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Estimation of Compensation of Employee Function: Panel Data Analysis of National Accounts of Nigeria

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Abstract

Fixed effect models otherwise known as least squares dummy variable regression model was applied to the study of the compensation of employee function. The estimates were compared with ordinary least squares (OLS) estimator. The evaluation criteria for the estimated models are; R-square, F-ratio and restricted F-test. The results showed that the coefficients of the explanatory variables, excluding indirect taxes positively explained compensation of employee. It also revealed that the coefficients of the explanatory variables excluding consumption of fixed capital play significant role in determining what should be paid as compensation to employee who suffer injuries or loses. The restricted F-test for the estimators showed that compensation function has not changed much across the sectors but that it has changed much more over the years.

***Key words**:* Panel data; Fixed effects; Least square dummy variable.

Introduction

The study of two dimensional Panel data is usually of interest in Statistics, Epidemiology and Econometrics. It contains observations on multiple phenomena observed over multiple time periods for the same individuals or households. Data of this type are usually analyzed by panel data regression models. The basic idea underlining the application of panel data regression model is to determine or estimate the functional parameters called the intercept and the slope coefficients as well as to capture the patterns of the relationship for the dependent variable over time series and cross sectional variables. Panel data regression model was developed for situations where the error term, μ_{it} is assumed to vary non-stochastically over i and t, making the model; fixed effects model (FEM) in one dimension. Where the error term, μ_{it} is assumed to vary stochastically over i and t, the model is random effects model (REM), Baltagi (2008). Fixed effects model (FEM) have been applied to both social and Economic problems. Some authors have used fixed effects model in their studies. Notable among them is Ahmed & Sobhi (2009), who studied a comparative study for estimation parameters, used Panel data regression model and their result shows that classical pooling estimator performed well in a fixed effect model only. Cheng and Kamil (1997) showed that fixed effects model may be applied in the analysis of liquidity constraints and firm investment. Treisman (2000) showed that fixed effects model could be extended in various areas, for example to identify the potential endogeneity of income and the instrument. Hsiao & Kamil (1997) showed that fixed effects model was used in selecting the final specification and evaluated the importance of financial constraints on firm's investment decision Lee & Russell (2004) also showed that fixed and random effects models could be applied in Panel data analysis of factors affecting as built roughness of asphalt concrete pavement. In this work, panel data regression model; fixed effects model was studied on "National Accounts of Nigeria". Measurements on cost components of value added at current prices in millions, for four activity sector; Electricity, Telecommunications, Transportation and Education were collected over twenty-six (26) year time period from 1981-2006. The components considered are; Compensation of Employee (CE), Consumption of Fixed Capital (CFC), Indirect Taxes (IT), Value Added at Current Basic Price

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(VACBP) and Operating Surplus (OS). These independent variables were actual life data published by National Bureau of Statistics (2007) Nigeria, to measure compensation as referenced.

Table 1. Ordinary least square (OLS) results

. reg CE CFC IT VACBP OS

Source	SS	df	MS
Model	2.7447e+10	4	6.8617e+09
Residual	4.2106e+10	99	425313673
Total	6.9553e+10	103	675272094

Number of obs	= 104
F(4, 99)	= 16.13
Prob > F	= 0.0000
R-squared	= 0.3946
Adj R-squared	= 0.3702
Root MSE	= 20623

CE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CFC	.0528031	.4898583	0.11	0.914	-.9191821	1.024788
IT	-.3764571	.1009102	-3.73	0.000	-.5766848	-.1762294
VACBP	.3835432	.099703	3.85	0.000	.1857108	.5813755
OS	.9283589	.2681361	3.46	0.001	.3963186	1.460399
_cons	1843.832	2305.708	0.80	0.426	-2731.193	6418.856

Table 2. Results of fixed effects when the error term is fixed

. xtreg CE CFC IT VACBP OS,fe

Fixed-effects (within) regression	Number of obs = 104
Group variable: id	Number of groups = 4
R-sq: within = 0.3702	Obs per group: min = 26
between = 0.7915	avg = 26.0
overall = 0.3933	max = 26
	F(4,96) = 14.11
corr(u_i, Xb) = 0.0594	Prob > F = 0.0000

