Carbon Performance, Company Financial Performance, Financial Value And Transmission Channel: An Analysis of South African Listed Companies

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Abstract

This article examines the influence of carbon performance on corporate financial performance and company financial value among South African listed firms for the period 2014 to 2018 using a two-step GMM panel process. The short-run findings show that carbon performance develops a positive and significant association with return on assets, firm value and Tobin’s Q. In the long run, the relationship between carbon performance and return on assets as well as firm value is significantly negative; however, the link with Tobin’s Q remains positively significant. Where carbon performance is employed as the dependent parameter, a positive, significant relationship is established with return on assets, firm value and Tobin’s Q in both the short and long run. The findings also demonstrate that carbon performance is a transmission channel whereby the debt-to-equity ratio, interest cover ratio, price to cash flow ratio and current ratio improve corporate financial performance and firm value in the long run. In the short run, the regression analysis frameworks produce mixed findings on whether carbon performance is a transmission channel. Policy recommendations are made based on the findings.

Keywords: Carbon performance; Return on assets; Tobin's Q; Firm value
1. Introduction

Profit-oriented companies seek to optimise shareholder value by producing commodities whose sale to consumers yields significant financial gains (Abban and Hasan, 2020; Ganda et al., 2015). However, from a social, economic, and political perspective, modern companies also have responsibilities to society. They are thus called on to respond to the needs of diverse parties who influence and are influenced by their business practices. These stakeholders could be internal (for instance, investors, employees) and external (for example, suppliers, clients, the local community, government, environmental interest groups). Carbon performance aimed at mitigating carbon emissions is an imperative aspect of corporate social responsibility. Since the adoption of the Rio Declaration on Environment and Development, sustainability issues have been high on the agenda of governments, companies, and individuals. Many business sectors produce emissions as well as waste that is detrimental to the natural environment and can cause irreversible damage to natural resources (Velte et al., 2020). Companies should thus be accountable and adopt initiatives that preserve the environment.

Efforts to reduce environmental degradation triggered by firm practices are indicators of company environmental and/or green performance. Worldwide, governments and other bodies have called on companies to reduce the negative environmental effects of their operations and to promote sustainability (Lin et al., 2019; Zhang and Vigne, 2021). This includes reducing and/or eliminating carbon emissions as well as producing green commodities (Ganda, 2021a, b). Furthermore, firms are required to adhere to green regulations and incorporate environmentally compatible technologies which reduce their ecological footprint. However, compliance with such requirements appears to be more complex in emerging economies like South Africa than in developed economies (Ganda, 2019). Carbon performance’s impact on financial performance and firm value is thus likely to differ in different contexts.

This study focuses on South Africa for numerous reasons. The country has recorded overexploitation of natural resources as well as increased carbon emissions in the past few decades. South Africa is one of the most industrialised economies on the African continent. Carbon Brief (2018) highlights that, due to over-reliance on coal, it is the 14th largest emitter of emissions in the world. The report also notes that 45% of South Africans regard climate change as a serious problem for the country’s development. The South African Department of Environmental Affairs (2014)
observes that energy firms (solid and liquid fuels), road transport, manufacturing, and construction (solid fuels) are responsible for 95% of greenhouse gas emissions. The Climate Action Tracker (CAT) (2020) explains that the approval of the Integrated Resource Plan (IRP) in October 2019 paved the way for a carbon-intense recovery process that promotes a shift from non-renewable resources towards green energy sources. Moreover, the carbon tax of R46 per tonne of carbon dioxide equivalent (tCO2e) that was introduced in 2019 is an important emission reduction strategy. This tax, which was increased by 5.6% in 2020 (ESI Africa, 2020), aims to encourage firms to adopt emission reduction policies and adopt green technologies.

It is against this background that this article focuses on South African CDP companies listed on the Johannesburg Stock Exchange (JSE) over the period 2014-2018 to firstly, analyse the influence of firm carbon performance on corporate financial performance and/or firm value in both short- and long-run settings. Secondly, it examines the impact of company corporate financial performance and/or firm value on carbon performance. Thirdly, the article investigates if, at the corporate level, carbon performance is a transmission channel whereby other variables (in this article, the debt-to-equity ratio, interest cover ratio, price to cash flow ratio and current ratio) promote corporate financial performance and/or firm value. It is anticipated that the findings will unveil vital policy concerns that need to be addressed at corporate, industrial, and national levels. In turn, this will enhance the development of green programmes and policies and green investment in companies in emerging economies such as South Africa.

This article adds to the existing body of knowledge in a number of respects. Previous empirical research mainly focused on the relationship between carbon performance and financial performance. This article expands this analysis by including several constructs. Furthermore, both short-run and long-run scenarios are examined. A single period analysis does not add much value to firm strategic decision making. The article examines whether carbon performance is a transmission channel (in the short and long term) whereby other control variables at corporate settings promote financial performance. Furthermore, it adds another important variable, corporate financial value as a dependent variable as well as an independent variable to investigate the relationship between carbon performance and financial value, and vice versa. To the best of the author’s knowledge, this has not been done previously in an African company setting. Finally, few
studies have been conducted on this relationship in emerging economies. The article thus offers
new insights into sustainable development within these countries.

The remainder of the article is arranged as follows: Section 2 reviews the recent literature on the
topic, while the third section focuses on the data and econometric procedure adopted. Section 4
presents and discusses the results, and the fifth section considers their implications. Section 6
concludes the article.

2. Literature Review

Previous studies on the relationship between carbon performance and corporate financial
performance and/or financial value used diverse samples and methodologies. However, they
produced mixed findings and consensus has not yet been reached on the nature of this relationship.

Ashraf et al.’s (2020) analysis of South Asian cement manufacturing firms demonstrates that
financial slack generates a positive relationship with carbon performance, and that this link is
moderated through carbon prices in a negative direction. However, company density was found to
positively moderate this association. Okafor et al.’s (2021) research on the top 100 US tech
companies listed on the S&P 500 highlights that firms that spend more on socially responsible
initiatives achieve both increased revenue and profit. Similarly, Trinks et al.’s (2020) survey of 1
572 international companies found that carbon-efficient firms achieve superior financial
performance. Wang et al. (2020) examined 289 Chinese companies and concluded that
environmental information reporting positively influences corporate financial performance
directly and indirectly (through analyst coverage, the number of reports, and several analysts).

A survey of 201 quoted Small and Medium Enterprises (SMEs) in the United Kingdom (UK)
(Boakye et al., 2021) found that SMEs that optimise environmental management achieve improved
financial performance. Velte et al.’s (2020) quantitative review of 73 previous studies
demonstrates that carbon performance improves financial performance, and that carbon
performance and carbon disclosure are positively associated, and that both are positively affected
by the composition of the corporate board. Zhang and Vigne (2021) highlight that a financing-
emission reduction policy punishes firms responsible for high levels of pollution and that such
firms also suffer low levels of total factor productivity, sales growth, and firm profitability. Abban
and Hasan’s (2020) analysis establishes that improved environmental performance enhances financial performance and points to bi-directional causality between the former and the latter.

