economy's competitiveness. Import weights is shown in equation (16) below : Import weights:

$$wm^{i}_{j} = \frac{m^{i}_{j}}{m_{j}} \quad \text{.....} \quad (16)$$

Equation (17) for instance, can be used in computing the weight of US in (i) Nigeria's bilateral imports (*j*).

II.4 Export Competitiveness Indicator

Using the double weighing approach, Nigeria's competitiveness could be compared against that of Canada by ascertaining the weight of Canadian exports in Nigeria's exports. This is a reflection of direct competition between exports and imports in a given market, and the weight of Canada as Nigeria's competitor in third markets, a reflection of both countries' competition in third markets. This is shown in equation (17) as:
Export weights:

$$wx^{i}_{j} = \left(\frac{x^{i}_{j}}{x_{j}}\right)\left(\frac{y_{i}}{y_{i} + \sum_{s \neq i,j}^{N} x^{i}_{s}}\right) + \sum_{k \neq i,j}\left(\frac{x^{k}_{j}}{x_{j}}\right)\left(\frac{x^{k}_{i}}{y_{k} + \sum_{s \neq k,j}^{N} x^{k}_{s}}\right) \quad \text{.....} \quad (17)$$

where:

$x^{i}_{j}\left(m^{i}_{j}\right)$ = exports (imports) of country *j* to (from) country *i*;

$x_{j}\left(m_{j}\right)$ = total exports (imports) of country *i*;

y_{i} = Output of country *i* for the domestic market;

N = all countries considered in calculating the index;

S = businesses of countries other than countries *i* and *j*.

In equation (18), the weights calculated could account for the share of Nigerian exports to the US and the importance of US companies as competitors of Nigerian firms in US domestic markets and the share of US firms in third markets.

II.5 Total Trade Weights

The use of sector-specific trade data would be more useful under such circumstance because Nigeria and Canada may export to third markets but the exports may not be close substitutes, as such competition, may not exist between the two countries in those market. Double weighted index are represented by the following relationships:

Total weights: $$w_i = \left(\frac{m_j}{x_j + m_j} \right) wm_j^i + \left(\frac{x_j}{x_j + m_j} \right) wx_j^i \quad \text{..... (18)}$$

II.6 Use of Price or Cost Indicators

Apart from the choice of what goods and services to include in the index, another issue that needs to be determined is whether cost or price indicators are to be used. In practice, cost indicators are often preferred because individual firms can reduce their profits or prices in reaction to economic conditions to preserve their share of the market. The problem with using cost indicators is that there is no global measure of cost but partial measures or price indices provide a guide.

Export Prices

Export prices are the most direct measure of internationally traded goods. However, the composition of the goods may differ significantly between countries. Consequently, detailed data may not be available. Beside this, export based price indices could easily be influenced by commodity prices, which are often exogenously determined by world markets. Thus, for countries like Nigeria in which one commodity (oil) has a large share in exports; this can be a major problem. As Lafrance (1988) has shown, a drop in commodity prices could lower the real exchange rate based on export

prices, without necessarily implying that the domestic country's international competitiveness has improved.

Producer Prices

Producer Price Indices are a reflection of true sales and not just exports in that they reveal the behaviour of prices in the tradable goods sector rather than that of general exports. However, they still suffer the shortcomings of export price indices. Primarily, they are incomparable because their composition varies across countries. They may also include goods not traded internationally and may be affected by exchange rate variation. Unlike the CPI, the construction of the PPI varies across countries. Consequently, changes in weights could show up as changes in RER which could serve as a major limitation for the PPI approach. This coupled with the high components of imported intermediate goods, result in a RER that is not a suitable measure of competitiveness.

