Panel Data Regression Modeling with Heteroscedasticity and Periodicity Effects

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***Abstract* — This research investigates the effects of heteroscedasticity and periodicity in a Panel Data Regression Model (PDRM) of audit fees for commercial banks. PDRMs are often associated with these effects, of which previous attempts to model audit fees have failed to investigate. This study thus explored this phenomenon by extending the existing works within the context of fitting an audit fee model and derivation of a Joint as well as conditional Lagrange Multiplier (LM) test via a two-way error component model. LM test results showed that the tests have good size and power as all the three tests are significant at 5%. Results were achieved through the empirical study of real-life data sourced from the banks' annual published accounts. Both LSDVM and REM captured the goodness of fit better when compared to the POLS model. However, the Hausman test revealed that LSDVM is most preferable.**

Keywords- *Audit Fee, Heteroscedasticity, Lagrange Multiplier Test, Panel data, Periodicity*

I. Introduction

Panel data regression models (PDRM) often suffer from phenomena of heteroscedasticity and Periodicity when fitted. This is as a result of the heteroscedastic nature of its individual-specific error μ_i and the serially correlated nature of its time (periods) effect λ_t [1]. Audit fees represent remuneration a company pays an external auditor in exchange for performing an audit [2]. Public companies are required by federal law to obtain an audit to provide assurance that management has presented a true and fair view of the company [3]. Furthermore, public companies must disclose audit fees paid to the auditor in its proxy statement, a practice that became effective in November 2000 following the security and exchange commission (SEC) directive [4]. According to [5], an extensive body of literature exists that focuses on possible drivers of audit fees with each given varying results. However, most studies agree that audit fees are influenced by factors such as size, complexity, inherent risk, and litigation risk. [6] laid emphasis on the impact of excess auditor remuneration on the cost of equity capital around the World. In [7] and [8], Auditor's remuneration model was fitted from Cross-sectional data comprising of four (4) explanatory variables namely profit before tax, total assets, total equity, and customers deposit. The model was evaluated for the effect of heteroscedasticity using white heteroscedasticity and Newey-West standard error and covariance. A Generalized Least Squares (GLS) model was then fitted to correct the heteroscedastic effect. This study, however, failed to account for the serial correlation effect as occasioned by its usage of cross-sectional data. [9] studies the views of external auditors and the client's representation as regards the determinants of audit fees in Lebanon. Questionnaires were examined on pre-suggested determinants and research shows that client profitability and size of the audit firm are the most important factors affecting the determinant of audit fees. The belief was that clients would pay more to international big firms due to their brand name and the higher audit quality provided. These outcomes can be likened to the reliance clients placed on the "big four" firms in Nigeria; namely Deloitte, PricewaterhouseCoopers, Ernst & Young and KPMG. [10] fitted an OLS model for audit fees; consistent with previous studies, their results showed that bank size, degree of bank complexity and volume of savings account deposit are the major determinants of audit fees among thirteen (13) Nigerian commercial banks sampled. However, the study made use of cross-sectional data to fit an ordinary least square model which does not reflect any inherent factors of unequal variability among the banks. In [11], ten (10) commercial banks were researched to provide an empirical examination of client attributes which significantly explain variations in the amount charged by bank auditors in Nigeria. A pooled OLS model was fitted for audit fees using Gross earnings, capital risk, credit risk, the total number of subsidiaries and the total number of branches. A fixed (within-group) effect and REM were equally fixed to overcome the associated highly restricted assumptions of the pooled regression. LM and Hausman test of effects comparison was used to choose between the FE and REM of which the study failed to examine any inherent effects associated with the models.

[12] studies the factors influencing the level of external audit fees paid by firms to their auditors in Jordan. Evidence shows that the major determinant of audit fees in Jordan is the client size.

In this paper, emphasis shall be placed on the specification of [13] as regards the scope of auditors' work in determining a panel data regression audit fees model and this shall be researched to bring into focus the effects of heteroscedasticity and periodicity in the operations of Nigerian commercial banks.

II. MATERIALS AND METHODS

Data was obtained mainly from the published financial reports of 16 Nigerian commercial Banks between the years (2006-2015). These banks represent the most consistent in terms of operations, corporate image and nomenclature due to series of mergers, acquisitions, change in nomenclature and transformation that took place in the Nigerian banking industry between July 2005 and December 2005.