Lin et al. (2019) evaluated 163 international automotive companies and determined that a Green Innovation Strategy (GIS) positively affects firm financial performance. Fernández-Cuesta et al.’s (2019) investigation of 428 listed firms in 16 European countries shows that carbon risk alongside capital expenditure are major causes of financial debt. The positive effect of carbon emissions on debt (driven by the role of emissions) was minimised by the companies' environmental performance. Tzouvanas et al. (2020) surveyed 288 European manufacturing firms and concluded that improved environmental performance results in firm financial gain. Therefore, the association between environmental and financial performance is positive, although the magnitude is different in different quantile ranges. Finally, Agyabeng-Mensah et al.’s (2020) research on 240 firms in Ghana supports the notion that integration of green logistics management has less impact in improving communities’ social wellbeing and health, while it does improve corporate financial performance (through environmental and market initiatives). More detail on these studies is presented in Table A in the Appendix.

3. Methodology

This section presents the data and econometric procedure adopted.

3.1 Data

The sample consisted of 107 CDP South African companies listed on the JSE Socially Responsible Index for five years (2014-2018). Purposive sampling was employed as these firms’ data is always available. Table 1 describes the variables.
| Variable | Definition | Unit | Source |
|----------|------------|------|--------|
| ROA      | Return on Assets | Computed value by INET BFA. | INET BFA Database |
| FIV      | Firm Value | The proxy for firm value is computed as follows: Common equity market value = number of shares outstanding × price per share of the company's common stock at a specific year-end. Reference includes Matsumura et al. (2014). | INET BFA Database |
| Tobin's Q | Tobin's Q | Tobin’s Q = (FMV + LV + LL) ÷ TA, where FMV is the market value of the company’s outstanding shares, LV refers to the liquidating value of the company’s outstanding preferred shares, Debt demotes the value of long-term liabilities, and TA is the book value of the company’s total assets. Reference sources include Lahouel et al. (2020) and Chung and Pruitt (1994). | INET BFA Database |
| CARPER  | Carbon Performance | Carbon Performance = Total carbon emissions at year-end (tonnes CO₂) ÷ total company sales at year-end. Reference sources include Luo and Tang (2014); Sutantoputra et al. (2012) and Clarkson et al. (2008) | Company Sustainability Reports. |
| DE      | Debt to Equity Ratio | Computed value by INET BFA. | INET BFA Database |
| IC      | Interest Cover Ratio | Computed value by INET BFA. | INET BFA Database |
| PCF     | Price Cash Flow Ratio | Computed value by INET BFA. | INET BFA Database |
| CR      | Current Ratio | Computed value by INET BFA. | INET BFA Database |

Notes: In this case, ROA, FIV and TOB are dependent variables. CARPER is the independent variable. DE, IC, PCF, and CR are control variables.
3.2 Econometric procedure

This research takes into account a diverse range of four panel frameworks. The multiple linear regression framework for individual $i = 1, 2, 3… N$ who is scrutinised at distinct periods $t = 1, 2, 3……T$. Suppose this regression model is founded on:

$$y_{it} = \theta + a_i + \beta x_{it} + \ldots + u_{it} \quad (1)$$

In this context, $y_{it}$ is the dependent variable; $x_{it}'$ refers to the K-dimensional row vector independent variables considered to be varying with time and $\theta$ is the intercept. Furthermore, $a_i$ is an individual particular impact. $\beta$ is the K-dimensional column vector of variables. $u_{it}$ is the error term of the regression model.

This first panelised model is based on the Fixed Effects (FE) framework. It assumes the existence of a mutual relationship of unknown form involving the entity’s error term and independent factors. Moreover, the entity’s error term along with individual-particular impact are not supposed to be mutually associated with the other parameters.

The second model specification employed is the Random Effects (RE) model. Competing with the FE model, the RE framework assumes that the individual-particular effect is a random parameter that is not mutually related to the independent variables. Nevertheless, in cases where the individual-particular effect is in fact unrelated, the RE framework is preferable to the FE framework. This decision is normally achieved by deploying the Hausman test that is only arguable under homoscedasticity and cannot take fixed effects into account.

The instrumental variables (IV) framework is the third model. It states that a selected number of exogenous explanatory variables are assumed to be endogenous. In this case, they could be mutually related to the error. The IV estimation process is known to considerably mitigate endogeneity effects. However, the procedure also violates the zero conditional mean assumption through endogenous variables. This may arise due to estimation error in the explanatory variables.
alongside omitted-variable bias. While the IV approach has drawbacks, it directs channels to acquire more compatible variable estimates and results. Thus, the IV model is expressed as:

\[ y_{it} = \beta_1 x_{it1}' + \beta_2 x_{it2}' + u_{it1} \] (2)

\[ x_{it1}' = \alpha_1 x_{it1}' + \alpha_2 x_{it2}' + u_{it2} \] (3)

In this situation, \( i = 1, 2, 3 \ldots N \) and \( t = 1, 2, 3 \ldots T \). \( x_{it1}' \) refers to the vector of endogenous independent factors. \( x_{it2}' \) refers to the vector of endogenous independent factors. \( x_{it3}' \) refers to the vector of instrumental parameters. \( \beta_1 \) together with \( \beta_2 \) structural parameter vectors. \( \alpha_1 \) and \( \alpha_2 \) are reduced-form variables. The vector \( (u_{it1}; u_{it2}) \) is considered to be multivariate normal with variance-covariance matrix:

\[ \text{Var} (u_{it1}; u_{it2}) = \Sigma = \begin{pmatrix} 1 & \Sigma_{12} \\ \Sigma_{12}' & 1 \end{pmatrix} \]

The framework is computed by employing Newey’s efficient two-step estimator.

Finally, this article deploys the IV-GMM model due to the presence of heteroscedasticity. This model is more effective than the usual IV method. Furthermore, if heteroscedasticity is not found, the GMM approach is no worse asymptotically when compared to the IV method. For instance, we employ a simple regression framework:

\[ y_{it} = \theta + a_i + \sigma y_{it-1} + \beta_1 x_{it}' + \ldots + u_{it} \] (4)

In the context, we perceive that some components of \( x_{it}' \) are endogenous. Vector \( z_{it} \) refers to instruments comprising of the parts of \( x \) which are exogenous along with more factors that are uncorrelated with \( u_i \). \( \theta \) is the intercept of the regression, while \( a_i \) is the individual-particular effect. In the GMM model approach, the moment conditions are identified as follows:

\[ E \{ z_{it} u_{it} (\beta) \} = E \{ z_{it} (y_{it} - (\beta) x_{it}') \} = 0 \] (5)
In this situation, the instruments employed are $x_{(i,t-1)}$, $x_{(i,t-2)}$, $x_{(i,t-3)}$ ....... $x_{(i,1)}$. GMM estimators select values that reduce the quadratic framework of the regression. This technique is effective in addressing over-identified configurations of the model. In addition, the GMM method minimises to method of moments in cases where the number of variables is equivalent to the number of moment conditions.

