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CAUSALITY TEST OF BUSINESS RISK AND CAPITAL STRUCTURE IN A PANEL DATA OF NIGERIAN LISTED FIRMS

Dauda Mohammed, Bayero University

ABSTRACT

In economic sense, some events may be subject to spill-over from economy-wide or world-wide shocks. For instance a country's fiscal policy, such as government spending, taxation, and borrowings, influence both the pattern of economic activity and also the level and growth of aggregate demand, output and employment. Therefore, causal relationship may flow from business risk to financing structure of companies and vice versa. The objective of this study is to show that Granger (1969) Causality test can be conducted on a panel data comprising of time series and cross-sectional data set. This study used a dynamic panel data of publicly listed firms in Nigeria for the period of 2000-2006, to analyse the direction of causality between our measures of leverage and business risk using the causality approach described by Granger (1969). The overall, results indicates that increases in either business risk or total liabilities as a proportion of total assets do not Granger-cause or predict higher future values of both variables over the short-to-medium term. The implication is that an analysis of the relationship between capital structure and business risk in Nigeria could be estimated in a dynamic panel framework

KEYWORDS: Capital Structure, Business Risk, Granger Causality, Instrumental Variables, Misspecification, Seemingly Unrelated Regression Equations, Three Stage Least Squares

JEL: C30, C33

INTRODUCTION

Financial researchers have often use contemporary pair-wise correlation coefficients to analyse the degree of correspondence of directional movement in the variable of interests. However, such estimated pair-wise correlation coefficients do not indicate whether the assumed relationship is unidirectional or bi-directional. For instance, it does not often show whether the dependent variable is causing change in the independent variable or vice versa Nwachukwu and Mohammed (2012). In other words some global events may be subject to spill-over from economy-wide or world-wide shocks. For instance a country's fiscal policy, such as government spending, taxation, and borrowings, influence both the pattern of economic activity and also the level and growth of aggregate demand, output and employment. It is therefore important to realize that changes in fiscal policy affect both aggregate demand (AD) and aggregate supply *(AS)* including that for a company's capital. In order to capture the impact of these changes in aggregate *demand* and aggregate *supply* researchers such as Granger, *et al.*(2000) and Koop (2006) employ econometric method to statistically detect the direction of the causal relationship between two time series variables using the Granger causality test. Similarly, previous studies on capital structure including Morley (2006) and Berger and Patti (2006), have utilized the Granger causality test in their panel data analysis.

The aim of this paper is to use causality test as described by Granger (1969) to examine the directional relationship between business risk and capital structure of Nigerian listed firms**.** For brevity, we limit our analysis of the direction of causality by assuming that the ratio of total liabilities to total assets (LEV) and

earnings risk (STDEV) form a simple two-variable model without the necessity of controlling for the effect of the other factors influencing the capital structure decisions of Nigerian companies. The remaining of the part of the paper is organised as follows; section 2 provide a literature review of causality. Section 3 explain the characteristics of the data, discusses the econometric problems inherent in quantitative researches when lagged dependent variables are included as one of the explanatory variables and present the model specification. Section 4 provide the results and discuss the finding while section 5 provide concluding comments.

LITERATURE REVIEW

The theoretical framework of the bi-variate Granger-causality test is based on the premise that a causal series contains information about the response variable that is unavailable from any other source (Pesaran *et al.* 2001). Therefore, a variable (X_{it}) for example, is said to cause another (Y_{it}) if the forecast for the current value of Y_{it} is significantly improved by the inclusion of the past value of X_{it} after controlling for the past value of Y_{it} (Pesaran *et al.* 2001). Given the challenges of Nigeria's business environment, it would not be impossible to have a causality relationship between capital structure and earnings volatility (*business risk*) running in both directions. It therefore follows that causation may run negatively from earnings risk to the total leverage ratio, provided that company managers are more inclined to retain a larger proportion of a marginal increase in earnings rather than distribute them to shareholders during periods of economic uncertainty. Thus, the additional retained profit is then substituted for debt capital. This implies that a forecast of changes in earnings variability would be followed by changes in the total leverage ratio in the opposite direction.

Previous studies on capital structure including Morley (2006) and Berger and Patti (2006), have utilized the Granger causality test in their panel data analysis. The perceptive ideas for bivariate causality are usually investigated by isolating the impact of the two variables of interest, in this case the leverage ratio of our sampled firms and our measure of earnings variability (business risk) assuming other variable are held constant. Research studies done in the past decade (Carkovic and Levine 2002; Nwachukwu, 2009) have shown that the inclusion of lagged dependent variables as one of the right hand side variables in a panel data framework presents problems for both fixed and random effect estimation techniques. This is because all panel data models make the basic assumption that at least some of the parameters are the same across the panel often referred to as the *pooling assumption*. When the pooling assumption does not hold, we refer to our panel as a *heterogeneous panel*.

Heterogeneity is introduced because we consider as cross-sections a relatively large number of companies that are in different sectors and in different stages of growth that are also in competition for a larger market share. Thus, if we impose constant parameter assumption incorrectly, then serious problem may arise and we can again get a biased result arising in both *static* and *dynamic* panels under certain circumstances. In a panel data set, there is always a reason to suspect that the idiosyncratic error of individual firm (i) correlates over time (*autocorrelation*). Generally, there are three types of misspecification bias that are frequently considered in a dynamic panel estimation which may prejudice the estimated parameter coefficients. They comprise errors induced by (i) non-stationarity in data, (ii) bias induced by the presence of firm-specific effect and (iii) the joint endogeneity of the explanatory variables. Previous research studies including; Bun and Carree (2005)Hayakawa (2005) and Nickell (1981) highlighted the implications of the simultaneity bias for a panel data study due to the inclusion of the firm-specific effect and non-stationarity or unit roots in the data. For instance, the inclusion of company-specific fixed effects would breach the basic assumption of both the fixed and random effect models. These biases have been dealt with in this study.