Since the scope of data coverage for this research is a balanced panel, it would not afford the inclusion of six (6) of the listed banks according to [14]; namely Citibank, Enterprise bank, Heritage Bank, Keystone Bank, Mainstreet Bank and Suntrust bank. These banks only registered between the years 2006 and 2012 either as a transformation from a unit financial institution or as a merger of at least two existing banks both in Nigeria and abroad, and most of them did not commence banking operations immediately upon registration.

It is pertinent to note that the modus operandi of all Nigerian commercial banks are almost the same, hence the exclusion of those six banks will not affect the validity of our specified model.

Model Specification

This model implied by the scope of auditor's work in CAMA (1990) and is thus presented as:

$$AF = f(PBT, TA, TL, SHF) + \varepsilon \quad (1)$$

Within the context of Panel data regression model (PDRM), both parameters and error terms of equation (1) are varied based on time and space that result in the following equations:

$$AF_{it} = \beta_{1i} + \beta_2 PBT_{it} + \beta_3 TA_{it} + \beta_4 TL_{it} + \beta_5 SHF_{it} + \varepsilon_{it} \quad (2)$$

Equation (2) is a Fixed Effect Model (FEM) that exhibits a variation of intercept across space while the slope coefficients remain constant. In estimation, the study employs the dummy variable technique (i.e. the differential intercept dummies) to account for both the individual and time effects which results into the equation specified below:

$$AF_{it} = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \cdots + \alpha_{16} D_{16i} + \lambda_0 + \lambda_1 D_1 + \lambda_2 D_2 + \cdots + \lambda_9 D_9 + \beta_2 PBT_{it} + \beta_3 TA_{it} + \beta_4 TL_{it} + \beta_5 SHF_{it} + \gamma_1 (D_{2i}\, PBT_{it}) + \gamma_2 (D_{2i}\, TA_{it}) + \gamma_3 (D_{2i}\, TL_{it}) + \gamma_4 (D_{2i}\, SHF_{it}) + \ldots + \gamma_{57} (D_{16i}\, PBT_{it}) + \gamma_{58} (D_{16i}\, TA_{it}) + \gamma_{59} (D_{16i}\, TL_{it}) + \gamma_{60} (D_{16i}\, SHF_{it}) + \psi_1 (D_1\, PBT_{it}) + \psi_2 (D_1\, TA_{it}) + \psi_3 (D_1\, TL_{it}) + \psi_4 (SHF_{it}) + \ldots + \psi_{36} (D_9\, PBT_{it})\, \psi_{34} (D_{T-1}\, TA_{it}) + \psi_{35} (D_9\, TL_{it}) + \psi_{36} (D_9\, SHF_{it}) + \varepsilon_{it} \quad (3)$$

where PBT, TA, TL and SHF represent Profit before Tax, Total Assets, Total Liability and Shareholders Fund respectively.

α_1 *represents intercept of the first bank on the list while* $\alpha_2, \alpha_3 \ldots, \alpha_{16}$ are the differential intercepts coefficients of the remaining banks. λ_0 is the intercept of the tenth year while $\lambda_1, \lambda_2 \ldots, \lambda_9$ are the remaining years intercepts. $D_{2i}, \ldots, D_{16i}$ and $D_1, \ldots, D_9$ are dummy variables for the remaining 15 banks and 9 years respectively, having sacrificed the first bank and the tenth year to avoid falling into the dummy variable trap. $\gamma_1, \gamma_2, \ldots, \gamma_{60}$ *and* $\psi_1, \psi_2, \ldots, \psi_{36}$ are the differential slope coefficients for individual and periodic effects respectively

In the course of this study, it was demonstrated that the conditional variance of AF_{it} increases as each of $PBT_{it}, TA_{it}, TL_{it}$ and SHF_{it} increases.

Model Estimation Techniques

Here, we provide brief theoretical formulations of the three (3) techniques considered in this study.

Pooled OLS: This technique pool the data over *i* and *t* into one nT observations, and estimates of the parameters are obtained by OLS using the model

y = X'β + ω (4)

where **y** is an $nT \times 1$ column vector of response variables, X is an $nT \times$ k matrix of regressors, β is a (k+1) × 1 column vector of regression coefficients, ω is an nT × 1 column vector of the combined error terms (i.e $\epsilon_i + u_{it}$).

