Purchasing Power Parity Exchange Rate, Misalignment and Export Growth in Nigeria*

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This paper analyzes the effect of real exchange rate misalignment on the growth of non-oil export in Nigeria over the period 1960-2002. The paper employs an equilibrium model of the export market and a co-integration technique for the analysis. Real exchange rate misalignment is derived on the basis of the purchasing power parity doctrine. The preliminary data analysis indicates the existence of a long-run relation between real exports and real foreign income. The final analysis shows that real exchange rate misalignment generates adverse effects on the growth of the country's non-oil export.

Keywords: Real exchange rate, export, non-oil export and misalignment

Introduction
Empirical studies on the effect of real exchange rate (RER) misalignment in sub-Saharan Africa (SSA) fall into two categories: those based on the purchasing power parity (PPP) doctrine (eg, Agarwala, 1983; Balassa, 1990; Cottani et al., 1990; Ghura and Greenes 1993) and those based on the model approach (eg, Edwards, 1988, 1989; Cottani et al., 1990; Savvides, 1992; Ghura and Greenes, 1993). While the model approach is theoretically and empirically appealing, the fact that most, if not all of the exchange rate rules adjunct to the economic reforms in SSA are based on the notion of PPP would appear to suggest the need to pay more attention to the PPP approach in empirical analyses. In addition, given the sensitive nature of exchange rate adjustment issues in developing countries, country-specific studies on the subject may be more convincing than the conventional cross-section or pooled data time-series analysis.

This paper examines the view that RER misalignment adversely affects export growth using Nigeria as the focus. Given the country's economic history, the analysis concentrates on the growth of non-oil export in the country during the period 1960 to 2002. Apart from being a country-specific study, the paper also departs from previous approaches by employing a co-integration analytical technique.

The rest of the paper is organized as follows: the next section briefly appraises the definition of equilibrium RER under the PPP theory, followed by a presentation of the empirical model. The next section deals with the framework of measurement and the methodology and data employed in the analysis, followed by a presentation of the results and their interpretations. The final section summarizes the paper with the conclusions.

PPP Doctrine and Equilibrium RER
There are two variants of the PPP doctrine: absolute and relative PPP. The absolute PPP hypothesis states that the exchange rate between two currencies should equal the ratio of the price levels of the two countries concerned, that is:

\[ E = \frac{P}{P^*} \]  \hspace{1cm} (1)

where:

\[ E \quad \text{nominal exchange rate (NER)} \]

\[ P \quad \text{price level in the home country} \]

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1 For an insight into the nature of recent exchange rate policies in developing countries, see for example Khan and Ostry (1992).

2 Nigeria is a major producer and exporter of crude oil; since the 1970s, crude oil has dominated its production and export structures.
\( P^* = \text{price level in the foreign country} \)

The relative version states that the exchange rate should be a constant proportion of the ratio of the national price levels, that is:

\[
E = kP/P^*
\]  

(2)

where \( k \) is a constant parameter.

Under either variant, a change in the ratio of the price levels implies an equiproportional change in the exchange rate. Absolute PPP may, however, not be a useful operational concept for the simple reason that information on national price levels is usually available in the form of price indices rather than absolute price levels (Isard, 1995). Consequently, most empirical studies focus on the relative PPP hypothesis in examining the validity of PPP. In this context, the PPP hypothesis is frequently expressed in terms of RER \((Q)\), such that:

\[
Q = EP^*/P
\]  

(3)

Under this framework, the equilibrium value of RER in any particular current period can be estimated by identifying a base period when the home country had external balance and adjusting this base period value for the inter-country difference in inflation rates between the current and the base period (Dornbusch, 1982).