4. Results and discussion

This section presents the descriptive statistics and the correlation matrix of the variables employed, as well as the two-step GMM findings.

4.1 Descriptive statistics

Summarised data on the sampled companies is presented in Table 2 below. Amongst the dependent variables, firm value (FIV) appears to have the highest mean at 22.3 (the second is ROA at 6.88 and the last Tobin’s Q at 0.65). Thus, for every rand of common stock, investors or the market perceive on average firm value of R22.30. The carbon performance minimum and maximum values range from -3.593785 to 268.4, pointing to large differences in the firms’ carbon emissions reduction initiatives. The mean of carbon performance is 1.359. On average, a company undertakes 1.359 activities in reducing carbon emissions. The kurtosis of the control variables, namely, the debt-to-equity ratio (DE), interest cover (IC), price to cash flow (PCF) and current ratio (CR) are all more than 3 (excess kurtosis>0). This result illustrates that the distribution of all these ratios is leptokurtic (the tails are longer and fatter, and the centre is very sharp and high). Moreover, in the case of control factors, only PCF is negatively skewed – the tail of the distribution points leftward. This implies that, while initially a few investors are prepared to pay for cash flow produced by the company; the substantial majority are long term. The remaining control parameters have positively skewed PCFs.
Table 2: Statistical summary of variables

| Variable | Min.    | Std. Dev. | Max. | Mean    | Skewness   | Kurtosis   |
|----------|---------|-----------|------|---------|------------|------------|
| ROA      | -121.8945 | 12.2755 | 46.85 | 6.876665 | -2.451006  | 28.02151   |
| FIV      | 15.39487 | 1.949516 | 31.00545 | 22.30046 | 0.9638672  | 7.9811     |
| Tobin’s Q | -0.0000249 | 3.340955 | 44.9605 | 0.6536921 | 10.47815   | 115.288    |
| CARPER   | -3.593785 | 12.4063 | 268.4 | 1.359019 | 19.06794   | 403.9869   |
| DE       | -25.95  | 2.99269  | 15.18 | 1.78686  | 0.5641117  | 20.50958   |
| IC       | -33.09  | 236.1772 | 3076 | 36.47366 | 10.10143   | 116.6607   |
| PCF      | -211    | 17.3625  | 94   | 10.6161  | 0.0544     | 95.03137   |
| CR       | 0       | 9.15024  | 159.31 | 2.174017 | 13.63601   | 206.121    |

4.2 Correlations

Table 3 below indicates a one-to-one relationship between the variables utilised in this article. It is evident that the direct association involving carbon performance (CARPER) and the dependent factors (ROA, FIV, Tobin’s Q) is negative in all cases. However, this outcome is not absolute as vital econometric processes are still outstanding due to the limitations associated with simple correlations. On a separate note, the correlation matrix is imperative in the selection of instruments to be deployed in the GMM procedure. In this respect, variables with the lowest correlation to the dependent variables are employed as instruments in the GMM analysis.

Table 3: Showing correlation matrix

| Variable | ROA     | FIV     | TOB     | CARPER  | DE      | IC      | PCF     | CR      |
|----------|---------|---------|---------|---------|---------|---------|---------|---------|
| ROA      | 1       |         |         |         |         |         |         |         |
| FIV      | 0.1034  | 1       |         |         |         |         |         |         |
| Tobin’s Q | 0.0810 | 0.1081  | 1       |         |         |         |         |         |
| CARPER   | -0.0081 | -0.0757 | -0.0107 | 1       |         |         |         |         |
| DE       | -0.1425 | 0.0492  | -0.0110 | -0.0180 | 1       |         |         |         |
| IC       | 0.2823  | -0.0183 | -0.0207 | -0.0156 | -0.0694 | 1       |         |         |
| PCF      | 0.1199  | 0.0168  | -0.0073 | -0.0052 | 0.0013  | 0.0544  | 1       |         |
| CR       | -0.1882 | -0.1375 | -0.0142 | -0.0047 | -0.0778 | 0.0739  | 0.0350  | 1       |
4.3 GMM Findings

Previous studies (for instance, Lahouel et al., 2020 and Moneva et al., 2020) state that addressing endogeneity matters and accounting for the presence of dynamic impacts are major aspects when analysing the influence of carbon performance on financial performance and/or firm value, and vice-versa. For procedural purposes and robustness checks, the findings from traditional static estimators (Random Effects and Fixed Effects models) are computed along with the instrumental variable approach. These findings are presented in the Appendix (See Tables B, C, and D). Since this article is interested in accounting for endogeneity and dynamism effects, the GMM outcomes are presented in a short-run and long-run setting.

Table 4: Two-step system-GMM short-run findings with (a) ROA (b) FIV (c) Tobin’s Q.

| Regression - (ROA) as Dep. Variable | Regression - (FIV) as Dep. Variable | Regression - (Tobin’s Q) as Dep. Variable |
|-------------------------------------|-------------------------------------|-------------------------------------------|
| Coefficient                        | Standard Error                     | Coefficient                               |
| ROAt-1                              | 0.7472047 (0.000) ***              |                                           |
| FIVt-1                              | 0.7204744 (0.000) ***              | 0.0249979                                 |
| Tobin’s Qt-1                        |                                     | -0.496234 (0.000) ***                    |
| CARPER                             | 0.0206518 (0.095) *                | 0.0123839                                 |
| DE                                 | -1.400456 (0.000) ***              | 0.01313002                                |
| IC                                 | 0.0033631 (0.000) ***              | 0.0003273                                 |
| PCF                                | 0.0573583 (0.000) ***              | 0.005974                                  |
| CR                                 | -0.1274749 (0.000) ***             | -0.0079984 (0.792)                       |
| Constant                           | 3.44786 (0.000) ***                | 6.130266 (0.000) ***                     |
| Wald (χ²)                          | 44519.90 (0.000) ***               | 3378.33 (0.000) ***                      |
| Arellano-Bond test for AR (1) in first differences | | |
| z = -1.77                          | Pr > z = 0.077*                    |                                           |
| z = -2.60                          | Pr > z = 0.009***                  |                                           |
| z = 0.67                           | Pr > z = 0.0505*                   |                                           |
Table 4 outlines the findings regarding the GMM short-run contexts on the link between carbon performance and financial performance and/or value. It shows that lagged ROA and lagged firm value (FIV) show a significant positive relationship with ROA and firm value (FIV) in the short run although this link is significantly negative in cases where lagged Tobin’s Q is involved. In this case, a 1% increase in previous ROA and previous firm value (FIV) leads to an increase in ROA and firm value (FIV) by 0.747% and 0.720%, respectively. This finding is consistent with Heikal et al.’s (2014) study on automotive firms listed on the Indonesian Stock Exchange, which highlights that ROA results in significant growth in company income. However, a percentage rise in the previous Tobin’s Q in this research reduces Tobin’s Q by 0.496%.