From equation (4)

$Y = X'\beta + \omega$

Using the least square method, we minimize the residual sum of square given as

$ESS = \omega'\omega$ (5)

But $w = Y - X'\beta$ (6)

Hence,

$$\omega'\omega = (Y - X'\beta)'(Y - X\beta) = Y'Y - \beta'X'Y - Y'X\beta + \beta'X'X\beta \quad (7)$$

Since the transpose of a scalar is scalar, equation (7) becomes

$$= Y'Y - 2\beta'X'Y + \beta'X'X\beta \quad (8)$$

Differentiate $\omega'\omega$ w.r.t β gives

$$\partial\omega'\omega \Big/ \partial\hat{\beta}_{pooled} = -2X'Y + 2\hat{\beta}X'X = 0$$

$$\hat{\beta}X'X = X'Y$$

$$\hat{\beta}_{pooled} = (X'X)^{-1}X'Y \quad (9)$$

Equation (16) is the POLS estimator.

Fixed Effect Least Square Dummy Variable: Let Y_i and X_i be the T observations for the i_{th} unit, i be a $T\ x\ 1$ column of ones, and let e_i be associated $T\ x\ 1$ vector of disturbances. Then

$$Y_i = X_i\beta + \mathbf{i}\alpha_i + e_i \quad (10)$$

Connecting these terms in matrix form gives

$$Y = [X \quad d_1 \quad d_2 \quad \ldots \quad d_N] \begin{bmatrix}\beta \\ \alpha\end{bmatrix} + e_i \quad (11)$$

where d_i is a dummy variable indicating the i^{th} unit. Multiply (10) by n x n non-singular transformation matrix D to obtain

$DY = (DX)\beta + DD_\alpha + D\varepsilon_i$ (12)

Then we apply OLS to the transformed variables DY and DX on the transformed model (12)

Consider a positive definite symmetric matrix M_D that satisfies the equation

$DM_DD' = I$ (13)

$M_D = (D'D)^{-1}$

$D(D'D)^{-1}D' = I$

Thus,

$D\varepsilon_i = DY - (DX)\beta - DD_\alpha$

We minimize the residual sum of squares given as

$ESS = D\varepsilon_i'\varepsilon_iD'$ (14)

Thus,

$D\varepsilon_i'\varepsilon_iD' = (DY - DX\beta - DD_\alpha)'(DY - DX - DD_\alpha)$
$= D'Y'YD - \beta'DX'YD' - DD_\alpha'YD' - \beta DXY'D' + D\beta'X'X\beta D' + \beta DXD_\alpha'D' - D'D_\alpha Y'D + \beta'DX'D_\alpha D' + D'D_\alpha'D_\alpha D$ (15)

Since the transpose of a scalar is a scalar, (15) becomes

$$D\varepsilon_i'\varepsilon_iD' = D'Y'YD - 2\beta'DX'YD' - 2D'D_\alpha'YD + 2\beta'D'DX'D_\alpha + \beta'X'D'DX\beta + DD_\alpha'D_\alpha D'$$

Differentiate $D\varepsilon_i'\varepsilon_iD'$ w.r.t β gives

$$\partial D\varepsilon_i'\varepsilon_iD' \Big/ \partial\hat{\beta} = -2X'D'DY + 2X'D'DD_\alpha + 2\hat{\beta}X'D'DX = 0$$

$$\hat{\beta}X'D'DX = X'D'DY$$

Since the intercept of dummy $D_\alpha = 0$

$\hat{\beta} = (X'D'DX)^{-1}X'D'DY$
$= [X'M_DX]^{-1}[X'M_DY]$ (15)

Equation (15) is the least squares dummy variable (LSDV) model. This model is a classical regression model, so no new results are needed to analyze it

Random Effect Estimator: Consider a random effect model

$$Y_{it} = \beta_0 + \beta_iX_{it} + a_i + u_{it} \quad (16)$$

we assume that $Cov(X_{it}, a_i) = 0$

If we use OLS, inference will not be correct because of the a_i which is of two components expressed as

$$v_{it} = a_i + u_{it} \quad (17)$$

Thus, we use Generalized Least Square (GLS) to estimate model (18) by transformation into

$$\bar{Y}_{it} = \beta_0 + \beta_1\bar{X}_{it} + \bar{V}_{it} \quad (18)$$

Where $\bar{V}_{it}$ does not have serial correlation anymore. We then multiply equation (18) by λ and take its difference from equation (16) as

$Y_{it} - \lambda\bar{Y}_{it} = \beta_0(1-\lambda) + \beta_1(X_{it} - \bar{X}_{it}) + v_{it} - \lambda\bar{V}_{it}$ (19)