Mukherjee, *et al.* (1998) and Hasio (2003) have shown that regressions of panel data that disregard cross-section error correlation and the inequality of parameter coefficient in model specification, could lead to

inconsistent estimates of the slope coefficients of the explanatory variables of interest. This is irrespective of whether the analysis was conducted using either the fixed and random effect estimation techniques. Indeed, Pesaran *et al* (2001) proved that both the Fixed Effects (FE) and Random Effect (RE) estimators may be inconsistent in a dynamic panel due to the problem of correlation between the lagged dependent variable and the differenced error term ($\varepsilon_{it} - \varepsilon_{i,t-1}$). Hence, the bias caused by the presence of firm-specific fixed effects would generally be eliminated in the standard econometric panel model by taking the first difference of the model equation. Moreover, an application of the Granger-causality test on the first difference of the natural log of the variable of interest will help induce stationarity in the series and improve the reliability of our results.

Several previous studies suggested that the correlation problem can be tackled by estimating causality equation with models that correct for cross-sectional covariance such as; (i) specific heteroskedasticity, (2) contemporaneous covariance and (3) the between-period covariance. These instrumental variable (IV) techniques include the 3SLS, GMM and SURE techniques. Indeed, Hausman (1978) originally proposed a test statistic for endogeneity upon direct comparison of coefficient values. The test is conducted by running an auxiliary regression on two sets of models. The lags of variables within the model and other variables considered as *exogenous* are included in the model. The two sets of estimates are then compared, one of which is consistent under both the null and the alternative hypothesis and a large difference between the two sets of estimates is taken as evidence in favour of the alternative hypothesis. The next section explains our data and the estimation techniques that accounted for the misspecification errors discussed above.

DATA AND METHODOLOGY

The data for our study is low frequency data i.e. they are annual financial data of Nigerian listed companies and obtained directly from the Nigerian Stock Exchange. In order to check the quality of the data, we compared it with those made available by some of the companies on their respective web sites. Further, we impose restriction by excluding firms with less than 8 years of continuous time series data on their total liabilities, total assets, and earnings before interest and tax between 2000 and 2006. We also dropped firms that were cross-listed on both the domestic and overseas capital markets. This helped to avoid the confounding implications of disparities in economic structure, exchange rates, legislation, and the level of development of local and foreign markets. The sample of our study comprises seven annual observations for 94 companies hence 658 observations. On the whole, they make up more than three-quarters of shares traded on the Nigerian Stock Exchange (NSE).

Table 1 below present a descriptive statistic of the key leverage ratio and business risk along with other explanatory variable of Nigerian listed firms. Table1 showed that, on average, the overall mean ratio of leverage for our sample of ninety four companies is 38%. This means that for every one hundred naira investment made by the sample companies is complemented by a short or long-term borrowing of thirty eight naira 'other things being equal'. Nigeria has a large economy relative to its population, hence providing a market for business to borrow and expand. Table 1 also shows that manufacturing industries are borrowing in the same proportion, which is not unexpected. This is because manufacturing firms such as drugs and chemicals tend to spend heavily on the development of new products by comparison to other industry sectors such as retail and services. They will therefore need to borrow more to finance new products. Manufacturing companies also, generally expend large amount of money on fixed assets such as lands, buildings and machinery vis-à-vis non-manufacturing companies, which can be sold if they go bankrupt. To finance these investments they will need to issue debt securities, perhaps by long term borrowings.

Table 1: Descriptive Statistics for Leverage Ratio of Nigerian Listed Firms and Its Other Explanatory Variable of Interest for the Period: From 2000-2006

Item		Mean	Standard deviation	Min	Max	Correlation with the leverage ratio
1.	***Total liability percentage of total assets (Leverage ratio)***					
	a A Panel of ninety-four listed firms	0.38	0.20	0.02	0.0.85	1.000
	b Manufacturing companies [62]	0.38	0.19	0.02	0.83	0.03
	c Firms with more 30 per cent foreign ownership [33]	0.36	0.20	0.05	0.83	-0.05
	d Firms aged 25years and above [53]	0.36	0.19	0.07	0.80	-0.04
2.	***Standard deviation of earnings before interest and tax profit % total asset (business risk)***					
	a A Panel of ninety-four listed firms	0.16	0.10	0.08	1.90	0.15***
	b Manufacturing companies	0.15	0.12	0.08	1.87	-0.10***
	c Firms with more 30 per cent foreign ownership	0.15	0.05	0.08	0.43	-0.06
	d Firms aged 25years and above	0.16	0.09	0.11	1.13	-0.01
3.	***Total Sales percentage of total assets (Agency cost)***					
	a A Panel of ninety-four listed firms	1.77	1.26	0.13	6.33	-0.16***
	b Manufacturing companies	1.71	1.54	0.13	5.86	-0.08**
	c Firms with more 30 per cent foreign ownership	1.95	1.19	0.14	5.86	0.11***
	d Firms aged 25years and above	1.98	1.25	0.25	6.12	011***
4	***Total fixed assets percentage of total assets (Tangibility)***					
	a A Panel of ninety-four listed firms	0.57	0.19	0.09	0.93	0.04
	b Manufacturing companies	0.56	0.19	0.08	0.92	-0.08**
	c Firms with more 30 per cent foreign ownership	0.56	0.20	0.10	0.93	-0.03
	d Firms aged 25years and above	0.58	0.19	0.12	0.93	0.07*
5	***Earnings before interest and tax percentage of total assets (Profitability)***					
	a A Panel of ninety-four listed firms	0.11	0.19	-0.82	0..88	-0.16***
	b Manufacturing companies	0.13	0.21	-082	0.88	0.18***
	c Firms with more 30 per cent foreign ownership	0.17	0.19	-0.33	0.88	0.23***
	d Firms aged 25years and above	0.12	0.19	-0.59	0.88	0.05
6	***Log of total sale revenue millions of Naira (Size)***					
	a A Panel of ninety-four listed firms	7.38	1.95	1.44	11.36	-0.06
	b Manufacturing companies	7.64	1.90	1.44	11.36	0.21***
	c Firms with more 30 per cent foreign ownership	8.46	1.45	3.55	11.37	0.44***
	d Firms aged 25years and above	8.41	1.41	4.17	11.36	0.36***
7	***Total assets annual percentage change (Growth prospects)***					
	a A Panel of ninety-four listed firms	20.00	37.00	-72.21	214.16	-0.06
	b Manufacturing companies	19.04	36.00	-572.20	214.16	0.02
	c Firms with more 30 per cent foreign ownership	20.31	35.04	-59.68	196.55	0.000
	d Firms aged 25years and above	18.14	30.59	-59.68	176.41	0.02

