FIRM SIZE-PROFITABILITY NEXUS: EVIDENCE FROM PANEL DATA FOR NIGERIA

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Abstract

The paper investigates the long run relationship and causality issues between firm size and profitability in 66 firms in Nigeria by using the panel cointegration method for the period 1999 –2007. The empirical results show that there is long run steady-state relationship between firm size and profitability. The short run causal relationship shows that there is bidirectional relationship between firms' size and profitability. This implies that firm size Granger causes profitability and profitability Granger causes firm size. The results clearly refute the general assumption that causation runs from only firm size to profitability on which most existing studies have been based.

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1 INTRODUCTION

Studies on the relationship between firm size and profitability occupy a substantial portion of economic literature. However, previous empirical investigations of the issue have yielded conflicting results. Some studies have obtained a weak or negative relationship or none at all (Marcus 1969; Samuels and Smyth 1968; Haines 1970; Shepherd 1972; Ammar et al. 2003); others have reported a positive association (Hall and Weiss 1967; Gale 1972; Punnose, 2008; Vijayakumar and Tamizhselvan, 2010). Still others have found a positive association that disappears or reverses itself among the firms with the largest assets (Alexander 1949; Crum, 1939). Besides the conflicting results on the relationship between firm size and profitability, almost all known existing studies have focussed on the impact of the former on the latter neglecting the possibility of feedback effect. However, it is possible for profitability to affect firm size and not vice versa. It is contended in the literature that the profit rates of the firms can persist over time, and increasing levels of profits can help firm grow faster. In the same way, it is not impossible to have a case of mutual causation between firm size and profitability. Interestingly, no known study have addressed the question of direction of causation between firm size and profitability. This is, no doubt, a big gap in the literature that needs to be filled. Hence, the objectives of this paper are twofold. The first is to determine whether or not firm size and profitability are cointegrated and the second to ascertain the direction of causality between firm size and profitability.

This paper contributes the following. First, we use cointegration test for a panel of firms which provides more powerful tests and allows us to increase the degrees of freedom compared to the cross-section approach. Next, we specify and estimate an error correction model appropriate for heterogeneous panels, which distinguishes between long run and short run causality.

The paper is organised as follows. Section 2 presents the model and data description. Section 3 discusses the methodology and section 4 reports the empirical findings of the study. The last section concludes the paper.

2 MODEL SPECIFICATION AND DATA

To investigate the causality between firm size and profitability in Nigeria, we employed panel cointegration and panel causality methods. Following the empirical literature, the log linear functional specification of long run relationship between firm size and profitability may be specified as[1]:

$$PROF_{it} = \alpha_{ij} + \sigma_{it} + \beta_i SIZ_{it} + \delta_i SGR_{it} + \varepsilon_{it} \tag{1}$$

where it allows for cointegrating vectors of differing magnitudes between firms, as well as firm (α) and time (σ) fixed effects. PROF is firms' profitability measured as profit before interest and tax divided by total assets[2]. SGR is the firm growth rate[3], SIZ is firm size measured as log of sales and ε_{it} is the error term. All variables are employed with their natural logarithms form (except sales growth that is already in growth form) to reduce heteroscedasticity and to obtain the growth rates of the relevant variables by their differenced logarithms.

The annual time series data are obtained from 66 firms listed in the Nigerian Stock Exchange for the period 1999-2007. The 66 firms selected for the study were chosen based on the availability of the relevant data.

[1] The incorporation of a control variable equally helps to make our analysis multivariate as against bivariate. This is important because some studies have shown that two variables might not be cointegrated under bivariate analysis but cointegrated when control variables are included (see the work of Nzue, 2006).

[2] We measured profitability as return on total assets. By convention, it is calculated as profit after tax divided by investment represents the pool of funds supplied by shareholders and lender; while profit after tax represents residue income of shareholders. Hence, it is conceptually unsound to use profit after tax in the calculation of return on assets. This explains the use of profit before interest and tax divided by total assets in this work. This measure enables us to compare the operating efficiency of the firms.

[3] In the literature, several measures of growth are in vogue. Some studies have used the rate growth of employment while some others have generated growth using the formula g = (E/B)1/n – 1 where g is compound growth rat , E is size of firm at end of growth period, B is the size of the firm at the beginning of growth period, and n is the number of years in the growth period. Also, many studies simply calculated growth as g = (Salest – Salest-1)/Salest . For details of these measures one may consult LaDue (1977) and Hall (1987) among others. In this work, we adopted the last measure of firm growth. Since the variable is already in growth form, we need not log it again.