Three defects are usually associated with the PPP approach. First, it is not easy to find an equilibrium base period. For example, in Nigeria, external equilibrium could be associated with some years during the oil boom. Using any of these years as a representative base year could, however, be misleading since the value of the nominal exchange rate \((NER)\) in the period was sustained by a transitory phenomenon. Second, under the PPP approach, equilibrium \(RER\) is deemed a constant. In a world where domestic and foreign goods are imperfect substitutes and there are shocks to the system, it is desirable to have deviations from PPP for the reason that the \(RER\) must adjust to the shock. This adjustment will require movements in the \(NER\) and domestic and foreign price levels (see eg, Balassa, 1964; Flood, 1981; Mussa, 1982; Hakkio, 1984; Krugman and Baldwin, 1989). Third, PPP does not seem to hold very well in the short run and probably also in the long run (Dornbusch 1980a; Dornbusch and Frankel 1987; Frenkel 1981).

In spite of its shortcomings, the PPP approach is still commonly employed in monetary models of \(RER\) and as a basis of policy formulation by policy makers.

The Empirical Model

The standard ‘two-country model’ of trade makes the change in demand for a country’s real volume of exports \((\Delta X)\) to depend positively on the change in real foreign income \((\Delta Y)\) and negatively on foreign relative prices \((\Delta P^*_e)\). Thus, it can be written that:

\[
\Delta X = X^e(\Delta Y, \Delta P^*_e)
\]  

(4)

where \(\Delta\) represents change.

The relative price of exportables abroad, \(P^*_e = P_e/EP^*_e\), where \(P_e\) is the price of the exportables in domestic currency, \(E\) is the exchange rate measured in the domestic currency and \(P^*_e\) is the foreign price level.

On the other hand, the change in the volume of export supplied \((\Delta X)\) can be expressed in terms of changes in domestic relative prices \((\Delta P)\), exchange rate misalignment \((Mis)\) and other exogenous determinants of exports \((OED)\). Thus:

\[
\Delta X = X^e(\Delta P^*_e, Mis, OED)
\]  

(5)

The signs under the variables signify partial derivatives. The domestic relative price of exportables is \(P_e/P\), with \(P\) representing the domestic price level. The relative price of exportables abroad can thus be

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3 For more recent views on the approach, estimation and problems of PPP, see for example, Black (1994); Breuer (1994); Papell and Theodoridis (1998) and Hinkle and Montiel (eds.) (1999).

4 For the reason underlying the popularity of the PPP doctrine in the policy circles of developing countries, see for example Dornbusch (1982).

5 See for example Dornbusch (1980b) and Savvides (1992); Savvides (1992) represents the inspiration for the empirical formulation in this study.

6 Such other exogenous factors would include trade agreements, membership of a custom or an economic union and terms of trade.
employed variable supply is times appears as: 

\[ P_t^* = P_t/Q \]  

where \( Q = EP^*/P \) is the real exchange rate.

The logarithmic equivalent of equations 4 and 5 are:

\[ \Delta x^t = \alpha_0 + \alpha_1 \Delta x^* - \alpha_2 \Delta p_e + \alpha_3 \Delta q + \mu \]  

\[ \Delta x^e = \beta_0 + \beta_1 \Delta p_e + \beta_2 \text{mis} + \beta_3 \text{ost} + \epsilon \]  

where \( \mu \) and \( \epsilon \) are random error terms.

Making an assumption of market equilibrium and solving for \( \Delta P_t \) from equation (8), we have:

\[ \Delta P_t = -\beta_2/\beta_1 + (1/\beta_1) \Delta x - (\beta_2/\beta_1) \text{mis} - (\beta_3/\beta_1) \text{ost} - (1/\beta_1) \epsilon \]  

(9)

Substituting equation 9 into equation 7 for \( \Delta P_x \) and solving for \( \Delta x \), we obtain the reduced form expression for the volume of exports as:

\[ \Delta x = (\alpha_0 \beta_1 + \alpha_3 \beta_1)/D + [(\alpha_1 \beta_1)/D] \Delta x^* + [(\alpha_1 \beta_1)/D] \Delta q + [(\alpha_1 \beta_1)/D] \text{ost} + [(\alpha_1 \beta_1)/D] \text{mis} + \omega \]  

(10)

where \( D = \alpha_2 + \beta_1 \) and \( \omega = (\epsilon + \beta_3 \mu)/D \).