*Note Manufacturing are firms officially classified as manufacturing by the United Nations International Standard Industrial Classification (ISIC), Foreign companies are firms having more than thirty per cent overseas share ownership and Old companies are those that are more than twenty-five years old. *** Statistically significant at 1% confidence level, ** Statistically Significant at 5% confidence level, and* statistically significant at 10% confidence level. The numbers in bracket in column 1 item 1 represent the numbers of our Nigerian listed firm in manufacturing sector, that have more than 30% of foreign ownership and aged above 25 years*

Our study examines the relationship between business risk and capital structure of Nigerian listed firms using annual data over the period 2000-2006. The last seven years were chosen in order to avoid the uncertainties associated with the Nigerian elections in 1999 and in 2007. The list of sampled companies use in this research and the definitions of all the variables used in this paper are given in Appendix Table A1 and A2 respectively. We use the natural logarithm of debt ratio and the volatility of the ratio of total earnings before interest and tax (EBIT) relative to total assets. The natural log as opposed to untransformed ratios allow us overcome the problem of skewed distribution as a result of the inclusion of companies with varying proportions in their sales variability and asset structure. Harris, *et al.* (2005) has suggested that some

skewed data can be transformed to normally distributed data and then analysed using more accurate parametric testing.

It should be understood that a dynamic heterogeneous model such as ours require selecting an appropriate lag length for the individual company equation. There are two methods of information criteria here; (i) Akaike Information Criterion (AIC), and (ii) Schwarz Criterion (SC). The AIC is often used in model selection for the non-nested alternative, while the Schwarz Criterion is an alternative to the AIC that imposes a larger penalty for additional coefficients. Again, following the empirical approach in dynamic panel study by Gaud *et al.* (2005) and Nwachukwu (2009) among several other studies, we settled for specifications with four-year lags for each explanatory variable that is $m = n = 4$. This is represented in equation 1 and 2 below. We first experimented with longer time lags of five and six years but our data proved too short to accommodate such lag periods. We begin with a max lag of 6 and slowly eliminated the ones that are insignificant using the Schwarz Bayesian criterion. Subsequently, the Granger causality test in equations 1 and 2 were estimated using four annual lags of the percentage changes in the total debt ratio and the standard deviation of total earnings relative to total assets (business risk). The two types of bivariate regression models estimated for our tests of the existence and direction of causality between the change in natural log of leverage ratio ($DLLEV$) on the one hand and earnings volatility as our measure of business risk ($STDEV$) on the other hand are represented in equations 1 and 2 below.

$$DLLEV_{i,t} = \eta_0 + \sum_{j=1}^{m} \alpha_j^{DLLEV} (DLLEV_{i,t-j}) + \sum_{j=1}^{n} \beta_j^{STDEV} (STDEV_{i,t-j}) + \Delta\varepsilon_{i,t}^{DLLEV} \quad (1)$$

$$STDEV_{i,t} = \eta_0 + \sum_{j=1}^{m} \alpha_j^{STDEV} (STDEV_{i,t-j}) + \sum_{j=1}^{n} \beta_j^{DLLEV} (DLLEV_{i,t-j}) + \Delta\varepsilon_{i,t}^{STDEV} \quad (2)$$

The regression analysis deploys a total of 658 observations generated from the panel data of our ninety-four companies over the period 2000 – 2006. Equations 1 and 2 above are estimated using three instrumental variables techniques of GMM-IV, SURE and 3SLS. For instance, Generalized-method-of-moment (GMM-IV) Arellano and Bond (1991) and Arellano and Bover (1995), is often employed to test for the presence of endogeneity. As the GMM method assumes that the independent variables involved are unrelated to the equation's residuals, the GMM-IV technique therefore makes no assumptions about how these residuals are formed. It thus assumes that the variables representing initial conditions are predetermined. That is to say, these regressors measured at the beginning of time period $t-1$ are uncorrelated with the error term ε_{it} (at level) at time t and beyond. Likewise, the current values of all the explanatory variables (χ_{it}) in the original equation 1 are presumed to be weakly exogenous. This means that their values at a given time period t are uncorrelated with random shock ε_{it} in the future time period $t+1$ and beyond. Furthermore, it is assumed that the difference error-term $\varepsilon_{it} - \varepsilon_{it-1}$ for each cross-sectional unit in the pooled regression equation 1 is serially uncorrelated over time at least up to the first lag and that there is no group-wise heterogeneity and cross-group autocorrelation.