CE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CFC	.2162725	.5122012	0.42	0.674	-.8004388	1.232984
IT	-.3753087	.10352	-3.63	0.000	-.5807942	-.1698231
VACBP	.3820496	.1023537	3.73	0.000	.1788791	.58522
OS	.8046859	.3073387	2.62	0.010	.1946234	1.414748
_cons	1856.271	2344.345	0.79	0.430	-2797.217	6509.758
sigma_u	3282.8113					
sigma_e	20757.125					
rho	.02440216	(fraction of variance due to u_i)				

F test that all u_i=0: F(3, 96) = 0.58 Prob > F = 0.6326

Theoretical Framework

The basic theoretical problem which will be considered in this work is based on the application of ordinary least squares (OLS) and fixed effects model, using least square dummy variable regression model. A Panel data model as given by Gujarati (2006) is:

$Y_{it} = \beta_1 + \beta_2X_{2it} + \beta_3X_{3it} + \ldots + \beta_kX_{kit} + \mu_{it}$ (1)

$i = 1, 2, \ldots, k$ and $t = 1, 2, 3, \ldots, n$

where i stands for the i^{th} cross sectional units (sectors)and t stands for the t^{th} time period (years) which are the cross sectional identifier and the time identifier respectively. β_1 is s constant. $\beta_2, \beta_3, \ldots, \beta_k$ are the regression coefficients. Y_{it} is the dependent variable while $X_2, X_3, \ldots, X_k$ are the independent variables.

Analytical Framework

Ordinary least squares (OLS)

The ordinary least squares (OLS) regression applied to investigate Compensation of Employee function when coefficients are constant across time and individual sectors is achieved by pooling all the observations together, Thus, equation (1) could be written as:

$CE_{it} = \beta_1 + \beta_2CFC_{2it} + \beta_3IT_{3it} + \beta_4VACBP_{4it} + \beta_5OS_{5it} + \mu_{it}$

$i = 1, 2, \ldots, 4$ and $t = 1, 2, 3, \ldots, 26$

where the variables are as defined in the introduction. Stacking all the twenty-six observations for each sector units, one on top of the other, thus, given in all, 104 observations for each of the variables in the model, disregarding the space and time dimensions of the pooled data and estimate the usual ordinary least squares regression. The results obtained are shown in Table 1.

Fixed effects model (FEM)

In fixed effects model, the error term μ_{it} is assumed to vary non- stochastically over i and t making the fixed effects model in one dimension. In fixed effects, we impose time independent effect on each entity that are possibly correlated with the regressors, Gujarati (2006); Gujarati & Porter (2009). Fixed effects model used in this work is given as:

$CE_{it} = \beta_{1i} + \beta_2 CFC_{2it} + \beta_3 IT_{3it} + \beta_4 VACBP_{4it} + \beta_5 OS_{5it} + \mu_{it}$ (2)

where $\mu_{it} = \mu_i + v_{it}$ and μ_i are individual sector specific time-invariant effect. The subscript i on the constant term suggests that the constants of the four sector may be different which may be as a result of some special features of each of the sectors such as management style and policies. The results obtained are presented in Table 2.

Least squares dummy variables (LSDV) regression models

Least squares dummy variable is a method which takes into accounts the individuality of each sector. This is achieved by allowing the constant to vary for each sector but still assume that the regression coefficients are constant across sector and/ or time periods, Hsiao (2003). Assuming that the constant varies across individual sectors but the regression coefficients are constant. Equation (2) becomes:

$CE_{it} = \alpha_1 + \alpha_2 D_{2i} + \alpha_3 D_{3i} + \alpha_4 D_{4i} + \beta_2 CFC_{2it} + \beta_3 IT_{3it} + \beta_4 VACBP_{4it} + \beta_5 OS_{5it} + \mu_{it}$ (3)

where D_2 = 1 if the observation belongs to Telecommunications, D_2 = 0 if the observation does not belong to Telecommunications;

D_3 = 1 if the observation belongs to Transportation, D_3 = 0 if the observation does not belong to Transportation services;

D_4 = 1 if the observation belongs to Education, D_4 = 0 if the observation does not belong to Education.α_1 represents the constant of Electricity while α_2, α_3 and α_4 are the differential constant coefficients, telling us by how much the intercepts of Telecommunication, Transportation and Education differ from the intercept of Electricity, which is our comparison sector. We used only three dummies to avoid falling into dummy variable trap (the situation of perfect collinearity). The results are presented in Table 3. When we assume that the regression coefficients are constant but the constant coefficient varies across individual time periods. Just as we used dummy variables to account for