The quasi-demeaning transformation for (19) is given as

$Y_{it}^* = X\beta_{RE} + u$ (20)

Applying OLS to the transformed variables TY_{it}^* and TX on the transformed model (20) by considering a positive definite symmetric matrix Ω that satisfy the equation, we have

$T'\Omega T = I$ (21)

$T'T = \Omega^{-1}$

Thus,

$Tuu'T' = (TY_{it}^* - TX\beta_{RE})'(TY_{it}^* - TX\beta_{RE}')$
$= TY_{it}^*Y_{it}^{*\prime}T' - Y_{it}^*T'X'\beta_{RE}' - T'Y_{it}^{*\prime}TX\beta_{RE} + \beta_{RE}'X'T'TX\beta_{RE}$
(22)

Since the transpose of a scalar is a scalar, (22) becomes

$Tuu'T' = TY_{it}^*Y_{it}^*T' - 2\beta_{RE}'X'T'\,TY_{it}^* + \beta_{RE}'X'T'TX\beta_{RE}$

Differentiate $Tuu'T'$ w.r.t β_{RE} gives

$$\partial Tuu'T' \Big/ \partial\beta_{RE} = -2X'T'TY_{it}^* + 2\hat{\beta}_{RE}X'T'\,TX$$

Set $\partial Tuu'T' \Big/ \partial\beta_{RE} = 0$ gives

$$\hat{\beta}_{RE}X'T'TX = X'T'TY_{it}^*$$

$$\hat{\beta}_{RE} = (X'T'TX)^{-1}X'T'TY_{it}^*$$

$$= (X'\Omega^{-1}X)^{-1}X'\Omega^{-1}Y_{it}^{*}$$

$$\hat{\beta}_{RE} = (X'\ \Omega^{-1}X)^{-1}(X'\ \Omega^{-1}y) \qquad (23)$$

(23)

where

$$\Omega^{1/2} = \sigma_u^{-1}(I - T^{-1}\lambda i_T i_T') \qquad (24)$$

And

λ (*the key transformation parameter*) *is given as*

$$\hat{\lambda} = 1 - \left(\frac{\sigma_u^2}{\sigma_u^2 + \sigma_\varepsilon^2}\right)^{1/2}$$

Thus, equation (23) is the specific GLS estimator called the Random effect estimator.

Poolability, Hausman and Lagrange multiplier tests were carried out at different stages of the analysis to assess the three estimators.

Model Testing

Here, we shall employ a two-way error component model as earlier emphasized, to test for the violation of homoscedasticity and zero serial correlation assumptions in our researched model.

Considering a two-way error component model stated as:

$$y_{it} = x_{it}\beta + u_{it}\ ,;\ \ i = 1,2,\dots,N \quad t = 1,2,\dots,T \ (25)$$

Within the context of two-way error component, the regression disturbances term u_{it} can be described by the equation

$$u_{it} = \mu_i + \lambda_t + v_{it} \qquad (26)$$

With μ_i representing individual-specific effect, λ_t representing time-specific effect and v_{it} the idiosyncratic remainder disturbance term, which is usually assumed to be well-behaved and independent from both the regressors x_{it} and μ_i. The two-way error component model can be written in matrix form as

$$y = X\beta + u \qquad (27)$$

The disturbance term u in equation (27) can be written in vector form as

$$u = (I_{NT} \otimes \iota_{NT})\upsilon + (I_N \otimes \iota_T)\mu + (I_T \otimes \iota_N)\lambda + V \ (28)$$

Where I_{NT} is an identity matrix of dimension NT, I_N is an identity matrix of dimension N, I_T is an identity matrix of dimension T, ι_{NT} is a vector of ones of dimension NT, ι_T is a vector of ones of dimension T, ι_N is a vector of ones of dimension N, $\mu' = (\mu_1, \dots, \mu_N)$, $\lambda' = (\lambda_1, \dots, \lambda_T)$, V is the AR(1) covariance matrix of dimension T, $\otimes$ denotes the kronecker product and

$$Var(\mu_i) = \sigma_{\mu i}^2 = h(f_i'(\alpha)) \quad , i = 1, \dots, N \qquad (29)$$

According to [15], the function $h(\cdot)$ is an arbitrary strictly positive twice continuously differentiable function, α *is a* $P\ x\ 1$ vector of unrestricted parameters and f_i is a $P\ x\ 1$ vector of strictly exogenous regressors which determine the heteroscedasticity of the individual-specific effects and the first element of f_i is one, and without loss of generality, $h(\alpha_1) = \sigma_\mu^2$.