Equation 10 states that the growth of a country’s exports depends on the growth of foreign real income, the growth of relative prices (that is, the real exchange rate), exchange rate misalignment and other exogenous factors. Representing the ‘other exogenous determinants’ by the terms of trade (ost), the equation to be estimated in this study can be expressed as:

\[ \Delta x = \lambda_0 + \lambda_1 \Delta x^* + \lambda_2 \Delta q + \lambda_3 \text{ost} + \lambda_4 \text{mis} + \omega \]  

(11)

Only the misalignment term (mis) is expected to be negative. Due to the possibility of the problem of multicollinearity with the presence of the real exchange rate and real exchange rate misalignment, real exchange rate (q) may not enter the final equation to be estimated.

Framework of Measurement, Methodology and Data

Equilibrium RER is derived by taking the average of the highest RER values for a number of years. Following Cottani et al. (1990) and Ghura and Greenes (1993), the highest RER values for three years are used. RER misalignment (RERMis) is then measured as the deviation of the observed RER from the equilibrium RER. Thus, we have:

\[ \text{RERMis}_t = [(S_{max RER}/RER_t)/3-1]*100 \]  

(12)

where \((S_{max RER})/3 \) \((j = 1, 2, 3)\) is the average of the highest values of RER.

The analysis employs a data-driven process methodology, which clearly distinguishes between the short-run nominal effect and the long-run real effect of export growth determinants. It consists of three estimation procedures. The first is a test for stationarity, that is a test of the order of integration of variables. The idea is to ensure that inferences drawn from estimated relationships are non-spurious. Second, non-stationary explanatory (long-run) variables, that is, long run variables not of the order of I(0) are tested for cointegration with the dependent variable. Third, a graduation of the co-integration result is the possible use of an error correction model in the estimation.

In this study, the test for stationarity is conducted using the Augmented Dickey-Fuller (ADF) test, which can be specified as:

\[ \Delta y_t = \beta y_{t-1} + \gamma y_{t-j} + \epsilon_t \]  

(13)

where \( j \) is the lag length.

The decision rule under the ADF is to reject the null of I(0) if \( t_f \) is less than its critical value and vice-versa. Typically, the lags on annual data tend to be about 4.

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7 The literature on manufactured export supply (eg. Moran, 1988; Paredes, 1993) often specifies a variable, such as export capacity as a key determinant. In Nigeria, primary produce such as cocoa, palm kernel and rubber account for a disproportionate percentage (about 87% in 1989 and 1990) of the total non-oil exports. The continuous decline in the international prices of these primary produce in recent times appears to be indicative of the fact that demand as opposed to supply is a key determinant of growth in the sector. As a result, a variable such as export capacity may not readily fit into the model employed in this study.

8 See Dickey and Fuller (1981).
Annual data are used in the analysis. The terms of trade variable refers to the real commodity price index. The data employed in the analysis were obtained from various issues of the Central Bank of Nigeria Statistical Bulletin, International Monetary Fund International Financial Statistics, IMF Yearbook, and United Nations Conference on Trade and Development Handbook of International Trade and Development Statistics.

Empirical Results
Figure 1 depicts the computed RER misalignments occurring in the period 1960 to 2002. The degree of misalignment appears to have risen steadily in the 1970s, culminating in an all time high of over 1000 per cent around the mid-1980s. It fell sharply in 1986 and remained generally low till 1992. Thereafter, it rose to a decade high of over 700 per cent in 1998 before turning negative in 1999 and remained generally low again between 1999 and 2002.

The 1970s was characterized by the oil boom. During the period, the Nigerian government based the exchange value of the country’s currency (the naira) on developments in its balance of payments. As things turned out, the appreciation of the naira during the period was sustained through reserve intervention. The 1980s represent the period of the oil glut, when the exchange rate policy inherited from the oil boom period became unsustainable. They also represent a period of unprecedented external indebtedness. The reduced RER misalignment in the latter part of the 1980s may not be unconnected with the exchange rate realignment effort in the form of the auction market-based exchange rate determination mechanism, which was introduced as part of the structural adjustment programme implemented during the period. The misalignments recorded in the 1990s, however, appear to reflect the maintenance of an official exchange rate policy by government. The abolition of the official exchange rate policy in 1998 manifested in the sharp decrease in the degree of misalignment in the following year.