Table 3. Results of Least Squares Dummy Variable for Individual Sector Effects

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reg CE CFC IT VACBP OS D2 D3 D4
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Source	SS	df	MS
Model	2.8191e+10	7	4.0272e+09
Residual	4.1362e+10	96	430858229
Total	6.9553e+10	103	675272094

Number of obs	104
F(7, 96)	9.35
Prob > F	0.0000
R-squared	0.4053
Adj R-squared	0.3619
Root MSE	20757

CE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CFC	.2162725	.5122012	0.42	0.674	-.8004388	1.232984
IT	-.3753087	.10352	-3.63	0.000	-.5807942	-.1698231
VACBP	.3820496	.1023537	3.73	0.000	.1788791	.58522
OS	.8046859	.3073387	2.62	0.010	.1946234	1.414748
D2	-7687.846	6351.404	-1.21	0.229	-20295.28	4919.591
D3	-1854.13	6408.816	-0.29	0.773	-14575.53	10867.27
D4	-3612.011	7048.79	-0.51	0.610	-17603.75	10379.73
_cons	5144.768	4727.201	1.09	0.279	-4238.652	14528.19

individual sector effects, individual time effects can easily be taken care of by introducing time dummies, one for each year in the sense that compensation function shift over time because of factors such as technological changes, changes in government, taxation policies and external factors as conflicts and war. Thus, equation (2) becomes:

$CE_{it} = \lambda_0 + \lambda_1 DUM_1 + \lambda_2 DUM_2 + ... + \lambda_{25} DUM_{25} + \beta_2 CFC_{2it} + \beta_3 IT_{3it} + \beta_4 VACBP_{4it} + \beta_5 OS_{5it} + \mu_{it}$ (4)

where DUM_1 = 1 for observation in 1981 and 0 otherwise; DUM_2 = 1 for observation in 1982 and 0 otherwise; DUM_3 = 1 for observation in 1983 and 0 otherwise; . . .; DUM_{25} = 1 for observation in 2005 and 0 otherwise. 2006 was treated as the base year whose intercept value is λ_0. The differential intercept coefficients λ_1, λ_2, λ_3, . . ., λ_{25} tell us by how much the intercepts of 1981, 1982, 1983, . . ., 2005 differ from the intercept of 2006 which is our comparison year. The results of model (4) are presented in Table 4.

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Table 4. Results of Least Squares Dummy Variable for Individual Time Effects

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. reg CE CFC IT VACBP OS DUM1- DUM25
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Source	SS	df	MS
Model	5.0315e+10	29	1.7350e+09
Residual	1.9238e+10	74	259975423
Total	6.9553e+10	103	675272094

Number of obs =	104
F(29, 74) =	6.67
Prob > F =	0.0000
R-squared =	0.7234
Adj R-squared =	0.6150
Root MSE =	16124

CE	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CFC	-2.333204	.4619527	-5.05	0.000	-3.253665	-1.412743
IT	-.2632973	.0800729	-3.29	0.002	-.4228461	-.1037485
VACBP	.2671535	.0792349	3.37	0.001	.1092745	.4250325
OS	.7290806	.2366246	3.08	0.003	.2575958	1.200565
DUM1	-116810.5	14918	-7.83	0.000	-146535.2	-87085.68
DUM2	-116856	14923.19	-7.83	0.000	-146591.1	-87120.93
DUM3	-117530.3	14892.99	-7.89	0.000	-147205.2	-87855.35
DUM4	-116685.2	14906.9	-7.83	0.000	-146387.9	-86982.6
DUM5	-116485.7	14884.8	-7.83	0.000	-146144.3	-86827.07
DUM6	-116440.2	14881.44	-7.82	0.000	-146092.1	-86788.28
DUM7	-116149.8	14852.32	-7.82	0.000	-145743.7	-86555.89
DUM8	-115720	14809.46	-7.81	0.000	-145228.5	-86211.49
DUM9	-115411.1	14773.09	-7.81	0.000	-144847.1	-85975.04
DUM10	-115030.6	14733.84	-7.81	0.000	-144388.4	-85672.8
DUM11	-114769.2	14708.7	-7.80	0.000	-144077	-85461.53
DUM12	-115018.1	14695	-7.83	0.000	-144298.5	-85737.64
DUM13	-113982.6	14658.61	-7.78	0.000	-143190.6	-84774.71
DUM14	-113210.3	14606.7	-7.75	0.000	-142314.8	-84105.85
DUM15	-111789.9	14527.11	-7.70	0.000	-140735.8	-82843.99
DUM16	-110582.5	14457.45	-7.65	0.000	-139389.6	-81775.38
DUM17	-109836.5	14408.7	-7.62	0.000	-138546.4	-81126.54
DUM18	-109047.3	14355.16	-7.60	0.000	-137650.6	-80444.04
DUM19	-108367.7	14302.92	-7.58	0.000	-136866.9	-79868.56
DUM20	-107691.4	14249.18	-7.56	0.000	-136083.5	-79299.27
DUM21	-102418.8	13648.61	-7.50	0.000	-129614.3	-75223.4
DUM22	-102288.7	13384.87	-7.64	0.000	-128958.6	-75618.73
DUM23	-100417.3	13213.59	-7.60	0.000	-126746	-74088.66
DUM24	-98476.71	13114.94	-7.51	0.000	-124608.8	-72344.63
DUM25	-92559.07	12595.28	-7.35	0.000	-117655.7	-67462.43
_cons	117431.3	12635.22	9.29	0.000	92255.03	142607.5