II.7 Choice of Indices

CPI Based Indices

The computations of most real effective exchange rate indices make use of consumer price indices (CPIs). Weig (1987) noted that there are theoretical reasons to prefer other types of price indices, but the CPI is highly favoured because of the availability of a wide array of data on several countries. Although majority of real exchange rate computations make use of the CPI, it is limited in applicability because the CPI may include a sizable proportion of imported goods, implying an understatement of the degree of improvement in competitiveness of the domestic economy, especially during times of devaluation of the domestic currency. Also, CPI includes non-internationally traded goods like housing and services instead of only consumer goods. In addition, CPI carries the weight of consumption taxes and subsidies, and these items are not normally considered when comparing competitiveness. Thus, the use of CPI indices is not generally accepted because it does not sufficiently measure the prices of non-tradables and weighs fairly heavily on non-traded goods and

services. Despite these limitations, the CPI based real exchange rate index computation is preferred due to data availability.

GDP Indices/GDP Deflators

By using GDP indices or GDP deflators, the principle of limitation to consumer goods associated with the CPI is violated because the GDP indices include capital goods and export products, but exclude imports. They also cover non-export sectors of the economy such as construction, household services and government. The use of unit labour costs (ULC) expressed in a common currency, often employed in international competitiveness measurement is not common in most developing countries due to data constraints. These are indicators of average expenditures on wages per unit of good or service produced. A good number of countries use the ULC or the cost of capital for international comparisons of competitiveness. ULCs, however, fail to capture cost of services for manufacturers, especially in sub-contracting some administrative and other services. The absence of appropriate mechanism for measuring productivity in the services sector makes for overestimation of productivity in the goods sector, thus, introducing a bias in international comparisons of competitiveness. Given these data constraints, limited use is made of these methodologies in this paper.

II.8 Choice of Base Year

The base year chosen for the computation may largely depend on the author's discretion. However, as a guide, recourse is made to the period of relative macroeconomic stability. Although the variables to be observed for the said stability depend on the author, nevertheless, the choice should be logically defendable. Generally, inflation and exchange rate play an important role.

III Computing Nigeria's Exchange Rate Indices

In computing Nigeria's exchange rate indices, we used data from 12 trading partners. The countries whose trade data with Nigeria was used include:

Brazil, China, France, Germany, India, Indonesia, Italy, Japan, Netherlands, Spain, United Kingdom and the United States. These twelve countries account for at least 79 per cent of trade with Nigeria for the period 1996 to 2007. The exchange rate used for France, Germany, Italy, Netherlands and Spain (who became members of the European Monetary Union with effect from 1st January 1999) was the euro which became the effective exchange rate for those countries as from that date. African countries were not included in the basket of trading partners because of the non-availability of reliable trade data. Although a large volume of informal trade takes place between Nigeria and her neighbors, African countries do not generally; have significant formal trade with Nigeria compared with any of the twelve countries in our sample.

To compute Nigeria's real effective exchange rate, trade data was obtained from Nigeria's National Bureau of Statistics and the International Monetary Fund's (IMF) Direction of Trade Statistics. We obtained the monthly consumer price indices and the country's nominal exchange rates with respect to the US dollar of the affected countries from the IMF's International Financial Statistics (IFS). The base year chosen for the computation of the relative consumer price indices and the exchange rate indices was May 2003, a period which coincides with Nigeria's CPI base year. The period January 1999 to December 2003 was chosen for computing the trade weights. The period represents the time Nigeria had the most phenomenal trade growth in decades in addition to increased oil revenues arising from rising oil prices. Given our trade data, we used the total trade volume and the bilateral weighing scheme for the computation. The geometric mean was employed in preference to the arithmetic mean because of the advantages of the former over the later, identified earlier. We also employed CPI indicators in preference to the other indicators due to data availability.

Table 1 shows the trade weights of Nigeria's major trading partners. The weights which sum up to one indicate that the US has the highest trade weight, accounting for 41.0 per cent of Nigeria's total trade for the period. This was followed by India (13.2%), France (7.2%), Spain (6.9%), Brazil (5.3%), and Italy (4.8%) amongst others.