![Figure 1. Real exchange rate misalignments (%) in Nigeria, 1960-2002](image)

The results of the stationarity test are presented in table 1. All variables appear to be I(1).

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF (Level)</th>
<th>ADF (First diff.)</th>
<th>Order of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>LogX</td>
<td>-0.926</td>
<td>-3.8446</td>
<td>1</td>
</tr>
<tr>
<td>LogY</td>
<td>0.0985</td>
<td>-3.9020</td>
<td>1</td>
</tr>
<tr>
<td>LogTOT</td>
<td>-2.061</td>
<td>-5.5837</td>
<td>1</td>
</tr>
<tr>
<td>LogMIS</td>
<td>-2.8064</td>
<td>-5.0794</td>
<td>1</td>
</tr>
<tr>
<td>Critical values at 5%</td>
<td>-2.9350</td>
<td>-2.9369</td>
<td></td>
</tr>
</tbody>
</table>

Source: Computed
Table 2 shows the cointegration tests, which were conducted according to Johansen’s procedure (Johansen, 1988 and Johansen and Juselius 1990). The Trace and the Maximum Eigen statistics suggest the existence of only one cointegrating vector at 5 per cent critical value.

Normalized cointegration coefficients are presented in table 3. Only the coefficient of real foreign income has the correct sign. Thus, real foreign income is the relevant vector on which the cointegration is normalized.

The initial over-parameterized error correction model is presented in the appendix. The final result obtained through an iterative process involving the deletion of the lags with low t-statistics is presented in table 4. The results show that the explanatory variables account for about 53 per cent of the variations in the country’s non-oil exports. The model has a standard error of about 27 per cent and appears from the relevant diagnostic test to be moderately subject to serial correlation. Current and lagged values of TOT generate positive effects on export growth. On the other hand, lagged values of real foreign income and RER misalignment have a negative effect on real export growth.

The strong significance of a lagged value of real foreign income may be a vindication of the earlier observation that the demand for the country’s export in real terms is on the decline. The trend in the lagged RER misalignment coefficients may, however, be a reflection of the degree of sophistication in the country’s non-oil export sub-sector. The error correction term (ECM(-1)) indicates a feedback of approximately 7 per cent of the previous year’s disequilibrium from the long-run real foreign income elasticity and it is not significant. The non-significance of the error correction term may be an indication that the co-integrating relationship between real non-oil export and real foreign income in the study is weak. The diagnostic tests generally suggest that this is a well behaved model.

Table 3. Normalized cointegrating coefficients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>LogX</td>
<td>1.00</td>
</tr>
<tr>
<td>LogY</td>
<td>3.96 (0.57)</td>
</tr>
<tr>
<td>LogTOT</td>
<td>-4.27 (0.67)</td>
</tr>
<tr>
<td>LogMIS</td>
<td>2.06 (0.57)</td>
</tr>
</tbody>
</table>