Carbon performance among South African listed companies shows a positive and significant association with ROA, FIV and Tobin’s Q in the short term. More specifically, a 1% surge in carbon performance stimulates a 0.02%, 0.008% and 0.0016% increase in ROA, FIV and Tobin’s Q, respectively. This is in line with Busch et al.’s (2020) exploration of publicly listed stock companies from 2005-2014, which found that increased carbon emissions (employed as a proxy for carbon performance) are related to robust, enhanced short-run corporate financial performance.

The debt-to-equity ratio (DE) shows a negative and significant link with ROA in the short run. Thus, finding illustrates that South African companies which employed debt finance to acquire assets experience a negative association with and/or effect on corporate financial performance – ROA. This concurs with Ullah et al.’s (2020) research on the textile sector in Pakistan during the period 2008 to 2017. However, other DE regression outcomes indicate that this variable has a

| Arellano-Bond test for AR (2) in first differences | z = -0.74 Pr > z = 0.459 | z = 0.23 Pr > z = 0.818 | z = -1.53 Pr > z = 0.126 |
| Hansen test of over-identifying Restrictions | chi2(37) = 42.23; Prob > chi2 = 0.255 | chi2(12) = 16.05; Prob > chi2 = 0.189 | chi2(12) = 10.98; Prob > chi2 = 0.531 |
| Observations | 427 | 427 | 427 |

Notes: [1] ***; ** and * indicate that the coefficients are significant at the 1%, 5% and 10% level of significance, respectively. Numbers in brackets are p-values. [2] The null hypothesis of diagnostic statistical analysis shown in the table above is (a) The Arellano-Bond test for autocorrelation: $H_0$=no autocorrelation; (b) The Hansen: $H_0$ = the set of instruments is valid.
positive and significant relationship with FIV and Tobin’s Q in the short term. In this case, a 1% increase in DE results in FIV and Tobin’s Q increasing by 0.07% and 0.02%, respectively.

The interest cover ratio (IC) of the listed companies develops a positive and significant relationship with both ROA and FIV in the short term. As such, one percentage growth in IC results in a 0.0033631% and 0.0001763% improvement in ROA and FIV, respectively. A higher interest coverage ratio means that the firm is able to repay its debts. This concurs with Leepsa and Mishra’s (2012) study on Indian manufacturing companies from 2003/04 to 2006/07 where interest cover as a proxy for leverage showed a positive relationship with firm financial performance. Nevertheless, IC generates a negative and significant link with Tobin’s Q. More particularly, a 1% escalation in IC reduces Tobin’s Q by 0.0002345%.

On the one hand, the price to cash flow ratio (PCF) shows a negative and significant connection with Tobin’s Q in the short run. On the other, the price to cash flow ratio (PCF) generates a positive and significant relationship with both ROA and FIV in the short run. In this respect, a 1% climb in PCF produces a 0.057% and 0.00029% increase in ROA and FIV, respectively. This is in line with Chakravarty and Hegde’s (2019) investigation of 55 distinct industries on the Indian Boards Database provided by the National Stock Exchange (NSE) between 2006 and 2015. Their study postulates that cash flows generated a positive and significant association with ROA and the market-to-book ratio.

The current ratio (CR) generates a negative and significant link with all proxies for financial performance and financial value in the short run. For instance, a 1% rise in CR leads to a 0.127%, 0.00799% and 0.0023% reduction in ROA, FIV and Tobin’s Q. Purwanto and Agustin (2017) evaluated 65 companies listed on the Indonesian Stock Exchange for the period 2009 to 2014. The study found that an increase in the current ratio decreases firm financial value. Theoretically, a higher CR results in increased firm value and vice-versa since investors prefer highly liquid companies.

The diagnostic tests presented in Table 4 above also validate the results in this section. It is apparent that for all regression models, the first-order serial correlations are rejected but the second-order serial correlations are accepted at a 5% significance level, thereby validating the instruments employed in this research. Furthermore, the Hansen tests are not weakened by employing the instruments as the null hypothesis in all the regression models is not rejected.
Table 5: Two-step system-GMM long-run findings with (a) ROA (b) FIV (c) Tobin’s Q

| Variable | Regression - (ROA) as Dep. Variable | Regression - (FIV) as Dep. Variable | Regression - (Tobin’s Q) as Dep. Variable |
|----------|-------------------------------------|------------------------------------|--------------------------------------------|
|          | Coefficient                        | Standard Error                     | Coefficient                                | Standard Error                        | Coefficient                        | Standard Error                        |
| CARPER   | -0.7265529 (0.000) ***             | 0.0168725                          | -0.7124038 (0.000) ***                     | 0.0251853                             | 0.497902 (0.000) ***               | 0.0584578                             |
| DE       | -2.14766 (0.000) ***               | 0.1310445                          | -0.6470975 (0.000) ***                     | 0.0235936                             | 0.5194649 (0.000) ***              | 0.0659242                             |
| IC       | -0.7438416 (0.000) ***             | 0.0101811                          | -0.720298 (0.000) ***                      | 0.0250093                             | 0.4959995 (0.000) ***              | 0.0583175                             |
| PCF      | -0.6898464 (0.000) ***             | 0.0121235                          | -0.7201807 (0.000) ***                     | 0.0251933                             | 0.495821 (0.000) ***               | 0.0581792                             |
| CR       | -0.8746796 (0.000) ***             | 0.0076558                          | -0.7284727 (0.000) ***                     | 0.0247444                             | 0.4938698 (0.000) ***              | 0.0591767                             |

Notes: ***; **; * mean significant at 1%, 5% and 10% significance level, respectively. Numbers in brackets are p-values.