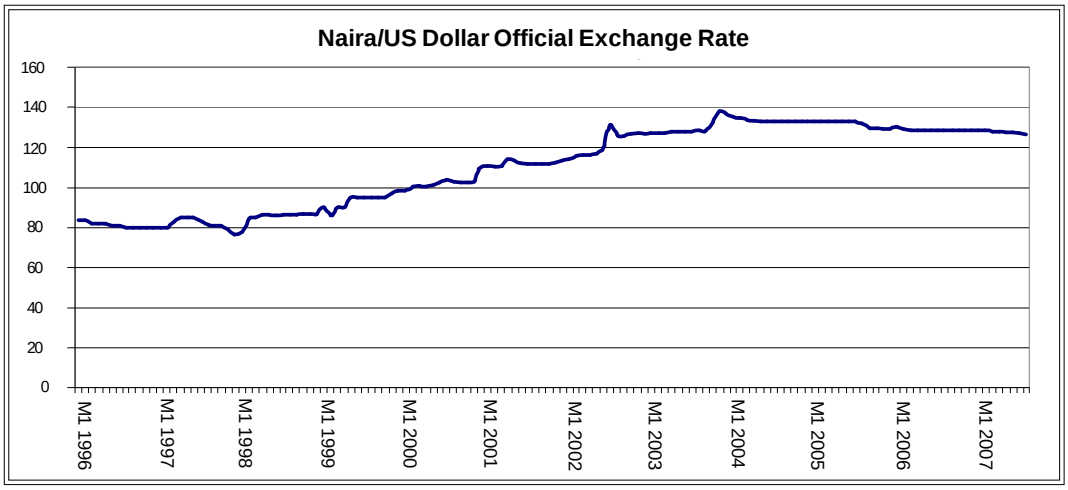
Table 1
Choice of Country Trading Partners

Country	Trade Weight (Percent)
Brazil	5.3
China	3.2
France	7.2
Germany	4.3
India	13.2
Indonesia	3.2
Italy	4.8
Japan	3.5
Netherlands	2.8
Spain	6.9
United Kingdom	4.6
United States	41.0

III.1 The Effective Nominal/Real Exchange Rate Indices Computations

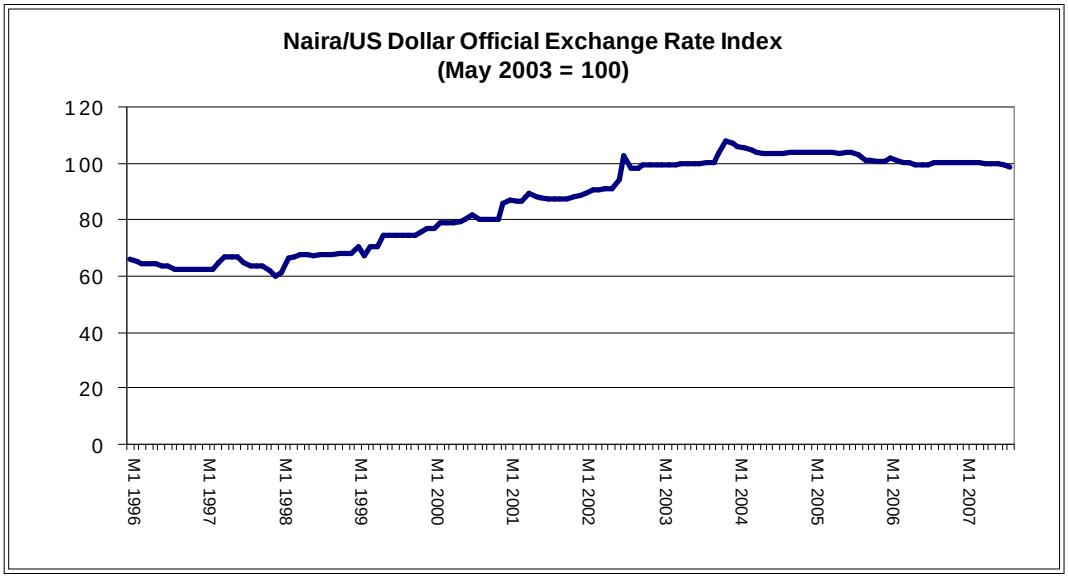
The effective nominal and real exchange rate indexes were computed based on the models outlined earlier in equations 4, 7, 8, and 9. Nigeria's official dollar based nominal exchange rate is presented in Table 2. The data shows that the dollar based exchange rate averaged x110.26/US$1 for the period January 1996-August 2007. From January 1996 to end-August 2007, the exchange rate depreciated in absolute terms.