Following [16], the variance-covariance matrix of u can be written as

$$E(uu') = \Sigma = \sigma_u^2(I_N \otimes \iota_T\ \iota_T') + (I_T \otimes \iota_N \iota_N')\sigma_\lambda^2 + \sigma_v^2 I_{NT} \otimes V$$

$$= (I_N \otimes \iota_T) diag[h(f_i'\alpha)](I_N \otimes \iota_T)' + (I_T \otimes \iota_N \iota_N')\sigma_\lambda^2 + \sigma_v^2 I_{NT} \otimes V$$

$$= diag[h(f_i'\alpha)] \otimes J_T + (I_T \otimes \iota_N \iota_N')\sigma_\lambda^2 + \sigma_v^2 I_{NT} \otimes V \ (30)$$

Where J_T is a matrix of ones of dimension T, $diag[h(f_i'\alpha)]$ is a diagonal matrix of dimension NxN and V can be expressed as

$$V = E(VV') = \sigma_v^2 \left(\frac{1}{1-\rho^2}\right) \qquad (31)$$

where V_1 is a symmetric matrix of order ρ^{T-N}

Consequently, the test statistic for joint LM test for homoscedasticity and no serial correlation of the first order, Conditional LM test for heteroscedasticity given zero serial correlation and Conditional LM test for first order positive serial correlation given homoscedasticity were derived respectively as :

$$LM_{\rho,\alpha} = D(\tilde{\theta})'[\tilde{I}(\theta)^{-1}]\, D(\tilde{\theta}) = \frac{1}{2[N-T]}\left[\frac{T\tilde{\sigma}_1^4 D(\hat{\rho})^2 - Th'(\tilde{\alpha}_1)2(T-1)^2\tilde{\sigma}_1^4\tilde{\sigma}_v^4 D(\hat{\rho})}{(T-1)^2(\tilde{\sigma}_v^4 - \tilde{\sigma}_1^4)} + \frac{2N(\tilde{\sigma}_v^4 - \tilde{\sigma}_1^4)g'\tilde{\sigma}_1^2 F'Fg - Th'(\tilde{\alpha}_1)^2\tilde{\sigma}_1^2\tilde{\sigma}_v^4\, D(\hat{\rho})g}{h'(\tilde{\alpha}_1)(\tilde{\sigma}_v^4 - \tilde{\sigma}_1^4)}\right] \qquad (32)$$

$$LM_{\rho|\alpha} = D(\hat{\rho})'[(I(\hat{\eta}_1))^{-1}|_{\rho\rho}]D(\hat{\rho}) \qquad (33)$$

where $(I(\hat{\eta}_1))^{-1}|_{\rho\rho} = \frac{1}{2} N \overset{lim}{\longrightarrow} \infty \left[\frac{1}{N}Z'\left(I_N - \frac{I_N I_N'}{N}\right)Z\right]$

$$LM_{\alpha|\rho} = D(\hat{\alpha})'[(I_{NT}(I(\hat{\eta}_2)))^{-1}|_{\alpha\alpha}]D(\hat{\alpha}) \qquad (34)$$

where

$$(I(\hat{\eta}))^{-1}|_{\alpha\alpha} = \frac{h'(\hat{\alpha}_1)^2\varphi^4(1-\hat{\rho})^4}{2\hat{\sigma}_v^4} N \overset{lim}{\longrightarrow} \infty \left[\frac{1}{N}F'\left(I_N - \frac{I_N I_N'}{N}\right)F\right]$$

Under the null hypothesis, the LM statistic of equations (32), (33) and (34) is asymptotically distributed as χ_{p+1}^2, χ_1^2 and χ_p^2 *as* $N, T \to \infty$ respectively.