Table 5 present the results on the long-run relationship between carbon performance and corporate financial performance and/or firm value. It shows that a 1% increase in carbon performance for the South African listed firms significantly reduces ROA and FIV by 0.727% and 0.712%, respectively in the long run. These results conflict with Trinks et al.’s (2020) study of 1,572 international companies over the years 2009 to 2017 which concludes that high carbon-efficient firms have superior financial performance. However, the current study’s finding that a percentage upswing in carbon performance heightens Tobin’s Q by 0.497% concurs with Trinks et al. (2020). The debt-to-equity ratio, interest cover ratio, price to cash flow ratio and current ratio also have significantly negative connections with both ROA and FIV in the long run. However, all these variables’ link with Tobin’s Q is significantly positive in the long run.
Table 6: Two-step system-GMM short-run findings with carbon performance as a transmission channel for firm financial performance and value

| Regression - (CARPER) as Dep. Variable | Regression - (CARPER) as Dep. Variable | Regression - (CARPER) as Dep. Variable |
|---------------------------------------|---------------------------------------|---------------------------------------|
| Coefficient                          | Coefficient                          | Coefficient                          |
| Standard Error                       | Standard Error                       | Standard Error                       |
| CARPER<sub>it−1</sub>                | 0.2741592                            | -0.4604968                           |
|                                       | (0.000) ***                          | (0.000) ***                          |
| ROA                                   | 0.0135549                            | 0.1999875                            |
|                                       | (0.000) ***                          | (0.028) **                           |
| FIV                                   | 0.0490563                            | 0.0907402                            |
| Tobin’s Q                             |                                       |                                       |
| DE                                    | 0.0041483                            | 0.00208048                           |
|                                       | (0.047) **                           | (0.502) **                           |
| IC                                    | -0.0000179                           | -0.0002836                           |
|                                       | (0.000) ***                          | (0.038) **                           |
| PCF                                   | 0.0018419                            | 0.0002067                            |
|                                       | (0.000) ***                          | (0.005) ***                          |
| CR                                    | -0.0037854                           | 0.0001015                            |
|                                       | (0.000) ***                          | (0.815) **                           |
| Constant                              | 0.5615374                            | -3.806417                           |
|                                       | (0.000) ***                          | (0.037) **                           |
| Wald (χ²)                             | 10751.76                             | 90.85                                |
|                                       | (0.000) ***                          | (0.000) ***                          |
| Arellano-Bond test for AR (1) in first differences | z = -1.37                            | z = -1.40                            |
|                                       | Pr > z = 0.171                       | Pr > z = 0.160                       |
| Arellano-Bond test for AR (2) in first differences | z = 1.30                            | z = 1.10                             |
|                                       | Pr > z = 0.193                       | Pr > z = 0.272                       |
| Sagan test of over-identifying. Restrictions | chi²(20) = 12.16; Prob > chi² = 1.000 | chi²(12) = 0.71; Prob > chi² = 1.000 |
|                                       | 427                                  | 427                                  |

Notes: [1] ***; ** and * indicate that the coefficients are significant at the 1%, 5% and 10% level of significance, respectively. Numbers in brackets are p-values. [2] The null hypothesis of diagnostic statistical analysis shown in the table above is (a) The Arellano-Bond test for autocorrelation: H₀ = no autocorrelation; (b) The Sagan: H₀ = the set of instruments is valid.

Table 6 illustrates the GMM short-run outcomes when carbon performance is employed as a dependent variable for both the financial performance and financial value regression frameworks.
Firstly, lagged carbon performance in a regression model (ROA, FIV, Tobin’s Q) demonstrates a significantly negative association with carbon performance. Thus, a 1% upswing in carbon performance reduces current ROA, FIV and Tobin’s Q by 0.27%, 0.46% and 0.325%, respectively in the short term. This finding demonstrates that South African companies’ previous carbon performance initiatives are not able to influence existing carbon performance measures. This could be due to weak regulatory practices, a lack of greening skills initiatives by companies and the fact that carbon management practices are not a priority in company strategy and hence tend to be overlooked. More specifically, the CDP (2018:3) asserts that, “Despite South African companies having been global leaders in supporting the low carbon transition for the first decade of CDP, in 2016 and 2017 the data indicated that South African companies may be faltering in some respects. In 2018 the data is mixed but the integration of climate change into governance is not producing the actions we need.”

Secondly, the GMM results in Table 6 indicate that the financial performance proxies (ROA, Tobin’s Q) and the financial value measure (FIV) show a positive and significant relationship with carbon performance in the short term. As such, a 1% rise in ROA, Tobin’s Q and FIV increases carbon performance by 0.0136%, 0.0026% and 0.199%, respectively in the short run. Alexopoulos et al.’s (2018) analysis of 931 Greek manufacturing firms during the period 2001 to 2007 concurs and adds that companies with superior financial performance tend to achieve improved environmental performance (inverted score of environmental pollution per production unit).

The GMM outcomes also show that the debt-to-equity ratio is significantly positively related to carbon performance in the case of the ROA and Tobin’s Q regression models, but the link is significantly negative in the context of the FIV regression framework. Since the DE ratio ascertains the degree to which a firm is financing its operations by means of debt versus wholly owned funds, South African companies could be attracting investors due to their ability to demonstrate company greening initiatives, thereby enhancing firm financial performance. However, in the case of the FIV model, increased DE significantly reduces carbon performance. Thus, it can be determined that carbon performance is not a transmission channel whereby the DE ratio promotes corporate financial value among these listed firms. In theory, a high DE ratio implies high risk (a firm financing its growth with debt), negatively influencing firm value.
The interest cover (IC) ratio is positive and significantly associated with carbon performance in the Tobin’s Q model in the short run, although that connection is negative and significant in the context of the ROA and FIV regression frameworks. Interest cover determines the firm’s ability to honour its debts and a high ratio indicates better financial health. As such, when market-based proxies such as Tobin’s Q are employed, carbon performance is a transmission channel through which the IC ratio motivates firm financial performance rather than through accounting-based proxies such as ROA and firm financial value.

The price to cash flow ratio (PCF) is positive and significantly related to carbon performance in the ROA and Tobin’s Q models for the listed South African companies, but the link is significantly negative in the case of the FIV framework. For both accounting-based measures (ROA) and market-based indicators (Tobin’s Q), carbon performance is an identifiable transmission channel whereby PCF promotes corporate financial performance. However, in the case of firm financial value (FIV), PCF decreases carbon performance and hence ceases to be a transmission channel. Theory supports these FIV findings as a high PCF ratio is less preferable than low PCF ratios since it shows that the company is trading at a high price but is unable to obtain adequate cash flow to promote firm operations. The current ratio (CR) significantly demotivates carbon performance in the ROA and Tobin’s Q frameworks in the short term, but significantly promotes carbon performance in the FIV framework.

The diagnostic test in Table 6 demonstrates there is no first-order autocorrelation in the disturbances of all the regression models, thereby concurring with Habimana (2017) and De Andres and Vallelado (2008). Most importantly for this study, the absence of second-order serial correlation in the disturbances is accepted for all regression equations. The Sargan test also demonstrates that the problem of over-identification is not present in the equations.