Chart 1



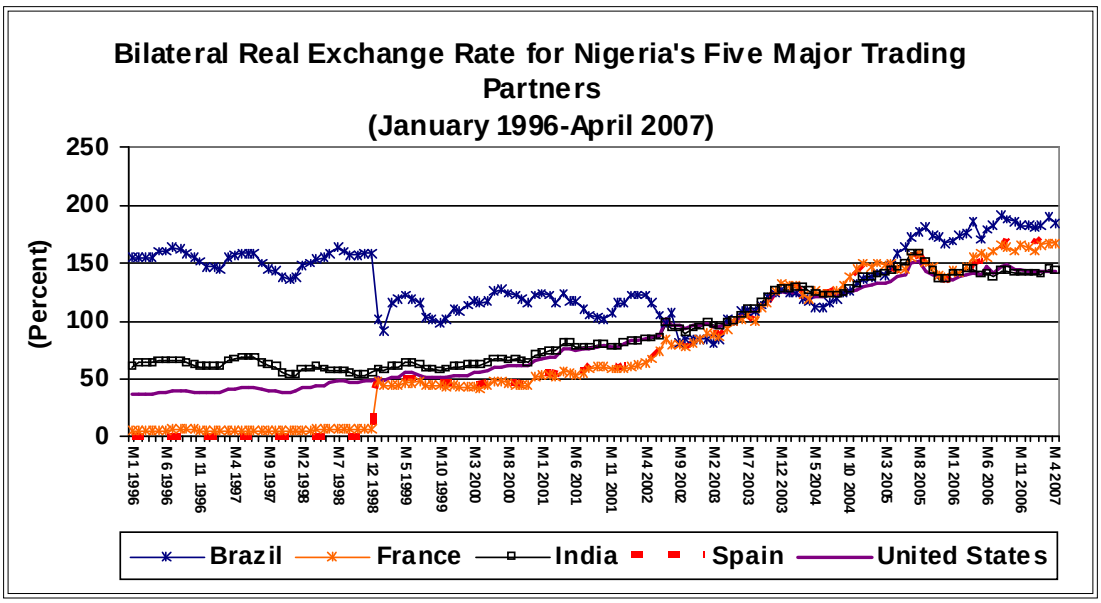
The index of the Naira/Dollar official exchange rate is presented in Chart 2 (The index has a base of May 2003).

Chart 2



The index shows that the dollar based official exchange rate depreciated steadily in nominal terms from January 1996 but stabilized between August 2002 (when DAS was reintroduced) and August 2003. Thereafter, the naira assumed a stable depreciation up to the third quarter of 2005 when it again appreciated in nominal terms.

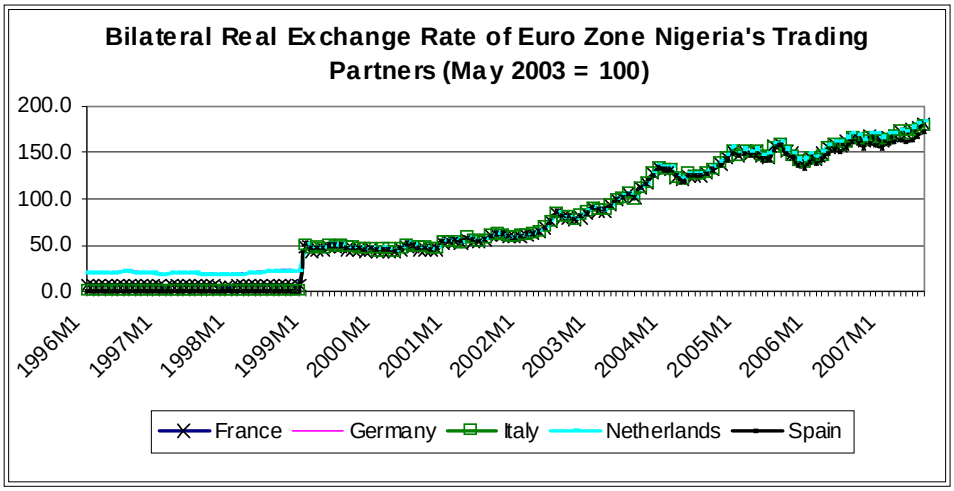
Chart 3



In Chart 3, we present the bilateral real exchange rate index for five of the major trading partners i.e. US (41.0%), India (13.2%), France (7.2%), Spain (6.9%) and Brazil (5.3%). The index show substantial real depreciation for all the countries, implying that on a bilateral basis, Nigeria's competitiveness worsened compared with that of its major trading partners due to persistently high inflation in Nigeria over most of the period. The divergence observed since 2003 reflects the relative efficiency of price management policies in the individual countries.