Note: Standard error in brackets.
Source: Computed

Table 4. Estimation of the parsimonious non-oil export equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔLOGX(-1)</td>
<td>0.354</td>
<td>0.171</td>
<td>2.066</td>
<td>0.049</td>
</tr>
<tr>
<td>ΔLOGX(-2)</td>
<td>0.189</td>
<td>0.148</td>
<td>1.277</td>
<td>0.213</td>
</tr>
<tr>
<td>ΔLOGX(-3)</td>
<td>-0.679</td>
<td>0.601</td>
<td>-1.13</td>
<td>0.269</td>
</tr>
<tr>
<td>ΔLOGX(-4)</td>
<td>0.251</td>
<td>0.536</td>
<td>0.452</td>
<td>0.655</td>
</tr>
<tr>
<td>ΔLOGY(-1)</td>
<td>-2.949</td>
<td>0.631</td>
<td>-4.677</td>
<td>0</td>
</tr>
<tr>
<td>ΔLOGTOT</td>
<td>0.757</td>
<td>0.205</td>
<td>3.692</td>
<td>0.001</td>
</tr>
<tr>
<td>ΔLOGTOT(-4)</td>
<td>0.392</td>
<td>0.213</td>
<td>1.845</td>
<td>0.076</td>
</tr>
<tr>
<td>ΔLOGMIS(-1)</td>
<td>-0.235</td>
<td>0.105</td>
<td>-2.231</td>
<td>0.035</td>
</tr>
<tr>
<td>ΔLOGMIS(-2)</td>
<td>0.385</td>
<td>0.105</td>
<td>2.715</td>
<td>0.012</td>
</tr>
<tr>
<td>ΔLOGMIS(-4)</td>
<td>-0.475</td>
<td>0.221</td>
<td>-2.148</td>
<td>0.041</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>-0.071</td>
<td>0.065</td>
<td>-1.089</td>
<td>0.286</td>
</tr>
<tr>
<td>C</td>
<td>0.104</td>
<td>0.095</td>
<td>1.09</td>
<td>0.286</td>
</tr>
</tbody>
</table>

R-squared: 0.672
Adjusted R-squared: 0.533
S.E. of regression: 0.266
Akaike Info criterion: 1.842
Schwarz criterion: 1.380
Log likelihood: 3.591
Durbin-Watson stat: 2.200

Test statistic: LM version
Serial Correlation: CHI(4) = 7.625 [0.106]
Normality: CHI(2) = 0.901 [0.637]
Functional Form: CHI(4) = 0.018 [0.892]
Hetoscedasticity: CHI(4) = 17.136 [0.756]

Source: Computed

11 The log of real export correlates negatively with that of real foreign income to the tune of about 90 per cent.
Summary and Conclusions
This study investigates the effect of RER misalignment on the growth of non-oil export in Nigeria during the period 1960 to 1990. The prime hypothesis tested in the study is that RER misalignment adversely affected the growth of non-oil export in the country in the relevant period. The study employed an equilibrium model of the export market and cointegration technique. The misalignment term was based on the purchasing power parity doctrine.

The data analysis suggests the existence of cointegration between non-oil export and real foreign income – a fundamental factor. Further analysis suggests that real foreign income is the relevant vector on which the cointegration should be normalized. In the parsimonious error correction model, the lagged value of RER misalignment has adverse effects on the country’s non-oil export supply. The analysis also establishes the lagged values of real foreign income and the terms of trade as major determinants of non-oil export growth in the country. The influence of real foreign income is, however, generally negative.

These findings suggest that policies causing RER misalignment tend to generate adverse effects on non-oil export growth and should, therefore, be avoided by the relevant policy making bodies in the country. The study also suggests that the flexible exchange rate policy adopted by the country in 1986 may not be unreasonable. Evidence from a related study (Oyejide and Ogun, 1995) shows that the policy has helped in checking the overvaluation tendency of the local currency, thereby contributing significantly towards proper RER alignment.

As suggested by the weight of the criticism of the PPP approach in the literature, there is room for further research in this area of international economics. In particular, further research is needed in the area of proper RER misalignment measurement under the PPP framework. This should ensure increased relevance of the concept in empirical studies.