Table 7: Two-step system-GMM long-run findings with carbon performance as a transmission channel for firm financial performance and value

| Regression (CARPER) as Dep. Variable | Regression (CARPER) as Dep. Variable | Regression (CARPER) as Dep. Variable |
|-------------------------------------|-------------------------------------|-------------------------------------|
| Coefficient                         | Standard Error                      | Coefficient                         | Standard Error |
| ROA                                 | 0.2877141 (0.000) ***               | 0.0038428                           |
Table 7 shows very interesting results in relation to carbon performance as a transmission channel for firm financial performance and value on a long-run basis. It appears that in a long-term setting higher return on assets, firm value and Tobin’s Q increases corporate carbon performance. Thus, high financial performance and firm value are likely to spur high carbon performance among South African companies. Other findings also illustrate that a heightened debt to equity ratio, interest cover ratio, price cash flow ratio and current ratio significantly increases carbon performance in the long run. It also implies that, in the long term, carbon performance is a vital transmission medium through which these variables promote improved financial performance and firm value.

5. Implications of the study: Examining the context of carbon performance

This article produced critical findings in the context of carbon performance that have implications for policy development, corporate practice, theory, and future research. It showed that carbon performance develops a positive and significant association with ROA, FIV and Tobin’s Q in the short term. Thus, it is apparent that green issues are well received by South African companies in the short run. There is a tendency for these firms to integrate practices that are imperative to achieve low-carbon emissions. However, in the long run, the relationship between carbon performance and either ROA or firm value (FIV) tends to be significantly negative although its relationship with Tobin’s Q remains positively significant. This points to gaps in the integration of sustainability issues in company policy, particularly for the long term. It would seem that the measures adopted to promote emissions reduction are not deeply embedded in company strategic
policy. It is for this reason that a negative association is demonstrated in the long term. These results can be explained by a number of factors. Firstly, government policy may not have been strong enough to motivate companies to engage in initiatives to mitigate carbon emissions and to sustain such practices. A lack of green human capital could be another factor. Insufficient expertise may prevent companies from understanding the way forward. There is also a need to establish sustainability accounting departments in South African companies, and sustainability issues should form part of their strategic policy. In the long run, this will enable companies to reap the benefits of incorporating zero-carbon practices.

This research also illustrated that when carbon performance was adopted as the dependent variable, critical results were generated. Firstly, lagged carbon performance in all the regression models (ROA, FIV and Tobin’s Q) has a significantly negative association with carbon performance in the short term. This points to how the companies under study practice business. The fact that previous carbon performance has a significantly negative link with current carbon performance suggests that these South African companies may be abandoning carbon emission mitigation initiatives undertaken in the past. Adopting new or alternative strategies in subsequent years will produce negative results. The previous year's zero-carbon activities in these companies should inform the carbon performance policy of the following years. There is also a need for companies to critically analyse the pros and cons, and lessons learnt and use such findings to inform current and future mitigation plans. In addition, efficient records should be maintained on sustainability issues in the context of carbon emissions as these will inform future green practice.

It was found that ROA, firm value (FIV) and Tobin’s Q had a positive and significant connection with carbon performance for the analysed companies in the short and long run. Thus, when the companies experienced improved financial performance and value in the short run, their carbon performance was enhanced. This concurs with the earlier findings where carbon performance was the explanatory parameter in the short term. Hence, in the short run, these variables and their relationships significantly complement one another. Ideally, there is a need for the companies under study to extend their short-term high level of commitment to carbon reduction initiatives to the long term. For example, durable green technologies, sustainable green investment practices and conduct in company projects, and permitting top management to participate in matters relating to firm green policy are vital to ensure sustenance.
The results also showed that the debt-to-equity ratio is significantly positively related to carbon performance in the ROA and Tobin’s Q regression frameworks, but it is significantly negative in the context of the FIV regression framework in the short term (in the long term, significantly positive relationships are valid in all equations). While carbon performance is determined to be a transmission channel whereby the debt-to-equity ratio promotes corporate financial performance in accounting-based and market-based contexts, this is not the case with financial value. Interestingly, the debt-to-equity ratio has a positive and significant relationship with FIV and Tobin’s Q (although this relationship is negative and significant in the case of ROA). This suggests the need for corporate managers to integrate realistic carbon performance practices that build shareholder confidence that the company’s financial value can be sustained, even in cases where it obtains increased financing by borrowing funds in the short run. This is supported by the finding that in the long run, the debt-to-equity ratio of the studied JSE listed firms shows a positive and significant association with carbon performance for all the regression equations - ROA, FIV and Tobin’s Q. Moreover, the companies should acquire loans with green features, pay them timeously and introduce an efficient green inventory management system as this ensures that funds are not wasted. They should also restructure their debt. Given that market rates for green loans are normally low, such loans would reduce the overall debt to equity ratio.

The results of this research demonstrate that the interest cover (IC) ratio is positive and significantly associated with carbon performance in the Tobin’s Q equation in the short run, although that connection is negative and significant in the context of the return on assets and firm value regression frameworks. This implies that, by improving carbon performance in the context of market-based firm financial performance, interest cover improves corporate financial performance. However, this is not the case for company financial value and accounting-based proxies. In the long run, however, by increasing carbon performance, interest cover is able to significantly raise all financial performance indicators along with firm financial value. This implies that these companies should continue to consider green risk in their projects along with operations. Adopting green instruments implies that the company is promoting sustainability as well as encouraging comprehensive deployment of climate-related and/or environmentally friendly projects. Given the existing green investment climate, if the interest cover ratio captures greening aspects, creditors and prospective lenders will not consider that high risks are involved in lending to the company. Other measures the company could consider would be to lower the among
borrowed for non-climate friendly projects or operations, or pay current debts while reducing operating costs for non-environmentally compatible activities.

Furthermore, the results confirm that the price to cash flow ratio is positive and significantly related to carbon performance for indicators of firm financial performance, but this link is significantly negative in the case of firm financial value in the short run. In the long run, the price to cash flow ratio develops a significantly positive connection with all the financial performance measures as well as firm value. Therefore, in most cases, carbon performance is a transmission channel whereby the presentation of the price to cash flow ratio benefits both financial performance and the value of the company. In this situation, it is imperative that companies integrate green stocks since this valuation ratio computes the company stock value with non-cash costs (for instance, depreciation). The price to cash flow ratio is vital for analysts and investors to gain a less distorted perspective of the firm’s financial standing since its cash flows are not as controlled and/or exploited as its earnings. As such, it is vital for companies to introduce carbon emissions reduction practices and policies that spur green perceptions and address risk tolerance among investors.