Following the adoption of the euro on 1st January 1999, the bilateral real exchange rate for the euro zone countries appreciated substantially because the euro was introduced at a highly appreciated rate for most countries. For Brazil, however, its bilateral real exchange rate depreciated on that day as its national currency appreciated. On the same day, Nigeria's national currency depreciated. The bilateral exchange rate for Brazil exhibits a peculiar feature compared with the other countries. For the euro zone countries (France and Spain), their bilateral real exchange rate reflected the change over from their national currencies to the euro on 1st January 1999.

Chart 4

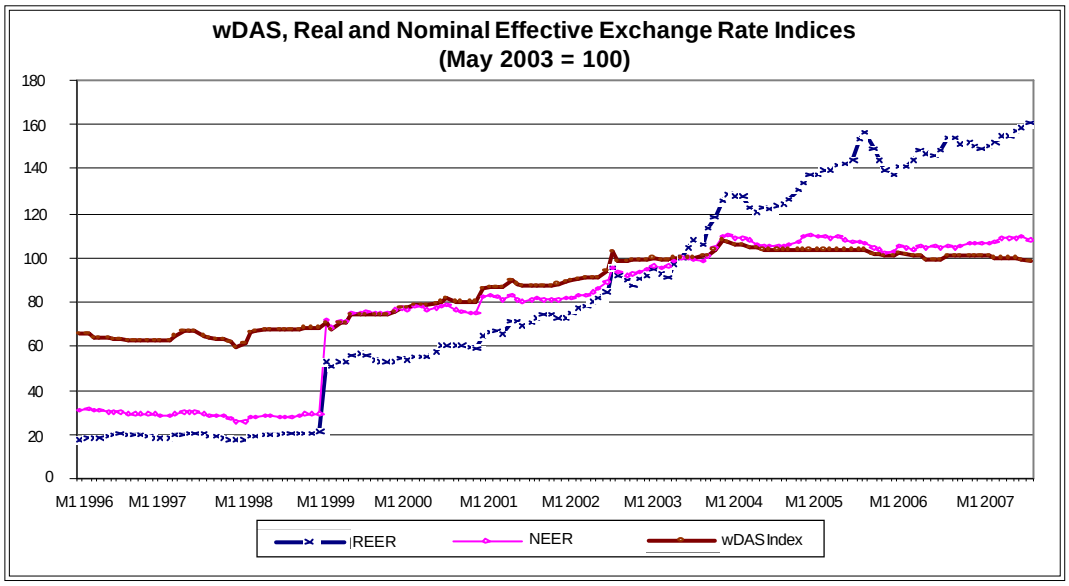


All the currencies of the euro zone countries appreciated in real terms against the naira before European unification and introduction of the euro on 1st January 1999. Following the introduction of the euro and prudent macroeconomic management their exchange rates appreciated continually against the naira in real terms. High inflationary tendencies, however, worsened the performance of the naira against the euro in the review period.

A decline in the index of the bilateral real exchange rate (representing a corresponding real exchange rate appreciation), is a reflection of low prices in the home country relative to the foreign country trading partner. Moderating domestic prices through fiscal discipline and efficient monetary management has far reaching implications on the country's external competitiveness. Although a weak domestic currency in real terms is an impetus for increased exports, in Nigeria, our inability to develop and explore the potentials of our non-oil export sector and the high dependence of the economy on imports makes such depreciations very costly to the economy.

The appreciations in the bilateral real exchange rate reflected in the overall real and nominal effective exchange rate indices. It was observed that in nominal terms, the naira depreciated continually throughout the review period.