Similar to the GMM-IV is the three stages least square (3SLS) estimator. This econometric technique is used in the analysis of cross-section residual autocorrelation and parameter heterogeneity. The (3SLS) method allows the error-term of each cross-section unit in the panel data regression model to be freely correlated across and within regression equations. Other instrumental variable estimation techniques include Seemingly Unrelated Regression Estimator (SURE) developed by Zellner, (1962). This technique can be used to analyse a system of multiple equations with cross-equation parameters and correlated error terms, given that it takes into account the fact that subtle interaction may be present between individual statistical relationships when each of these relationships is being used to model some aspect of behaviour. For instance, a set of equations such as 1 and 2 may be related not because they interact, but because their

error terms are related. Greene (2003) argued that the 3SLS model may provide a spurious regression result when short term period data are used. He noted that the impact of cross-section correlation might take a long time to feed into available dataset. Indeed, Brooks (2002) mentioned that in a panel data analysis, the 2SLS and 3SLS estimation techniques require that the time series observations (T) for each cross-section unit are at least as large as the number of entities (N). This implies that the 3SLS estimator may not provide reliable coefficient estimates for an analysis based on a small time period relative to cross section units. On the other hand, the Seemingly Unrelated Regression Estimator (SURE) can recognise several individual relationships that are linked by the fact that their disturbances are correlated. For example, in the SURE model, the correlation among equation 1 and 2 disturbances could come from several sources including correlated shocks to company earnings. The SURE model can also be used to estimate equations that set out to explain some phenomena in different companies or sectors, given that any event may be subject to spill-over from economy-wide or world-wide shocks. These may include among others, a country's fiscal policy change as a result of economic downturn.

RESULTS

The regression analysis deploys a total of 658 observations generated from the panel data of our ninety-four companies over the period 2000 – 2006. The use of annual observation means that we can consider separately short and long-run Granger causality effects (Elbadawi and Mwega, 1998; Attanasio *et al.* 2000). Consequently, equations 1 and 2 above are estimated using the three instrumental variables techniques of GMM-IV, SURE and 3SLS mentioned above and the results are presented in Table 2 below. The result of our Granger causality test in Table 2 indicates that it is sensitive to the methods of analysis, thus implying that it not consistent (robust) across the four models. For instance the GMM that correct for endogeneity problem among the explanatory variable suggest no causality. The 3SLS which allows the error-term of each cross-section unit in the panel data regression model to be freely correlated across and within regression equations also imply that there is no causality running from both directions**.**

However, the Seemingly Unrelated regression estimator (SURE) developed by Zellner, (1962) and which correct for error term within and across cross section suggest there is a bi-directional relation particularly from earnings volatility to leverage as suggested by the implied long-run Granger causality in column 3 of Table 2 above. Therefore, discussions of our granger causality analysis would be based on the significance of the variables tested in particular, the SURE model reported in Columns 3 and 4 of Table 2 above. As is customary in the literature on Granger causality tests, we report the estimated group constant, the coefficients on the changes in the lagged values of total liability ratio and earnings volatility (business risk) variables in equations 1 and 2 respectively. In addition, we present the result of our calculation for the sum of the lag coefficients β_j^{DLLEV} and β_j^{STDEV} from the relevant equations, along with their probability values ($p-values$). We focus on the sum of the lagged coefficients which captures the total effect of the variables of interest as the appropriate statistic for testing causal relationships between our variables of interest, rather than the individual lag coefficients.

Table 2: Granger Causality Analysis between Capital Structure and Business Risk in Nigeria during the Period 2000-2006

Number of Observations 609						
Methods	GMM-IV		SURE		3SLS	
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Dependent (y) variable	DLLev	Stdev	DLLev	Stdev	DLLev	Stdev
Independent (x) variables						
Constant	-0.238	1.102	0.178	0.070**	0.556	1.220
	[-0.102]	[0.906]	[1.269]	[4.961]	[0.281]	[0.876]
DLLev (-1)	-0.138	-0.294	-0.109**	-0.006	-0.476	-0.318
	[-0.194]	[-0.805]	[-1.728]	[-0.939]	[-0.789]	[-0.752]
DLLev (-2)	-0.252	0.087	-0.139**	0.008	-0.228	0.093
	[-1.315]	[0.663]	[-2.161]	[1.288]	[-1.116]	[0.644]
DLLev (-3)	-0.173	-0.029	-0.049	-0.005	-0.190	-0.034
	[-1.304]	[-0.354]	[-0.819]	[-0.879]	[-1.382]	[-0.349]
DLLev (-4)	-0.700	-0.476	0.136**	0.002	-1.026	-0.525
	[-0.552]	[-0.738]	[1.913]	[0.304]	[-0.886]	[-0.646]
Stdev (-1)	0.011	2.243	0.464	0.311**	2.719	2.330
	[0.002]	[0.940]	[0.752]	[5.033]	[0.682]	[0.832]
Stdev (-2)	-1.030	-0.858	-0.438	0.200**	-1.082	-0.773
	[-0.443]	[-0.615]	[-0.600]	[2.727]	[-0.487]	[-0.496]
Stdev (-3)	0.383	3.647	-0.173	0.124	5.544	3.836
	[0.0393]	[0.718]	[-0.214]	[1.531]	[0.661]	[0.651]
Stdev (-4)	3.589	-11.004	-0.178	-0.087	-9.069	-12.110
	[0.134]	[-0.821]	[-0.231]	[-1.127]	[-0.403]	[-0.767]
Sum Beta coefficients[5]	2.953	-5.971	-0.326	-0.001	-1.887	-6.717
Wald test 1: χ^2 [5];(probability value)	[0.840]	[0.444]	[0.483]	[0.961]	[0.880]	[0.443]
Sum of alpha coefficients[5]	-1.264	-0.711	-0.162	0.548**	1.920	-0.785
Wald test 2: χ^2 [5];(probability value)	[0.495]	[0.429]	[0.260]	[0.001]	[0.244]	[0.498]
Implied long-run Granger-causality coefficients	1.304	-3.489	-0.280	-0.002	-0.646	-3.764
Wald test 3: χ^2 [7]];(probability value)	[0.918]	[0.435]	[0.010]	[0.001]	[0.784]	[0.443]
Null no serial correlation up to lag order one	[0.658]	[0.359]	[0.935]	[0.349]	[0.295]	[0.300]
Ljung-Box Q-statistics χ^2 [1];(probability value)						
Null no serial correlation up to lag order two						
Ljung-Box Q-statistics χ^2 [1];(probability value)	[0.903]	[0.522]	[0.993]	[0.619]	[0.554]	[0.470]
Sargan Test	[0.97]	[0.999]				