Finally, the findings indicate that a rise in the current ratio significantly lessens carbon performance in all the financial performance measures but supports corporate financial value in the short run. In the long run, an upsurge in the current ratio has a significantly positive influence on carbon performance for all the corporate financial performance indicators and financial value. This finding demonstrates the positive impact that the current ratio can have on carbon performance and financial performance and/or firm value. It is thus vital for these companies to sell non-green assets since such resources are no longer producing financial gains to the firm. They should also investigate whether term green loans are suitable for reamortisation and should not acquire non-green capital purchases using cash (for green capital purchases, the company could consider delaying the acquisition).

6. Conclusions

This article investigated the impact of carbon performance on corporate financial performance and company financial value among South African CDP listed firms from 2014 to 2018. The corporate
performance proxies were the accounting-based indicator, ROA and market-based measure, Tobin’s Q. The 2-step Generalised Method of Moments was used to ascertain this relationship from a short-run to a long-run horizon. The short-run results show that carbon performance has a significantly positive link with return on assets, firm value and Tobin's Q. Nevertheless, in the long run, the association between carbon performance and both return on assets and firm value is negative and significant although the relationship with Tobin's Q remains positive and significant. Other important findings emerged where carbon performance was used as the dependent variable. Return on assets, firm value and Tobin’s Q showed a significantly positive relationship with carbon performance in both the short and long run horizons. The results highlight that the debt-to-equity ratio is positive and significantly linked with carbon performance for the return on assets and Tobin's Q equations, while that association was found to be significantly negative for the firm value equation in the short run. In the long term, the article demonstrated that the debt-to-equity ratio is significantly positively related to carbon performance for the return on assets, Tobin's Q and firm value regression equations.

This research also found that the interest cover ratio was significantly positive linked with carbon performance in the context of Tobin's Q regression in the short term while the link was ascertained to be negative and significant in the return on assets and firm value regression equations. In the long term, interest cover was positive and significantly connected with carbon performance for the ROA, firm value and Tobin’s Q regressions. Furthermore, the price to cash flow ratio was significantly positively associated with carbon performance for all the proxies for firm financial performance, but the association was significantly negative in the case of firm financial value in the short run. In the long run, the price to cash flow ratio had a significantly positive relationship with all the financial performance measures as well as firm value. The findings thus provide strong evidence that an increase in the current ratio significantly reduces carbon performance in all the financial performance measure frameworks but supports corporate financial value in the short run. In the long run, an upsurge in the current ratio had a significantly positive influence on carbon performance for all the corporate financial performance indicators and financial value.

It is important to note that this research only considered large companies listed on the JSE; hence, the findings do not reflect small and medium company settings. Future studies could expand the sample by taking into account diverse company sizes and comparing results. Future research could
also investigate how other facets of sustainability such as social and economic sustainability impact on the studied companies’ financial performance and firm value.

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## Appendix

### Table A: Outlining previous studies and their outcomes

| Author(s) | Firm (s) | Period | Variables | Methodology | Result (s) |
|-----------|----------|--------|-----------|-------------|------------|
| Ashraf et al.(2020) | South Asian cement manufacturing firms | 2005-2012 | Carbon performance; Firm age; Carbon prices; Financial slack; Projects portfolio; Projects types; Industry diversification; Country. | Linear Regression | Financial slack has a positive link with carbon performance and that connection is moderated by carbon prices in a negative direction. Also, company dense set-up positively moderates the connection involving financial slack along with carbon performance thereby supporting the idea that intermediaries are influencing operations in the carbon market. |
| Trinks et al.(2020) | An international sample of 1572 companies | 2009-2017 | Carbon efficiency; Financial performance; Directional distance function; Total factor productivity. | Productive Efficiency Model | Improved financial performance is found in carbon-efficient companies (thus, the firms have higher financial returns as well as reduced systematic risk). |
| Okafor et al.(2021) | United States top 100 tech companies listed on the S&P 500 | 2017-2019 | Tobin’s Q; Return on assets; CSR spending; Revenue growth rate; Age of the firm; Corporate governance rank; Employee relations rank; Environment; Human rights rank; Return on equity; Climate change rank. | Fixed-effects plus pooled regression models | The major findings demonstrate that tech firms which spend more on corporate social responsibility experience increases in both revenue and profits. |
| Wang et al.(2020) | 289 Chinese listed firms | 2013-2017 | Environmental information disclosure; Firm Visibility; Company Liquidity; Firm financial performance. | Multiple Linear Regression | Environmental information reporting positively influences corporate financial performance directly and indirectly (through analyst coverage- the number of reports, and several analysts). |
| Study | Sample | Time Period | Variables | Method | Findings |
|-------|--------|-------------|-----------|--------|----------|
| Boakye et al. (2021) | 201 quoted Small and Medium Enterprises (SMEs) from the United Kingdom (UK) | 2011-2016 | Environmental management; Financial performance | The generalized method of moments (GMM) approach | A non-monotonic association involving environmental management along with financial performance was determined. This indicates that SMEs which maximise environmental management initiatives optimise their financial performance. |
| Velte et al. (2020) | 73 quantitative peer-reviewed empirical studies | 2008-2019 | Carbon performance; Carbon disclosure; Corporate governance; Management control; Financial performance. | A systematic literature review. | Carbon performance increases financial performance. Carbon performance and disclosure and positively associated (both are also positively influenced by board composition). |
| Zhang and Vigne (2021) | Chinese manufacturing firms | 2005-2013 | Financial–emission reduction policy; Firm performance; Financial constraints | A difference-in-difference estimation method. | Financing–emission reduction policy demonstrates a punishing impact on firms that have high pollution (also total factor productivity, sales growth and firm profitability). |
| Abban and Hasan (2020) | 60 Australian mining firms | 2012/2013 - 2017/2018 | Liquidity; Net sales; Capital intensity; Age; Total emissions and environmental performance; ROA; ROE; Tobin’s Q; Stock Returns. | Granger causality test; Vector Autoregression model | Bi-directional causality is valid involving environmental and financial performance. Moreover, heightening environmental performance increases financial performance. |
| Lin et al. (2019) | 163 international automotive companies | 2011-2017 | Green Innovation Strategy; ROA; ROE; Return on Sales; Leverage; Advertising intensity; Free Cash Flow; Research and Development intensity. | GMM | Green Innovation Strategy (GIS) positively affects firm financial performance. |
| Fernández-Cuesta et al. (2019) | 428 Listed firms from 16 European countries | 2005-2015 | Financial debt; Greenhouse Emissions; Profitability; Size; Tangible assets; Non- | The fixed-effect model estimator | Carbon risk along with capital expenditure tangibility are major motivators of the deployment of financial debt. The positive effect of carbon emissions on debt |
| Tzouvanas et al. (2020) | 288 European manufacturing firms | 2005-2016 | Financial performance (ROA, ROE); Environmental performance; Trading scheme participation; compliance to environmental standards; Leverage; Number of employees; Sales growth. | Quantile regression framework | Better environmental performance improves firm financial gain. The link between environmental and financial performance is positive and different in examined quantile ranges. Financial and environmental performance are endogenously associated in circumstances where high profitable companies are only assessed. |
| Agyabeng-Mensah et al. (2020) | 240 firms from Ghana | August 2019 - September 2019 | Green logistics management practices; Environmental performance; Social performance; Market performance; Financial performance. | The structural equation modelling partial least square | The integration of green logistics management has less effect on increasing the social and health of the community while it is improving corporate financial performance (through environmental and market initiatives). |
### Table B: Findings of panel data for regression 1: ROA