Chart 5



The wholesale Dutch Auction System Index which reflects the official exchange rate appreciated continually from 1996 to July 2002 when it stabilized, reflecting the reintroduction of the Dutch Auction System. Although the reintroduction of DAS did not stem the depreciation of the naira, it nonetheless stabilized at around a 5 per cent upper band. The foreign exchange reforms of February and April 2006 initiated deliberate policy moves that would cause an appreciation in the nominal exchange rate of the naira as indicated above. Following complementary macroeconomic policies which improved non-oil foreign exchange flows and direct foreign investment, the naira has appreciated in the official window of the foreign exchange market since 2006.

As shown in the Chart above, the nominal effective exchange rate (NEER) index mimicked the behaviour of the wDAS index since January 1999. Consequently, the NEER appreciated consistently throughout the review period. The highly appreciated nominal effective exchange rate reveals the danger of ignoring the effects of macroeconomic changes in our major trading partner countries on our dollar based official exchange rate. Macroeconomic changes in countries with large trading ties with Nigeria will more readily impact on our exchange rate, which at present ignores

the magnitude of such effects. A highly depreciated nominal effective exchange rate has serious implications, especially for an import dependent economy like Nigeria. While the revenue implications favour the exporting countries, the high cost of imports has adverse effects on external sector stability and the country's economic development.

Similarly, the real effective exchange rate (REER) appreciated throughout the review period. A real effective exchange rate appreciation shows a loss of competitiveness by the computing country. The loss in competitiveness may arise from high domestic inflation and poor macroeconomic management. A depreciating REER may imply that the national currency is gaining strength against the currencies of the other trading partners in real terms; hence, fewer units of the national currency are buying more foreign goods. This may not be the case in nominal terms as the national currency may actually be depreciating against those of other trading partners, probably due to high domestic inflation. The implication is that an appreciation in the real exchange rate may typify an overvalued domestic currency.

Since April 2006, the wDAS index has been declining indicating an appreciation of the nominal exchange rate. However, this did not affect the NEER and the REER as both indices have continued to appreciate unabated. The appreciation in the REER is particularly worrisome as it shows continuous loss of competitiveness by Nigeria relative to our major trading partners. The need to consistently combat inflation with both monetary and fiscal policy becomes highly imperative. A consistent regime of high domestic prices when our major trading partners are successful in maintaining consistent low inflation regimes is injurious to Nigeria's trade. It is imperative therefore, for the monetary authorities to galvanize all efforts to achieve a regime of low prices on a consistent basis.

The continuous appreciation of the nominal exchange rate of the naira at the official window is only hurtful to Nigeria as it portends no economic benefits to the country. The nominal appreciations do not seem to stem from market fundamentals but rather, bear the marks of concerted collusion by market operators and a plan to congregate around a particular market

rate. In the medium term, the monetary authorities must insist on the full operation of the two way quote in wDAS where authorized dealers who quote ridiculous purchase rate are compelled to sell to the monetary authorities at that rate, irrespective of the liquidity position for the day. This punitive measure would deter the perpetuation of these unwholesome practices. In the long term, the Central Bank must work towards nurturing a virile foreign exchange market in which it is not a participant but a regulator who steps in only to achieve its monetary policy goal for the day/period. The envisaged market should create its own supply and demand, such that the evolving exchange rate would bear the inputs of the market.

IV Summary and Conclusion

The paper set out to compute Nigeria's real effective exchange rate indices. The country's trade data with major trading partners for the period 1996 to 2007, representing 79 per cent of Nigeria's international trade was used. Although the paper identified most of the common approaches used in real exchange rate computation, it was of the opinion that the use of any one methodology depended on the availability of data for both the home and trading partner countries in the basket. Whatever methodological choices are made, depending on data availability and the purpose for which the index is being computed, the emerging index/rate may show substantial variation from each other. Also, the choice of trade weights and countries in the basket, which are at the author's prerogative, played a major role in the diverse outcomes of the resulting index/rates.