3 METHODOLOGY

This paper utilizes recent heterogeneous panel data techniques for a group of 66 non financial firms. Recent literature on panel data econometrics widely emphasized that traditional unit root, cointegration and causality tests have low power performance when the time series sample is small. However, an increasing finite sample performance can be achieved by using either longer time horizons or pooling time series and cross sections. Indeed, several studies have shown that the power of the unit root tests using panel data is substantially improved over univariate testing procedures (Abuaf and Jorion, 1990, Choi 2001 and Im et al. 2003)[4]. Moreover, Jun (2004) argues that adoption of panel data may provide more useful information on the nature of the economic system of equations for a group of firms, rather than individually analyzing single equation for each firm. Thus, in this work, we adopt the panel data techniques to eliminate the problems associated with the low power of the traditional tests for 66 firms which have a short data span and some differences in characteristics. Taking cue from the Engle and Granger (1987) two-step procedure, we explore the nexus of relationship between firm size and profitability. First, we test for a panel unit root and panel cointegration. Second, we test the causal relationships by using error correction based causality models.

3.1 Panel Integration Analysis

In this study, we test for the stationarity of the variables by employing three recently developed heterogenous panel unit root tests. These tests are the Fisher ADF (Choi, 2001), IPS (Im et al., (2003) and Hadri (2000). Choi (2001) considers the model as:

$$y_{it} = d_{it} + \chi_{it}(i = 1, \ldots, N; t = 1, \ldots, T_i) \tag{2}$$

where $\mathrm{d}_{it} = \beta_{i0} + \beta_{i1} + \ldots + \beta_{imi}\mathrm{t}^{mi}$, $\chi_{it} = \alpha_i \chi_{i(t--1)} + \mu_{it}$ and μ_{it} is integrated of order zero. Choi allows each time series v_{it} to have a different sample

[4] In the same way, Pedroni (1997, 1999, and 2004) demonstrates the power improvement of the panel cointegration approach.

size and a different specification of nonstochastic and stochastic components depending on i. The null hypothesis is that all the individual series in the panel are nonstationary (H$_0$:α_i = 1 for all $_i$) and against the alternative of some of the time series stationary (H$_1$:$|\alpha_i|$< 1 for all i's). Choi proposed a Fisher-type test as:

$$Z = \frac{1}{\sqrt{N}} \sum_{1}^{N} \Theta^{-1}\left(p_i\right) \tag{3}$$

where Θ is the standard normal cumulative distribution function. Since 0=ρ_i=1, $\Theta^{-1}(\rho_i)$ is a $N(0,\,1)$ random variable and $Ti \longrightarrow 8$ for all i Z => $N(0,\,1)$.

In the same way, Im et al. (2003) developed a unit root test for dynamic heterogeneous panels based on the mean of individual unit root statistics. They propose a standardized t-bar test based on the ADF statistics averaged across the groups. The stochastic process, y_{it}, is generated by the first- order autoregressive process:

$$y_{it} = (1-\rho_i)\mu_i + \rho_i y_{i,\,t-1} + \varepsilon_{it} i = 1, \ldots N; t = 1, \ldots T \tag{4}$$

where initial values, y$_{io}$, are given. In the testing the null hypothesis of unit roots, ρi = 1 for all i. Equation 4 can be expressed:

$$\Delta\, y_{it} = \alpha_i + \beta_i y_{i,\,t-1} + \varepsilon_{it}. \tag{5}$$

The null hypothesis is that each individual series in the panel has a unit root and alternative hypothesis that allows for α_i to differ across groups:

$$H_0 : \beta_i = 0 foralli \tag{6}$$

$$H_1 : \beta_i < 0, i = 1, 2, \ldots N_1, \beta_i = 0, N_1 + 1, N_1 + 2, \ldots, N \tag{7}$$

The modified standardized t$_{IPS}$statistic below is distributed as $N(0,\,1)$ when T $\longrightarrow\infty$ followed the N $\longrightarrow\infty$ sequentially:

$$t_{IPS} = \frac{\sqrt{N}\left(\bar{t} - \frac{1}{N}\sum_{i=1}^{N} E\left[t_{iT}\,|\beta_i = 0\right]\right)}{\sqrt{\frac{1}{N}\sum_{i=1}^{N} var\left[t_{iT}\,|\beta_i = 0\right]}} \tag{8}$$