Notes: *The sum of beta coefficients is the sum of the coefficients on the lagged explanatory (x) variable in the respective equations. The sum of the alpha coefficients is the sum of coefficients on the lagged dependent (y) variables in the equation concerned The probability value of the sum of beta and alpha coefficients are associated with a Chi-square statistics obtained from a Wald test of the null hypothesis that such additions of the estimated causality are equal to zero. The long-run Granger-causality coefficient is calculated as the sum of beta coefficients divided by one minus the sum of alpha coefficients. The probability value is for a Chi-square statistics following results of a Wald test of the hypothesis that all the beta coefficients are jointly equal to zero. The probability values of the Ljung-Box statistics are obtained by applying view-residual-test function in the EViews version 6.0 to the residual of each specification 6 and 7. The results show that the null hypothesis of no first and second-order serial correlation in the difference residuals cannot be rejected at the five percent confidence. The Sargan test for the GMM model in column 1 and 2 is not significant at the 5% confidence level and hence accepts the validity of our instruments. The table above shows the regression estimates of equation.* $DLLEV_{i,t} = \eta_0 + \sum_{j=1}^{m} \alpha_j^{DLLEV}(DLLEV_{i,t-j}) + \sum_{j=1}^{n} \beta_j^{STDEV}(STDEV_{i,t-j}) + \Delta\varepsilon_{i,t}^{DLLEV}$ *and equation* $STDEV_{i,t} = \eta_0 + \sum_{j=1}^{m} \alpha_j^{STDEV}(STDEV_{i,t-j}) + \sum_{j=1}^{n} \beta_j^{DLLEV}(DLLEV_{i,t-j}) + \Delta\varepsilon_{i,t}^{STDEV}$ *Column 1- 6 shows the results for the full sample of 94 listed Nigerian firms The figures in brackets […] are the t-statistics. ***, **, *indicate significance at 1, 5 and 10 per cent levels respectively*

The probability values correspond to a Chi- squared statistic generated by Wald's coefficient restriction test of the null hypothesis that such additions are equal to zero. It is assumed that if there is a significant causal

effect running from the earnings volatility (*business risk*) variable to the total leverage ratio annual changes, in the short-run, then the hypothesis that the sum of lagged coefficients β_j^{STDEV} in Equation 1 (see also Column 1, 3 and 5 of Table 2) is equal to zero will be rejected at the five-per cent confidence level. Also, if the direction of causality runs from the total debt ratio to the measure of business risk in the short-run, then the null hypothesis that the sum of lagged coefficients β_j^{DLLEV} in Equation 2 (Column 2, 4 and 6 of Table 2) is equal to zero will also be rejected at the conventional five per cent level.

We also report in Table 2 the long-run effects associated with our estimated lagged beta β_j coefficients, together with the probability values ($\rho - values$) of the Wald test of the null hypothesis that all the lagged beta β_j coefficients in the equations under consideration are jointly equal to zero. Under this null hypothesis, the Wald test statistic has an asymptotic Chi-square distribution with degrees of freedom equal to the number of restrictions tested. For example, in our analysis of the significance of long-term effects of the estimated lagged beta coefficients in Table 2, the applied specification that $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ implies four restrictions. The estimated long-run effects were computed as the sum of the lagged β_j (*beta*) coefficients in the relevant equation divided by one minus the sum of corresponding lagged α_j (*alpha*) coefficients.

The result obtained from the Wald test long-run multiplier effect in Column 3 suggests that the long run effect of the business risk measure is significant at the 1 per cent confidence level. This is unexpected, given that the individual estimates show that the estimated parameters on the earnings volatility (business risk) are all equal to zero. Possible explanations and a solution to this spurious causal long-run relationship from business risk to capital structure were offered by Berger (1995). They included the fact that the individual lag coefficients may be a reflection of (i) the non-uniform effect of earnings risk on capital structure, (ii) collinearity among the earnings risk lags or (iii) that correlations with lags more than four periods past if one assumes that volatility of projected earnings are highly serially correlated. However, as noted by Berger (1995), these problems are corrected in part by focusing our discussion on the sum of the lagged beta coefficients. Consequently, our discussion on causal relationship in this paper will be restricted to the short-term relationships of our measure of earnings volatility (business risk) and the leverage ratio of firms under the assumption that our group of listed companies are operating under a normal market outlook. Before proceeding to discuss the major findings of our analysis, we need to point out that the null hypothesis of the absence of first and second-order serial correlation in the residuals cannot be rejected at the five per cent confidence level. The probability values of the Ljung-Box Q statistics in Columns 1 and 6 are considerably more than 0.05. Thus, the major conclusions arising from the estimated sum of lag β_j coefficients and the resultant short-run effects in Columns 3 and 4 of Table 2 above may be summarized in the following section.