III. Results

Model results as well as test carried out on the models are presented below

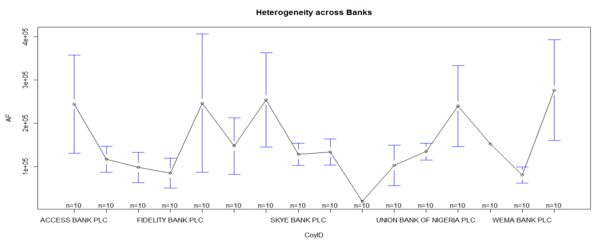

Fig 1: Means plot of audit fees across banks

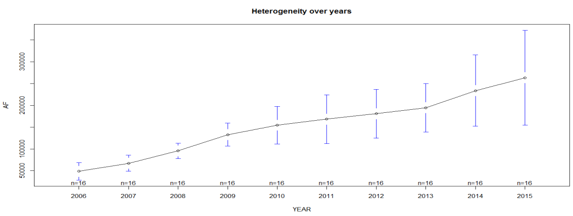

Fig 2: Means plot of audit fees over years

Figure 1 reflect the presence of heteroscedasticity in audit fees paid across banks with Standard chartered bank (SCB) paying the highest average for the periods while figure 2 presents the audit fees for each year which reveals that the average audit fees of the 16 banks varied over years as a result of unequal variability in the audit fees paid as occasioned by frequent changes in their operational capacities.

The estimated models using POLS, Within and GLS estimators fitted into the obtained panel data are presented as follows:

Table 1: Presentation of Pooled OLS Results

Variables	Coefficients	S.E	t-value	Pr(>|t|)
Intercept	120,970	10,011	12.084	0.0000
PBT	0.00080588	0.00027278	2.9543	0.0036
TA	-0.0000261	0.00001296	-2.0131	0.0458
TL	0.000008048	0.00003542	2.2724	0.0244
SHF	0.00025419	0.00012246	2.0757	0.0396

$\boldsymbol{R^2 = 0.26043, \bar{R}^2 = 0.2523, F = 13.6451, DF(4,155), P-value = 0.0000}$

The model specified from table 1 is given as

$$AF = 120{,}970 + 0.00080588PBT - 0.000026096TA + 0.00000482TL + 0.00025419SHF \quad (35)$$

Though, equation (1) gives a reasonable projection of audit fees for a unit increase in each of the predictors which are equally statistically significant based on the computed 't' and 'F' values. However, its weak coefficient of determination ($R^2 = 0.26043$) which implies that only 26.04% of the variation in audit fees is accounted for by the predictors clearly shown that the model cannot be adjudged a best fit. In addition to this defect, the model assumes that the slope coefficients and intercepts of the 16 banks are the same. This overly restrictive nature of the model can lead to error process that is heteroscedastic across the banks and serially correlated within the banks, hence the need to test for poolability effect.

Table2: Test for Poolability

F	DF1	DF2	P-value
8.4059	**60**	**80**	**0.0000**

$H_0: There's\ no\ pooling\ effect\ (u_1 = u_2 = \cdots = u_{16})$
$H_1: There's\ pooling\ effect\ (the\ u_i\ are\ not\ all\ equal)$

Here we reject the null hypothesis that the intercept and slope coefficients for all the banks are equal. We conclude that there are differences in the banks' parameters, and that the data should not be pooled into a single model with a common intercept parameter, hence the needs to fit the specified least square dummy variable model (LSDVM) and random effect model (REM) as given below:

Least Square Dummy Variable Model that accounts for only Individual

Access:
$$AF = 218{,}000 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.1)$$
Diamond:
$$AF = 100{,}100 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.2)$$
Eco:
$$AF = 51{,}800 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.3)$$
Fidelity:
$$AF = 73{,}800 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.4)$$
First:
$$AF = 197{,}480 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.5)$$
FCMB:
$$AF = 136{,}280 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.6)$$
GTB:
$$AF = 205{,}500 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.7)$$
SKYE:
$$AF = 115{,}800 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.8)$$
SIBTC:
$$AF = 121{,}370 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.9)$$
SCB:
$$AF = 13{,}400 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.10)$$
STERLING:
$$AF = 97{,}100 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.11)$$
UNION:
$$AF = 140{,}690 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.12)$$
UBA:
$$AF = 206{,}220 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.13)$$
UNITY:
$$AF = 151{,}080 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.14)$$
WEMA:
$$AF = 79{,}600 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.15)$$
ZENITH:
$$AF = 192{,}900 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (36.16)$$

Equations (36.1) to (36.16) represent the LSDVM results which take into account only the cross-sectional differences that exist among the banks. It is pertinent to state that the first bank on our list, Access bank plc has been sacrificed in terms of a dummy variable to avoid falling into the dummy variable trap. A dummy variable was created for the remaining fifteen (15) banks and their parameters estimate tell us by how much each of their intercepts differs from that of the Access bank. Thus, the sixteen models specified from these results are not equal in terms of intercept, which is a clear case of heteroscedasticity. The estimated coefficients of only nine(9) of the banks are statistically significant at 5% level of significance based on their t-values, and this is in line with the poolability test which specified that all the banks coefficient are different from one another. However, all the specified models are statistically significant based on their F-value of 6.236 with a P-value of 0.0000 < 0.05. It is obvious that the coefficient of determination gives a better value of 0.4584 compared to the pooled OLS model, which indicates that 45.84% of the total variation in audit fees is jointly explained by the chosen predetermined variables.