Appendix
Table 1. Overparameterized export equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔLOGX(-1)</td>
<td>0.413</td>
<td>0.314</td>
<td>1.316</td>
<td>0.206</td>
</tr>
<tr>
<td>ΔLOGX(-2)</td>
<td>0.162</td>
<td>0.227</td>
<td>0.715</td>
<td>0.484</td>
</tr>
<tr>
<td>ΔLOGX(-3)</td>
<td>0.031</td>
<td>0.196</td>
<td>0.158</td>
<td>0.876</td>
</tr>
<tr>
<td>ΔLOGX(-4)</td>
<td>-0.035</td>
<td>0.212</td>
<td>-0.166</td>
<td>0.87</td>
</tr>
<tr>
<td>ΔLOGY</td>
<td>-0.103</td>
<td>0.866</td>
<td>-0.119</td>
<td>0.907</td>
</tr>
<tr>
<td>ΔLOGY(-1)</td>
<td>-0.879</td>
<td>0.878</td>
<td>-1.001</td>
<td>0.331</td>
</tr>
<tr>
<td>ΔLOGY(-2)</td>
<td>-0.218</td>
<td>0.887</td>
<td>-0.245</td>
<td>0.809</td>
</tr>
<tr>
<td>ΔLOGY(-3)</td>
<td>0.114</td>
<td>0.996</td>
<td>0.125</td>
<td>0.902</td>
</tr>
<tr>
<td>ΔLOGY(-4)</td>
<td>-3</td>
<td>1.062</td>
<td>-2.824</td>
<td>0.012</td>
</tr>
<tr>
<td>ΔLOGTOT</td>
<td>0.72</td>
<td>0.297</td>
<td>2.422</td>
<td>0.026</td>
</tr>
<tr>
<td>ΔLOGTOT(-1)</td>
<td>0.003</td>
<td>0.342</td>
<td>0.008</td>
<td>0.994</td>
</tr>
<tr>
<td>ΔLOGTOT(-2)</td>
<td>0.16</td>
<td>0.365</td>
<td>0.438</td>
<td>0.667</td>
</tr>
<tr>
<td>ΔLOGTOT(-3)</td>
<td>-0.164</td>
<td>0.326</td>
<td>-0.504</td>
<td>0.621</td>
</tr>
<tr>
<td>ΔLOGTOT(-4)</td>
<td>0.5</td>
<td>0.325</td>
<td>1.538</td>
<td>0.142</td>
</tr>
<tr>
<td>Δ LOGMIS</td>
<td>0.064</td>
<td>0.148</td>
<td>0.43</td>
<td>0.673</td>
</tr>
<tr>
<td>ΔLOGMIS(-1)</td>
<td>-0.273</td>
<td>0.142</td>
<td>-1.928</td>
<td>0.071</td>
</tr>
<tr>
<td>ΔLOGMIS(-2)</td>
<td>0.302</td>
<td>0.177</td>
<td>1.706</td>
<td>0.106</td>
</tr>
<tr>
<td>ΔLOGMIS(-3)</td>
<td>-0.051</td>
<td>0.16</td>
<td>-0.32</td>
<td>0.753</td>
</tr>
<tr>
<td>ΔLOGMIS(-4)</td>
<td>-0.516</td>
<td>0.358</td>
<td>-1.441</td>
<td>0.168</td>
</tr>
<tr>
<td>ECM(-1)</td>
<td>-0.099</td>
<td>0.08</td>
<td>-0.863</td>
<td>0.4</td>
</tr>
<tr>
<td>C</td>
<td>0.141</td>
<td>0.203</td>
<td>0.694</td>
<td>0.497</td>
</tr>
</tbody>
</table>

R-squared 0.696 Mean dependent var -0.161
Adjusted R-squared 0.338 S.D. dependent var 0.390
S. E. of regression 0.317 Akaike info criterion 0.841
Sum squared resid 1.708 Schwarz criterion 1.746
Log likelihood 5.022 H0 statistic 1.944
Durbin-Watson stat 2.192 Prob(F-statistic) 0.085

Diagnostic Tests

<table>
<thead>
<tr>
<th>Statistic</th>
<th>LM Version</th>
<th>F Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Statistic</td>
<td>Chi^2(4) = 14.6342[0.006]</td>
<td>F(4, 19) = 2.0355[0.148]</td>
</tr>
<tr>
<td>Serial Correlation</td>
<td>Chi^2(2) = 0.7144[0.700]</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Normality</td>
<td>Chi^2(4) = 0.0417[0.838]</td>
<td>F(4, 19) = 0.0176[0.896]</td>
</tr>
<tr>
<td>Heteroscedasticity</td>
<td>Not computable due to insufficient number of observations</td>
<td></td>
</tr>
</tbody>
</table>

Source: Computed.

References
Oluremi Ogun: PPP Exchange Rate, Misalignment and Export Growth in Nigeria


Biographical Note

Oluremi Ogun is a senior lecturer in the Department of Economics, University of Ibadan.