First, starting with the ratio of total debt to total asset annual changes in Column 3 of Table 2 for the SURE model, we found that there is no significant causal correlation running from the measure of earnings volatility (*business risk*) to the total leverage ratio for both the short and long term at the five per cent confidence level. The sum of the beta β_j coefficients on the individual lagged earnings volatility variables in Equation 1 i.e. [$\sum_{j=1}^{n=4} \beta_j^{STDEV}$] is -0.33 with a probability value of 0.48. However, the sum of the coefficients on the lagged measures of earnings volatility is negative and insignificantly different from zero. On the other hand, the coefficients of leverage lagged one, two and four periods in Column 3 for the SURE model, is statistically significant at the 5% confidence level. Consequently, the statically significant value for one and two year lagged periods suggests that the income variability (business risk) of the sampled

companies may lead to a decrease in the gearing ratio of firms. This is indeed the inference of the negative value of -0.33 resulting from the summation of the coefficients of the lagged variable of earnings volatility. The outcome of this relationship may not be too surprising, given that companies' borrowing decisions may be strongly determined by the projected level and regularity of their earnings, given that debt obligations include a fixed contractual payment (debt) which a company has to honour irrespective of its future income. Therefore, the more volatile a company's earnings are the greater are the chances of failing to meet the repayment of debt and interest. This will increase the probability of the firm becoming financially distressed and may in the end led to bankruptcy.

On the other hand, the estimated alpha α_j coefficients for the SURE model in Column 4 show statistically significant value. This seems to suggest that current borrowing decisions of Nigerian companies are determined more by the magnitude of the previous year's debt ratios than by earnings volatility. For example, the alpha coefficient of leverage lagged one year indicates that a percentage increase in last year's gearing ratio was related to an 11 per cent decrease in the current debt to total asset ratio. Similarly, a rise in total debt ratio two years earlier in 2004 caused our average listed firm to cut its borrowing requirements in 2006 by roughly 14 per cent of total assets. In fact the alpha coefficient of the two year lagged leverage variable is statistically significant at the five per cent confidence level. The trend continues in the third preceding year though the negative coefficient on the lagged total debt variable which is very small at circa 0.1 and is not statistically significant.

The negative correlation between past and current total leverage annual changes is probably because the anticipated increase in the total liabilities as a proportion of total assets raises the expected cost of financial distress including bankruptcy. The inverse relationship suggests that our group of listed companies may have "overshot" its optimal capital ratios in the early 2000s, partly because of (i) expansion in bank liquidity following a rise in oil prices, (ii) the changes in regulatory environment including federal bank laws and (iii) an improvement in local market profit opportunities in the wake of a boom in the Nigerian economy. It would seem that the cumulative effect of these country and firm-specific factors was to lower interest rates on loans by comparison with the costs of new equity issues. Thus, firms in need of finance between 2002 and 2006 sold bonds and/or borrowed from the banks, regardless of their target capital structure. To reduce the risk of financial distress and the associated deadweight liquidation costs, our listed firms reacted by cutting the total leverage ratio over the subsequent four years ending in 2006.

Consequently, the overall negative impact of past leverage ratio changes on current borrowing decisions of a typical Nigerian listed firm was shown to be insignificantly different from zero, as indicated by a probability value of the sum of the alpha coefficients of 0.50 per cent. This evidence is consistent with the standard trade-off hypothesis, which postulates a negative past debt to current debt relationship when the past leverage ratio is above its optimal level and a positive relationship when the previous total debt ratio is below its optimum. Under this hypothesis, the past debt-current debt ratio of our group of listed companies may be expected to vary over time with changes in company financial risk, regulatory environment and outlook for future profit opportunities in the Nigerian economy.

We note however that the estimated insignificant negative coefficient is due to the summing up of the positive alpha coefficient on the fourth year lag, which partly neutralized the negative sign on the third year lagged variable. All the same, the loss of statistical significance of the observed overall negative correlation between past and current debt ratios suggests that the coefficients of our simple two-variable regression model in Table 2 above are biased downward perhaps by the exclusion of other determinants of capital structure. These control variables would be considered in our future search for spurious associations between past and current debt ratio changes in a more complex multivariate regression model. *Secondly* the results of the reverse causal relationship from the total leverage ratio to business risk for the SURE model are reported in Column 4 of Table 2. The sum of the estimated beta coefficients of the four year

lagged variable $\sum_{j=1}^{n=4} \beta_j^{DLLEV}$ in Equation 2 is minus -0.001 and is statistically insignificantly different from zero. This suggests that a higher debt to assets ratio does not Granger cause or help predict future year-on-year changes in earnings volatility. An empirical implication of this insignificant causal relationship is that the business risk arising from the uncertainty in the forecasts of future cash flows is broadly similar for the firms in our sample of study, including those that raised their total debt ratio over the group sample mean. This correspondence in earnings risk would be manifested primarily in the form of comparable interest expenses on uninsured debt, as the rates on this debt would incorporate a similar premium for the expected bankruptcy costs. This means that the rates paid on uninsured debt by our sample of listed Nigerian firms over the period 2000 to 2006 were broadly similar, irrespective of their proportions of total liabilities in total assets. We should recognise, however, that the predictions of our simple bivariate relationship between capital and earnings volatility may have been held down by the "spurious" effects of the omitted control variables.