Table 3: Presentation of LSDVM Results that Accounts for Only Time Effects

Variables	Coefficients	S.E	t-value	Pr(>|t|)
Intercept	42,820	23810	1.799	0.074138
PBT	-0.0003292	0.00001201	-2.741	0.006900
TA	0.0007216	0.00002691	2.681	0.008175
TL	0.00000668	0.000003255	2.055	0.041701
SHF	0.0007216	0.00002691	2.681	0.008175
YR- 2007	0.0002586	0.000115	2.249	0.026005
2008	0.0002628	0.0003391	0.775	0.439568
2009	0.0009526	0.0003445	2.765	0.006422
2010	0.0008981	0.0003379	2.658	0.008741
2011	0.00001142	0.0003398	3.362	0.000989
2012	0.0008981	0.000339	2.658	0.008741
2013	0.00001253	0.0003421	3.664	0.000347
2014	0.00001561	0.0003463	4.507	0.0000134
2015	0.00001613	0.0003615	4.461	0.0000162

$$R^2 = 0.4395, \bar{R}^2 = 0.3896, F = 8.807, DF(13.146), P-value = 0.0000$$

From table 3, ten (10) different models can be specified for each of the years (2006 -2015). Though, the differential intercept dummies for the years will have little or no significant impact on the banks' intercept for each of the years as can be observed from their coefficients values. These results were estimated for (T-1) dummies to avoid falling into the dummy variable trap. Coefficients were estimated for each of the years 2007 – 2015, and these represent differential intercepts of audit fees paid by the banks for each of the years under consideration as a mark of periodicity effect. The estimated coefficients for all the years are statistically significant except for the years 2007 and 2008. Just like the individual effect results, all the coefficients in the models are different than zero based on the computed F-value of 8.807 with a P-value < 0.05.

Table 4 presents the results of two-way effects Within-Group (WG) estimator. In line with [16], this model implements the LSDV model better, and this can be observed from the significant levels of the banks intercepts. The estimated intercepts for all the banks are statistically significant at both 1% and 5% level of significance except that of Standard Chartered bank. Despite this anomaly, the estimated audit fee presented by this bank's model is still a reasonable sum of 19.961 million US dollars at constant values of all the predetermined variables. However, contrary to the inspiring theoretical expectations of this estimator, the overall validity status of the results appears doubtful. Its coefficient of determination is relatively low compared with other LSDVM results (i.e 4.73%), and on the average, the estimator produces an insignificant estimate based on its F-statistic with a P-value of 0.1712 > 0.05. This implies that the heteroscedasticity and periodicity effects on the bank's audit fees are better accounted for individually as justified by previous LSDVM results which provide better and significant estimates for the parameters concerned. Therefore, models (36.1) to 36.16) shall be upheld as our fixed-effect models for all the sixteen (16) banks under consideration, as the models present superior goodness of fit. Thus, we find the average intercepts of these models in order to derive a universal fixed-effect model in conformity with the aim of this research. This model therefore becomes

$$AF = 131{,}320 - 0.0000019PBT + 0.00000803TA + 0.000558TL + 0.0000247SHF \quad (37)$$

Table 4: Presentation of LSDVM Results that Accounts for Both Individual and Time Effects (Two-ways effects Within Model)