However, Hadri (2000) is of the view that the null should be reversed to be the stationary hypothesis in order to have a stronger power test. Hadri's (2000) Lagrange multiplier (LM) statistic can be written as

$$L\hat{M} = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{\frac{1}{T^2}\sum_{t=1}^{T} S_{it}^2}{\hat{\sigma}_{\varepsilon}^2}\right), S_{it} = \sum_{j=1}^{t}\hat{\varepsilon}_{ij} \tag{9}$$

where $\hat{\sigma}_{\varepsilon}^2$is the consistent Newey and West (1987) estimate of the long-run variance of disturbance terms.

3.2 The panel cointegration tests

For the 66 firms, heterogeneity may arise as a result of differences in the stage of development and other characteristics of the firms. In order to ensure broad applicability of any panel cointegration test, it is necessary to allow for as much as heterogeneity as possible among individual members of the panel. To take this into consideration, Pedroni (1997, 1999, 2004) developed a residual-based panel cointegration method that also allows a lot of heterogeneity through individual effects, slope coefficients and individual linear trends across firms. Pedroni (1999) considers the following time series panel regression

$$y_{it} = \alpha_{it} + \delta_{it}t + X_i\beta_i + \varepsilon_{it}, \tag{10}$$

where $y_{it}$and X_{it} are the observable variables with dimension of (N*T) $\times$ 1 and (N*T) $\times$ m, respectively. He develops asymptotic and finite-sample properties of testing statistics to examine the null hypothesis of non-cointegration in the panel. The tests allows for heterogeneity among individual members of the panel, including heterogeneity in both the long-run cointegrating vectors and in the dynamics, since there is no reason to believe that all parameters are the same across countries.

Two types of tests are suggested by Pedroni. The first type is based on the within-dimension approach, which includes four statistics. They are panel v-statistic, panel ρ-statistic, panel PP-statistic, and panel ADF-statistic. These statistics pool the autoregressive coefficients across different members for the unit root tests on the estimated residuals. The second test by Pedroni is based on the between-dimension approach, which includes three statistics. They are group panel p-statistic, group panel PP-statistic, and group panel ADF-statistic. These statistics are based on estimators that simply average the individually estimated coefficients for each member. Following Pedroni (1999), the heterogeneous panel and heterogeneous group mean panel cointegration statistics are calculated as follows:

panel v-statistic:

$$Z_v = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{it-1}^{2}\right)^{-1} \tag{11}$$

panel ρ-statistic:

$$\mathrm{Z}_\rho = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{it-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{\varepsilon}_{it-1}\Delta\hat{\varepsilon}_{it}-\hat{\lambda}_i\right) \tag{12}$$

Panel PP-statistic:

$$\mathrm{Z}_t = \left(\hat{\sigma}^2\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{it-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{\varepsilon}_{it-1}\Delta\hat{\varepsilon}_{it}-\hat{\lambda}_i\right) \tag{13}$$

Panel ADF:

$$Z_t{}^* = \left(\hat{s}^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{it-1}^{*2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{\varepsilon}_{it-1}^{*}\Delta\hat{\varepsilon}_{it}^{*} \tag{14}$$

Group ρ-statistic:

$$\tilde{Z}_\rho = \sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{\varepsilon}_{it-1}^{2}\right)^{-1}\sum_{t=1}^{T}(\hat{\varepsilon}_{it-1}\Delta\hat{\varepsilon}_{it}-\hat{\lambda}_i) \tag{15}$$

Group PP − statistic:

$$\tilde{\mathrm{Z}}_t = \sum_{i=1}^{N}\left(\hat{\sigma}^2\sum_{t=1}^{T}\hat{\varepsilon}_{it-1}^{2}\right)^{-1/2}\sum_{t=1}^{T}\left(\hat{\varepsilon}_{it-1}\Delta\hat{\varepsilon}_{it}-\hat{\lambda}_i\right) \tag{16}$$

Group ADF- statistic:

$$\tilde{Z}_t^* = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{s}_i^2 \hat{\varepsilon}_{it-1}^{*2} \right)^{-1/2} \sum_{t=1}^{T} \left(\hat{\varepsilon}_{it-1}^* \Delta \hat{\varepsilon}_{it}^* \right) \tag{17}$$