Another interesting finding from our results of the SURE model in Column 4 of Table 2 is that the estimated coefficient for earnings volatility lagged 1 and 2 years indicates a significant positive relationship with the current year income variability of circa 0.31 and 0.20 respectively. This implies that an increase of 1 unit in the last two years' earnings volatility would amplify the present income variability by 0.31 units, declining to 0.20 units in the subsequent year. This suggests that, other things being equal, it takes approximately two years for a typical Nigerian publicly-quoted firm to forecast with reasonable accuracy the size of its future after-tax operating profit with related investment requirements.

This outcome is probably a reflection of the time it takes an average Nigerian firm to work out the distortions arising from a number of factors influencing its expected cash flows, investment budget and the strategy for dealing with them. These factors may include changes in government policy, market demand conditions, foreign exchange risk exposure and/or the poor quality of infrastructure, such as the shortage of power supply. For instance, buying a generator set as an alternative source of energy supply will involve projections of the level and variability of the demand for the firm's products, costs of other production inputs, including petrol or diesel, ability to raise output prices to reflect higher input costs, installation costs and the general maintenance of the machine. These projections will have to be fed into the sales revenue and cost of goods sold before the calculations for the level of operating profits and its variability can be reported.

Thus the overall result of our Granger-causality analysis shows that the two variables are independent of each other in a statistical sense. However, this result does not necessarily prove that capital structure and earnings variability are autonomous in economic terms. It is also being recognised that the predictions of such a simple two-variable empirical analysis may be biased because of the effect of omitted firm-specific variables that may impact on the capital structure choices of companies. The result also suggests that analysis of capital structure and business risk in Nigeria could be estimated in a dynamic panel framework. This is given the statistical significance of the previous debt ratios lag 1, 2 and 4 in the SURE model in Column 2 and 3 of Table 2 above.

CONCLUDING COMMENTS

The aim of this paper is to use causality test as described by Granger (1969) to examine the directional relationship between business risk and capital structure of Nigerian listed firms**.** We limit our analysis of the direction of causality by assuming that the ratio of total liabilities to total assets (LEV) and earnings risk (STDEV). We form a simple two-variable model without the necessity of controlling for the effect of the other factors influencing the capital structure decisions of Nigerian companies. We use low frequency data of annual financial information of total liabilities, total assets, and earnings before interest and tax

between 2000 and 2006 of Nigerian listed companies obtained directly from the Nigerian Stock Exchange. This makes a total of 658 observations across 94 listed firms. We estimated our model using the three instrumental variables techniques of GMM-IV, SURE and 3SLS.We utilized the three techniques because of their efficiency in estimating panel data equations. For instance, Generalized-method-of-moment (GMM-IV) is employed to test for the presence of endogeneity because the method assumes that the independent variables involved are unrelated to the equation's residuals. On the other hand, we use the three stages least square (3SLS) estimator because it allows the error-term of each cross-section unit in our annual panel regression model to be freely correlated across and within regression equations. Similarly, the Seemingly Unrelated Regression Estimator (SURE) takes into account the fact that subtle interaction may be present between individual statistical relationships when each of these relationships is being used to model some aspect of behaviour. Consequently our discussions of granger causality analysis is built on the significance of the variables tested in particular, the SURE model

We found among others that; *First,* the long run effect of the business risk measure is significant at the 1 per cent confidence level. *Second* that an increase of 1 unit in the last two years' earnings volatility would amplify the present income variability by 0.31 units and may decline to 0.20 units in the subsequent year. This suggests that, other things being equal, it takes approximately two years for a typical Nigerian publicly-quoted firm to forecast with reasonable accuracy the size of its future after-tax operating profit with related investment requirements. Similarly, we show that the overall negative impact of past leverage ratio changes on current borrowing decisions of a typical Nigerian listed firm was shown to be insignificantly different from zero, as indicated by a probability value of the sum of the alpha coefficients of 0.50 per cent. This evidence is consistent with the standard trade-off hypothesis, which postulates a negative past debt to current debt relationship when the past leverage ratio is above its optimal level and a positive relationship when the previous total debt ratio is below its optimum

Thus the overall result of our Granger-causality analysis shows that increase in business risk or total liabilities as a proportion of total liabilities do not Granger cause higher values for both variables in the short-run i.e. the two variables are independent of each other in a statistical sense. However, this result does not necessarily prove that capital structure and earnings variability are autonomous in economic terms. It is also being recognised that the predictions of such a simple two-variable empirical analysis may be biased because of the effect of omitted firm-specific variables that may impact on the capital structure choices of companies. The result also suggests that an analysis of the relationship between capital structure and business risk in Nigeria could be estimated in a dynamic panel framework. Nonetheless, we recognised that the causal predictions of such a simple two-variable empirical analysis may be biased because of the effect of omitted firm-specific variables that may impact on the capital structure choices of companies. These control variables would be considered in our future search for spurious associations between past and current debt ratio changes in a more complex multivariate regression model.