Results and Discussion

The results of Tables 1 to 4 show that the coefficients of the regression have positive signs consistent with a priori expectation, except that of Indirect Taxes which has a negative sign. Implying that, Consumption of Fixed Capital (CFC), Value Added at Current Basic Price (VACBP) and Operating Surplus (OS) positively explained Compensation of Employee function. In other words, an increase in any of these variables will increase Compensation of Employee while an increase Indirect Taxes will lead to a reduction of compensation of employee and vice versa. The results revealed that the coefficients of Indirect Taxes (IT), Value Added at Current Basic Price (VACBP) and Operating Surplus (OS) are highly statistically significant. Implying that the percentage paid as tax or the amount paid as tax, Current Basic prices at which sectors offer their products for sale and Surplus, a situation where revenue generated is greater the expenditure, play major/significant role in determining what should be paid as compensation to staff (workers) who suffer injury or loss. Only the coefficient of Consumption of Fixed Capital (CFC) is not statistically significant. This is because majority of the fixed Capitals (tangible assets) might be old or broken down becoming liabilities to the sectors instead of being productive. The coefficients of determination, R^2 of 0.3946 and 0.3702 in Tables 1 and 2 respectively are relatively low, indicating about 39.46 and 37.02 percent of the total variations observed in the dependent variable were actually accounted for by the independent variables included in the models 1 and 2. Table 3 showed that all the estimated coefficients of the sector units are individually statistically not significant, as p- values 0.229, 0.773 and 0.610 of the estimated t-coefficients are small. The constant values of the four sector units are statistically different; being 5144.768 for Electricity; -2543.08 (5144.768 – 7687.846) for Telecommunications services; 3290.64 (5144.768 – 1854.13) for Transportation and 1532.76 (5144.768 – 3612.011) for Education. The differences in their constant values may be due to unique features of each sector, such as managerial ability technological changes, changes in government, taxation policies etc. The negative value for Telecommunications services suggests that the differential constant of Telecommunications services differ by -2543.08 from the constant of Electricity. The R^2 value of 0.4053 shows an increment of 0.0107 over that of Table1. The restricted F-test of 0.58 is not statistically significant; therefore suggesting that the differential intercepts of model (3) are the same. The results in Table 4 revealed that individual time dummy coefficients are statistically

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significant. Again all the time dummy coefficients have negative signs showing that compensation of employee is negatively explained by individual time periods (years). Coefficient of determination, R^2 value of 0.7234 was reasonably high when compared with the R^2 value of 0.3946 in Table 1; which shows an increment of 0.3288. The restricted F-test value of 29.32 shows that the increment is highly statistically significant, this probably suggests that model (4) seems not valid, suggesting that the differential time intercepts for model (4) are not the same.

Conclusion

The regression model estimators used in this work showed that the coefficients of all the explanatory variables except that of indirect taxes are positively related to Compensation of Employee. Also, all the coefficients of the explanatory variables excluding that of Consumption of Fixed Capital are highly statistically significant. However, on the bases of the restricted F-test for the estimated model (3), compensation function has not changed much across sector but restricted F-test for estimated model (4), compensation function has changed much more over the years.

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