Here, $\hat{\varepsilon}_{it}$ is the estimated residual from Eq. (10) and $\hat{L}_{11i}^2$is the estimated long-run covariance matrix for$\Delta\hat{\varepsilon}_{it}$. Similarly,$\hat{\sigma}_i^2$and $\hat{S}_i^2 \left(\hat{S}_i^{*2}\right)$ are, respectively, the long run and contemporaneous variances for individual i. The other terms are properly defined in Pederoni (1999) with the appropriate lag length determined by the Newey-West method. All seven tests are distributed as being standard normal asymptotically. This requires standardization based on the moments of the underlying Brownian motion function. The panel v-statistic is a one-sided test where large positive values reject the null of no cointegration. The remaining statistics diverge to negative infinitely, which means that large negative values reject the null. The critical values are also tabulated by Pedroni (1999).

3.3 Granger causality Model

Panel cointegration technique only ascertains whether or not firm size and profitability are cointegrated; it does not show the direction of causality. Once the variables are cointegrated, the next step is to implement the Granger causality test. We adopt a panel-based error-correction model to account for the long-run relationship using the two-step procedure from Engle and Granger (1987). The first step is the estimation of the long run model for eq. (10) in order to obtain the estimated residuals ε_{it}. The second step is to estimate the error-correction based Granger causality models. The error-correction based causality allows for the inclusion of the lagged error correction term derived from the cointegration equation. Essentially, inclusion of the lagged error-correction term ensures that the long run information that is lost through differencing is reintroduced in a statistically acceptable way (Narayan and Smyth, 2008). Therefore, the Granger causality model with a dynamic error correction model employed is as follows:

$$\Delta PROF_{it} = \theta_{1j} + \lambda_{1i}\varepsilon_{it-1} + \sum_k \theta_{11ik}\Delta PROF_{it-k} + \sum_k \theta_{12ik}\Delta SIZ_{it-k} + \sum_k \theta_{13ik}\Delta SGR_{it-k} + \mu_{1it} \quad (18)$$

$$\Delta SIZ_{it} = \theta_{2j} + \lambda_{2i}\varepsilon_{it-1} + \sum_k \theta_{21ik}\Delta PROF_{it-k} + \sum_k \theta_{21ik}\Delta SIZ_{it-k} + \sum_k \theta_{23ik}\Delta SGR_{it-k} + \mu_{2it} \quad (19)$$

Where Δdenotes first differencing and 'k' is the lag length and is chosen optimally for each firm using a step-down procedure up to a maximum of two lags. The firm growth equations are omitted because they are not relevant to the focus of our work.

The source of causation is identified by testing for the significance of the coefficients of the dependent variables in equations (12) and (13). For the short run causality we test H_0: $\theta_{12ik} = 0$ for all i and k in equation (12) or H_0: $\theta_{21ik} = 0$ for all i and k in equation (13). The long run causality is ascertained by examining the significance of the speed of adjustment λ, which is the coefficient of the error correction term ε_{it-1}. The significance of λ indicates the long run relationship of the cointegrated process, and so movements along this path can be considered permanent. For long run causality, we test H_0: $\lambda_{1i} = 0$ for all i in equation (12) or H_0: $\lambda_{2i} = 0$ for all i in equation (13). Finally, we use the joint test to verify for a strong causality test, where variables bear the burden of a short-run adjustment to re-establish a long run equilibrium, following a shock to the system (Asafu-Adjaye, 2000; Oh and Lee, 2004 and Lee, 2005). As all variables enter the model in stationary form, a standard F-test is used to test the null hypothesis.

4 EMPIRICAL RESULTS

Table 1 presents the results derived from the three heterogeneous panel unit root tests for the order of panel intergration. The results of the unit root test are as shown in table 1 indicate that at 1% significant level except for firm size in level under ADF-Choi Z-Statistic and IPS W-Statistic, other statistics confirm that the three series have a panel unit root. Employing these

TABLE 1-Nigeria: Panel Unit Root Tests

Variables	ADF-Choi Z-Stat	IPS W-Stat	Hadri-Z-Stat
PROF	-5.84***	-4.99**	3.24**
SGR	-6.83***	-6.29**	3.44**
SIZ	2.04	1.44	12.70**
Δ PROF	-10.45***	-9.79***	8.32***
Δ SGR	-12.28***	-13.52***	6.53***
Δ SIZ	-9.42***	-8.22***	5.91***

Source: Authors calculation

Note: Δ denotes first differences. All variables are in logarithms.
*** indicate significance 1% level.

results, we proceed to test for cointegration among profitability, firm growth, and size in order to determine if there is a long run relationship to control for in the econometric specification. Table 2 reports the panel cointegration estimation results. In the table, all the statistics significantly reject the null hypothesis of no cointegration. Thus, it can be seen that Prof, Siz and Sgr move together in the long run. That is, there is a long run steady-state relationship between firm size and profitability for a cross-section of firms in Nigeria after allowing for a firm-specific effect.