Variables	Coefficients	Standard Error	t-value	Pr(>|t|)
PBT	0.00025179	0.000252	1.0008	0.3188
TA	-0.0000094	0.000012	0.7979	0.4264
TL	0.00000582	0.000006	0.000003	0.0339
SHF	0.00001832	0.000109	0.1686	0.8664
Access Bank	239750	25140	9.5366	0.0000
DIAMOND	114625	24424	4.6931	0.0000
ECO	97900	28504	3.4347	0.0006
FIDELITY	83564	24855	3.3621	0.0008
FIRST	239005	27177	8.7943	0.0000
FCMB	146134	24663	5.9253	0.0000
GTB	240149	27660	8.6823	0.0000
SKYE	127638	24323	5.2476	0.0000
SIBTC	131288	24306	5.4014	0.0000
SCB	19961	24328	0.8205	0.4119
STERLING	102944	24158	4.2613	0.0000
UNION	142986	25747	5.5536	0.0000
UBA	235795	25542	9.2317	0.0000
UNITY	153649	24198	6.3497	0.0000
WEMA	81289	24128	3.3690	0.0008
ZENITH	244608	30532	8.0116	0.0000

$$R^2 = 0.0473, \bar{R}^2 = 0.0387, F = 1.62711, DF(4.131), P-value = 0.1712$$

Table 5: Presentation of Random Effect Model Results that Accounts for Both Individual and Time Effects (Two-ways effects Model)

Effects	Variance	SD	Shares	Lambda
idiosyncratic	5809000000	76210	0.746	-
individual	1894000000	43520	0.243	0.5155
time	85800000	9263	0.011	0.1006
Total	-	-	-	0.08774
Variables	**Coefficients**	**SE**	**t-value**	**Pr(>|t|)**
Intercept	130400	130400	1.6386	0.0000

PBT	0.00061736	26438	2.3351	0.02082
TA	-0.0000113	0.00001	0.8682	0.38664
TL	0.0000079	0.000003	2.4860	0.01398
SHF	0.0000991	0.000120	0.8234	0.41152

$R^2 = 0.15611, \bar{R}^2 = 0.15611, F = 7.16815, DF(4,155), P-value = 0.0000$

$$AF = 130{,}400 + 0.000062PBT - 0.000011TA + 0.0000079TL + 0.000099SHF \quad (38)$$

The results are estimated through the generalized Least Squares (GLS) estimators for the slope parameters of REM. Since the value of key transformation parameter, $\lambda > 0$ for both effects, the coefficients of the specified model include both the within-entity and between-entity effects. Thus, each of the coefficients represents the average effects of the explanatory variables on audit fees when the former changes across time and between banks by one unit. Though, all the coefficients in the models are different than zero based on the computed F-value of 7.16815 with P-value < 0.05, it's $\boldsymbol{R^2}$ of 0.15611 which explained 15.61% variation in the payment made for audit fees is however too small to provide a goodness of fit.

Table 6: Presentation of Hausman Test Results

Chi-square	Df	p-value
1193.6	4	0.0000

$H_0: (Cov(X_{it}, a_i) = 0)\ vs\ H_1: (Cov(X_{it}, a_i) \neq 0)$ Hausman test results according to [18] were presented to select the best between the estimated fixed and random effect models. Since the P-value of Hausman test is < 0.001, then we assumed unique errors are correlated with regressors and reject the null hypothesis. Thus, a fixed effect model becomes the recommended model for the determination of audit fees in Nigerian commercial banks. Based on this inference, equation (37) represents the focused model in the course of this research. Such a scientific model would fix the audit fees objectively and forestall the occurrence of serial correlation in annual audit fees paid by banks, as there would not be room for any errors associated with a given time period to be carried forward into future time periods. Moreover, equation (37) is the ideal model for this research based on the set aim, which is to specify the audit fees model for each of the banks (not for each of the years) that will suffice for the fixing of audit fees in Nigerian commercial banks and diaspora.

The fact that both heteroscedasticity and serial correlation are present in the POLS estimator was established through the conduct of joint LM test and conditional LM tests. The LM results are asymptotically chi-square distributed with Z-values of 4.0063, 35.3806 and 7.1462 with P-values of 0.00006168, 0.0001075 and 0.000000000000446 respectively for the three tests. These results prompt the rejection of null hypothesis and thereby validate the homoscedastic nature and no serial correlation effect in the residual of our chosen model.

IV. Conclusion

The essence of conducting this research is to develop an Audit Fee Model (AFM) estimated by panel data regression techniques while evaluating the usual associated heteroscedasticity and periodicity problem via a two-way error component model, with a view to generating an AFM to provide guide for the review of audit fees in Nigerians Banks, whose estimates are not only consistent but reliable. Therefore, based on the results obtained by the empirical analysis of the sourced data, equations (3) is the only recommended model that satisfies the purpose of this research. Thus, the researched AFM can become a policy statement from the Central Bank through which necessary guides on the scientific determination of auditors' remuneration can be provided for commercial banks.

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