| Variable | Random Effect Model | Fixed Effect Model | Instrumental Variable Model |
|----------|---------------------|--------------------|----------------------------|
|          | Coefficient         | Standard Error     | Coefficient                | Standard Error     | Coefficient | Standard Error     |
| CARPER   | 0.000182 (0.996)    | 0.0359167          | 0.0033307 (0.929)          | 0.0374406          | -0.0133191 (0.754) | 0.0424372 |
| DE       | -0.6096503 (0.001)*** | 0.1917924          | -0.66335 (0.005)***        | 0.2322801          | -2.049495 (0.001)*** | 0.6286435 |
| IC       | 0.0098202 (0.011)** | 0.00274            | 0.0023813 (0.531)          | 0.0037983          | 0.013511 (0.000)*** | 0.0022922 |
| PCF      | 0.0635652 (0.011)** | 0.0251083          | 0.0540582 (0.039)**        | 0.0260547          | 0.0814705 (0.007)*** | 0.0303428 |
| CR       | -0.0291869 (0.586)  | 0.0535738          | 0.1226658 (0.036)**        | 0.0583669          | -0.335223 (0.000)*** | 0.059512  |
| Constant | 7.001639 (0.000)*** | 0.9476775          | 7.140721 (0.000)***        | 0.6157663          | 9.903208 (0.000)*** | 1.335937  |
| R²       | 0.1130               | 0.0166             |                            | 0.0275             |              |                  |
| Wald (χ²) | 29.88***             |                    |                            | 85.02              |              |                  |
| F statistic |                          | 3.56               |                            |                    |              |                  |
| Breusch-Pagan test (χ²) | 212.51 (0.000)*** |                    |                            |                    |              |                  |
| Durbin (score) chi2(1) |                          |                    |                            |                    |              |                  |
| Wu-Hausman |                          |                    |                            |                    |              |                  |

Notes: ***, ** and * indicate that the coefficients are significant at the 1%, 5% and 10% level of significance, respectively. Numbers in brackets are p-values.
### Table C: Findings of panel data for regression 2: FIV

|          | Random Effect Model | Fixed Effect Model | Instrumental Variable (IV) Model |
|----------|---------------------|--------------------|----------------------------------|
|          | Coefficient         | Standard Error     | Coefficient                     | Standard Error |
| CARPER   | 0.0026953 (0.169)   | 0.0019597          | 0.002949 (0.135)                | 0.0019669      | -0.0055463 (0.710) | 0.0149363 |
| DE       | 0.0515344 (0.000)** | 0.0120311          | 0.0523853 (0.000)**             | 0.0122026      | 1.311278 (0.000)** | 0.2212584 |
| IC       | 0.0001012 (0.603)   | 0.0001943          | 0.0001083 (0.588)               | 0.0001995      | 0.0010096 (0.211) | 0.0008068 |
| PCF      | -0.0015507 (0.256)  | 0.001364           | -0.0016444 (0.230)              | 0.0013688      | 0.0006606 (0.951) | 0.0106795 |
| CR       | -0.0040722 (0.181)  | 0.003046           | -0.0035343 (0.250)              | 0.0030662      | 0.0022162 (0.916) | 0.0209459 |
| Constant | 22.22617 (0.000)**  | 0.1872622          | 22.2261 (0.000)**               | 0.0323486      | 19.8785 (0.000)** | 0.4701987 |
| R²       | 0.0031              | 0.0025             |                                  | 4.2707         |
| Wald (χ²)| 23.02 (0.0003)**    |                    |                                  | 37.88          |
| F statistic |                    | 4.61               |                                  |
| Breusch-Pagan test (χ²) | 941.55 (0.000)**    |                    |                                  |
| Durbin (score) |                    |                    | 188.365 (0.000)**              |
| chi²(1)  |                    |                    | F(1,523) = 288.365 (0.000)**   |
| Wu-Hausman |                    |                    |                                  |
| No. of observations | 534               | 534                | 534                             | 534            | 530             | 530          |

Notes: ***; ** and * indicate that the coefficients are significant at the 1%, 5% and 10% level of significance, respectively. Numbers in brackets are p-values.
**Table D: Findings of panel data for regression 3: TOBIN’S Q**

| Model                  | Random Effect Model | Fixed Effect Model | Instrumental Variable Model |
|------------------------|---------------------|--------------------|-----------------------------|
|                        | Coefficient  | Standard Error | Coefficient | Standard Error | Coefficient | Standard Error |
| CARPER                 | -2.36e-06  | (0.999)      | 0.0000359 | (0.991)      | -0.002507 | (0.815)      |
| DE                     | -0.0104002 | (0.576)      | 0.0185916 | 0.018887     | -0.0223459| (0.888)      |
| IC                     | -0.0000177 | (0.953)      | 0.0003011 | (0.989)      | 0.0003088 | (0.652)      |
| PCF                    | 0.0004226  | (0.841)      | 0.00021027| 0.0004386 | (0.836)    | 0.0021185 | (0.933)      |
| CR                     | 0.0002878  | (0.951)      | 0.004699  | (0.940)      | -0.0006453| (0.933)      |
| Constant               | 0.6679097  | (0.042)**   | 0.3280199 | (0.000)***  | 0.6565196 | (0.051)*     |
| R²                     | 0.0001     | 0.0001      | 0.0001    | 0.0001      | 0.35      |
| Wald (χ²)              | 0.35***    | 0.35        | 0.35      |
| F statistic            | Breusch-     | Pagan test   |
|                        | 991.89     | (0.000)***  |
| Durbin (score)         | Wu-         |
| chi2(1)                | Hausman     |
| No. of observations    | 534         | 534          | 534        | 534          | 530          |

Notes: ***; ** and * indicate that the coefficients are significant at the 1%, 5% and 10% level of significance, respectively. Numbers in brackets are p-values.
Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- CDPcompileddataStataForAnalysis.xls