The paper found that there was divergence between Nigeria's real effective exchange rate and the nominal effective exchange rate which tended to mimic the dollar based official exchange rate indices. The dollar based official exchange rate was found to be an inappropriate measure of the value of the naira because it failed to track major changes in trading partner economies.

The paper indicated that the monetary authorities must ensure price stability if Nigeria would benefit from trade relations with other countries.

A situation where the REER appreciated throughout the period under review was deemed unsatisfactory with respect to the price stability efforts of the monetary authorities. In addition it was shown that the appreciation in the nominal exchange rate of the naira was not beneficial to the country. Moreover, the monetary authorities should work towards the establishment of a stable foreign exchange market and then exit as a major player in the market to give way for the market to create its own demand and supply. Consequently, the monetary authorities would only intervene occasionally to achieve its liquidity management objective for the day/period.

The results should, however, be interpreted with caution because of some limitations of the study. For instance, the existence of a large informal foreign exchange market in Nigeria creates an added pressure for the official exchange rate. However, such effects were not captured in the computation of the real effective exchange rate. These drawbacks notwithstanding, the computed real exchange rate could serve as a useful input for policy. However, the issues raised here provide ample challenges for potential research in Nigeria's real effective exchange rate computation.

Appendix

Table 2
Nigeria's Real/Nominal Effective and wDAS Exchange Rate Indices
(May 2003=100)

Month/Year	REER	NEER	wDAS Index
M1 1996	17.9260	31.01	65.52
M2 1996	18.3228	31.24	65.33
M3 1996	18.3337	30.71	64.15
M4 1996	18.3446	30.51	64.15
M5 1996	19.1784	30.35	64.15
M6 1996	19.4715	30.05	63.37
M7 1996	20.2300	30.19	63.37
M8 1996	20.1616	29.75	62.59
M9 1996	19.8242	29.57	62.59
M10 1996	19.4732	29.63	62.59
M11 1996	19.0596	29.57	62.59
M12 1996	18.5656	29.44	62.59
M1 1997	18.4125	28.98	62.59
M2 1997	18.3515	28.67	62.59
M3 1997	19.7250	29.73	64.94
M4 1997	20.1036	30.25	66.50

Table 2 cont'd

Month/Year	REER	NEER	wDAS Index
M5 1997	20.5185	30.43	66.50
M6 1997	20.7001	30.29	66.50
M7 1997	20.4317	29.14	64.94
M8 1997	19.3830	28.38	63.57
M9 1997	18.7777	28.35	63.37
M10 1997	18.7316	28.43	63.37
M11 1997	17.8788	27.34	61.81
M12 1997	17.6134	26.05	59.85
M1 1998	17.2731	25.77	61.02
M2 1998	18.8034	28.10	66.15
M3 1998	19.0447	28.11	66.50
M4 1998	19.9188	28.84	67.60
M5 1998	19.6836	28.34	67.61
M6 1998	19.8124	27.69	67.28
M7 1998	20.5066	28.06	67.67
M8 1998	20.4720	28.22	67.67
M9 1998	20.3095	28.74	67.67
M10 1998	20.7433	29.50	68.06
M11 1998	20.8301	29.19	68.06
M12 1998	21.1282	29.29	68.06
M1 1999	53.0591	72.13	70.41
M2 1999	50.3438	68.14	67.28
M3 1999	53.0739	71.52	70.41
M4 1999	53.0907	71.44	70.41
M5 1999	56.0950	74.90	74.23
M6 1999	56.4235	74.85	74.23
M7 1999	56.0679	75.53	74.23
M8 1999	53.5710	74.94	74.23
M9 1999	53.0047	74.94	74.23
M10 1999	52.5879	75.21	74.32
M11 1999	53.1588	76.06	75.97
M12 1999	54.5902	77.20	76.83
M1 2000	53.4581	76.41	76.79
M2 2000	55.0506	77.93	78.59
M3 2000	55.1706	77.76	78.68
M4 2000	55.0915	76.33	78.52
M5 2000	57.0827	76.81	79.17
M6 2000	60.3521	78.14	79.96
M7 2000	60.2359	78.64	81.36
M8 2000	60.0893	76.74	80.23
M9 2000	59.9651	75.79	80.00
M10 2000	59.3206	74.73	80.19
M11 2000	58.7574	75.15	80.27
M12 2000	64.4068	82.09	86.10
M1 2001	65.9543	82.71	86.68
M2 2001	66.5525	82.07	86.53
M3 2001	65.6160	80.56	86.61
M4 2001	71.4142	82.81	89.34