Appendix 1: Sample of Nigeria Listed Companies

Item	Company Name	Sector
1	ellah lakes	agriculture
2	presco plc	agriculture
3	dunlop nigeria plc	automobile & tyre
4	incar nigeria plc	automobile & tyre
5	r.t briscoe motors	automobile & tyre
6	champion breweries plc	breweries
7	guiness breweries plc	breweries
8	jos int breweries	breweries
9	nigerian breweries	breweries
10	ashaka cement plc	building materials
11	benue cement company	building materials
12	cement company of nothern nig	building materials
13	west african portland cement	building materials
14	berger paint plc	chemical & paint
15	chemical and allied product plc	chemical & paint

16	d.n. meyer plc	chemical & paint
17	nigerian-german chemical plc	chemical & paint
18	trans- nationwide express plc	commcial services
19	triple gee company	computer service
20	a.g leventis (nigeria) plc	conglomerates
21	cfao (nigeria) plc	conglomerates
22	chellarams (nigeria) plc	conglomerates
23	john holt plc	conglomerates
24	pz industries plc	conglomerates
25	uacn plc	conglomerates
26	unilever nigeria plc	conglomerates
27	utc nigeria plc	conglomerates
28	cappa & d'alberto plc	construction
29	costain (west africa) plc	construction
30	julius berger nigeria plc	construction
31	roads nigeria plc	construction
32	interlinked technologies	engineering tech
33	nigerian wire and cable com	engineering tech
34	seven-up bottling company	food, beverages & tobacco
35	cadbury nigeria plc	food, beverages & tobacco
36	flour mill nigeria plc	food, beverages & tobacco
37	northern nigeria flour mills plc	food, beverages & tobacco
38	nestle nigeria plc	food, beverages & tobacco
39	nigeria bottling company plc	food, beverages & tobacco
40	ecorp plc	health care
41	evans medical plc	health care
42	glaxo smithkline consumer nig plc	health care
43	may and baker nigeria plc	health care
44	morrison industries plc	health care
45	nemeth international pharma plc	health care
46	pharmadeco plc	health care
47	aluminium extrusion ind plc	ind & domestic products
48	b.o.c gases nigeria plc	ind & domestic products
49	first aluminium nigeria plc	ind & domestic products
50	nigeria enamelware plc	ind & domestic products
51	vitafoam nigeria plc	ind & domestic products
52	vono product plc	ind & domestic products
53	b.h.n plc	machinary (marketing)
54	jaupaul oil & maritime sevices	maritime services
55	avon crowncaps & containers (nig)	packaging
56	beta glass plc	packaging
57	nampak nigeria plc	packaging
58	poly products nigeria plc	packaging
59	studio press (nigeria) plc	packaging
60	african petroleum plc	petroleum marketing
61	conoil nigeria plc	petroleum marketing
62	eternal oil & gas company plc	petroleum marketing
63	mobil oil nigeria plc	petroleum marketing
64	oando nigeria plc	petroleum marketing
65	texaco nigeria plc	petroleum marketing
66	total nigeria plc	petroleum marketing
67	academy press limited	printing and publishing
68	longman nigeria plc	printing and publishing
69	university press plc	printing and publishing
70	uacn property dev company	real estate
71	afprint nigeria plc	textiles
72	united nigeria textile plc	textiles
73	adswitch plc	second-tier securities co
74	cutix plc	second-tier securities co
75	juli plc	second-tier securities co
76	union ventures and petroleum	second-tier securities co
77	livestock feed	agriculture
78	okomu oil palm company	agriculture
79	dunlop nigeria	automobile & tyre
80	international breweries	breweries
81	nigerian rope	building materials
82	nigerian wire industries	building materials
83	african paint	chemical &paint
84	premier paints	chemical &paint
85	chellarams	commcial services
86	thomas wyatt	computer & office equip
87	scoa nigeria	conglomerates
88	g. cappa	construction
89	onwuka hi-tek industries	engineering technology
90	national salt company nigeria	food, beverages & tobacco
91	west african glass industry	packaging
92	afro oil nigeria	petroleum
93	capital oil	second-tier securities co
94	smart products nigeria	second-tier securities co

Appendix Table 2: the Definitions of Variables

$LLEV$	The total leverage ratio. this is calculated as the ratio of total liabilities to total assets
$DLLEV_{t-1}$	percentage change in the natural logarithm of the total leverage ratio lagged one year, t-1
$DLLEV_{t-2}$	percentage change in the natural logarithm of the total leverage ratio lagged two years, t-2
$DLLEV_{t-3}$	percentage change in the natural logarithm of the total leverage ratio lagged three years, t-3
$DLLEV_{t-4}$	percentage change in the natural logarithm of the total leverage ratio lagged four years, t-4
$SDEV$	The standard deviation of the ratio of earnings before depreciation, interest and tax to total assets. An increase in this variable denotes a worsening in earning volatility (i..e, business risk)
$SDEV_{t-1}$	the standard deviation of the ratio of earnings before depreciation, interest and tax to total assets lagged one year, t-1
$SDEV_{t-2}$	the standard deviation of the ratio of earnings before depreciation, interest and tax to total assets lagged two years, t-2
$SDEV_{t-3}$	the standard deviation of the ratio of earnings before depreciation, interest and tax to total assets lagged three years, t-3
$SDEV_{t-4}$	the standard deviation of the ratio of earnings before depreciation, interest and tax to total assets lagged four years, t-4

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BIOGRAPHY

Dauda Mohammed teaches Finance and Statistics at the Department of Business Administration and Entrepreneurship Bayero University Kano Nigeria. He also coordinates the MBA programmed of the

University. He obtained a BSc in Business Administration and a MBA from Bayero University Kano Nigeria. He also had an MSc in Corporate Finance and a PhD in Finance from The University of Salford, Greater Manchester UK. Dauda is a Certified Financial Analyst and also a consultant in Financial Management, statistics and Econometric data handling. He has published articles in Accounting and Taxation journal of IBFR and African Business Journal. Dauda can be contacted at the following address: Department of Business Administration and Entrepreneurship, Bayero University, PMB 3011, Kano Nigeria. E-mail: *daudaknt@yahoo.co.uk*