TABLE 2: Nigeria: Panel cointegration Tests (Prof., Sgr and siz)

	Without Trend	***With intercept and Trend Time effect fixed***
Panel Variance	-2.39***	-5.11***
Panel ρ	2.11***	4.71***
Panel pp	-9.37***	-22.56***
Panel ADF	-5.16***	-10.23***
Group ρ	5.62***	8.42***
Group PP	-10.09***	-19.29***
Group ADF	-6.13***	-10.11***

Source:Authors calculation

Note: Statistics are asymptotically distributed as normal., The variance ratio test is right-sided, while the others are left sided.

**** Reject the null hypothesis of no cointegration at the 1% level*

Once, the three variables are cointegrated, the next step is to implement the Granger causality test. This study used a panel-based error correction model to account for the long run relationship using the two-step procedure from Engle and Granger (1987). The results of a panel causality test between profitability and firm size is presented in tables 3. The results from table 3 show that there is bidirectional long run and short run causal relationship between firm size and profitability. The bidirectional causality shows that firm size has significant affect profitability and profitability equally has significant effect firm size in the case of Nigeria.

TABLE 3-Nigeria: Panel Causality Test

Dependent Variable	***Sources of causation***		***(Independent variable)***		
	Short run		***Long run***		
	Δ ***Prof***	Δ **Siz**	***ECT***	***ECT/***Δ ***Prof***	***ECT/***Δ **Siz**
Δ Prof	-	9.48*** [0.00]	49.19*** [0.00]	-	16.55*** [0.00]
Δ Siz	14.39*** [0.00]	-	3.44** [0.06]	4.95** [0.02]	-

*Source: Authors calculation, Note: p-value in parenthesis *** and ** indicate statistical significant at 1% and 5% levels respectively*

5 CONCLUSION

There is a growing literature on the relationship between firm size and profitability. However, the bulk of this literature focuses on the effect of firm size on profitability without considering the possible feedback effect. To our knowledge, there is no study that examines the co-movement and causal relationship between firm size and profitability in literature.

Our goal was to examine if there is any long run relationship and causality between firm size and profitability for 66 firms in Nigeria for the period 1999 – 2007 using the heterogenous panel cointegration technique. The empirical results show that firm size and profitability are cointegrated. According to the short-run and the long-run dynamics of firm size and profitability, we refute the neutrality and unidirectional hypotheses advanced in some existing studies. Firm size is found to Granger cause profitability and vice versa. The results of bidirectional long-run and short-run causal relationship between firm size and profitability show that increased firm size can enhance firm profitability in Nigeria. Likewise, increased firm's profitability can lead can lead to increased firm size. This implies that greater attention to efficiently managing firms' size to optimal level will impact positively on the firms' level of profit. In the same way, efficient management of the firms to achieve high profit level will impact positively on firms' size in Nigeria.

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ČVRSTA VEZA VELIČINE I PROFITABILNOSTI: DOKAZI IZ PANEL PODATAKA ZA NIGERIJU

Sažetak

Rad proučava dugoročnu vezu i pitanja kauzalnosti između veličine tvrtke i profitabilnosti u 66 tvrtki u Nigeriji koristeći metodu panelne kointegracije za period od 1999. do 2007. Empirijski rezultati pokazuju da postoji dugoročna stabilna veza između veličine tvrtke i profitabilnosti. Kratkoročna kauzalna veza pokazuje da postoji dvosmjerna veza između veličine tvrtki i profitabilnosti. To ukazuje na činjenicu da Granger veličine tvrtke uzrokuje profitabilnost a Granger profitabilnosti uzrokuje veličinu tvrtke. Rezultati jasno pobijaju opću pretpostavku da uzročna veza postoji samo od veličine tvrtke prema profitabilnosti, na čemu se bazira većina dosadašnjih istraživanja.

Ključne riječi: veličina tvrtke, profitabilnost, panelna kointegracija, kauzalnost