Table 2 cont'd

Month/Year	REER	NEER	wDAS Index
M5 2001	71.4612	80.89	88.48
M6 2001	69.2827	79.94	87.62
M7 2001	70.5754	80.62	87.39
M8 2001	72.7598	81.67	87.31
M9 2001	74.0462	81.08	87.31
M10 2001	74.2492	80.51	87.31
M11 2001	72.4055	81.10	88.09
M12 2001	72.6697	81.68	88.76
M1 2002	75.0264	81.50	89.34
M2 2002	77.1285	82.67	90.52
M3 2002	77.5130	83.34	90.83
M4 2002	79.7786	84.34	90.99
M5 2002	81.2548	85.59	91.38
M6 2002	84.6225	89.02	93.88
M7 2002	95.5236	95.84	102.50
M8 2002	91.6583	93.05	98.58
M9 2002	89.8703	91.79	98.58
M10 2002	87.2969	92.58	99.16
M11 2002	90.3280	93.00	99.29
M12 2002	91.6001	94.69	99.28
M1 2003	94.5902	95.93	99.57
M2 2003	92.4082	95.65	99.37
M3 2003	91.4317	96.27	99.53
M4 2003	97.2857	98.16	99.99
M5 2003	100.0000	100.00	100.00
M6 2003	104.6113	99.58	100.08
M7 2003	108.0148	98.92	99.93
M8 2003	105.9807	98.53	100.38
M9 2003	113.1960	100.60	100.42
M10 2003	118.2449	104.31	103.68
M11 2003	125.5294	109.29	108.12
M12 2003	128.8741	110.33	107.18
M1 2004	127.8985	108.64	105.85
M2 2004	127.9858	108.57	105.62
M3 2004	122.5602	107.67	104.60
M4 2004	120.6281	106.04	104.29
M5 2004	122.6607	105.31	103.86
M6 2004	122.2938	105.13	103.86
M7 2004	123.2538	104.93	103.91
M8 2004	124.3056	105.27	103.92
M9 2004	126.7291	106.12	103.95
M10 2004	130.4413	107.29	103.95
M11 2004	133.7654	109.28	103.96
M12 2004	137.7222	110.54	103.94
M1 2005	137.3329	109.49	103.94
M2 2005	139.3366	109.77	103.94
M3 2005	139.5864	108.81	103.94
M4 2005	141.5446	109.11	103.94

Table 2 cont'd

Month/Year	REER	NEER	wDAS Index
M5 2005	142.5673	107.84	103.92
M6 2005	144.0861	107.25	103.95
M7 2005	153.7684	106.93	103.94
M8 2005	156.2655	106.41	103.30
M9 2005	149.4039	104.34	101.31
M10 2005	144.1433	103.76	101.34
M11 2005	139.3885	102.47	100.93
M12 2005	137.6937	102.61	100.92
M1 2006	140.9452	105.20	101.93
M2 2006	141.2021	103.99	101.14
M3 2006	144.2429	103.74	100.55
M4 2006	148.3750	105.16	100.49
M5 2006	146.9524	104.55	99.50
M6 2006	146.4376	104.74	99.50
M7 2006	148.7321	104.51	99.45
M8 2006	154.1027	105.16	100.37
M9 2006	154.4749	104.68	100.35
M10 2006	151.4127	105.29	100.38
M11 2006	152.1537	106.53	100.35
M12 2006	150.9079	106.72	100.35
M1 2007	149.3943	106.20	100.36
M2 2007	150.7554	106.82	100.36
M3 2007	152.2870	107.33	100.19
M4 2007	155.0887	108.64	100.04
M5 2007	154.9825	108.53	99.74
M6 2007	156.8829	108.43	99.60
M7 2007	158.7536	109.16	99.45
M8 2007	161.0256	107.92	98.73

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