Carbon emissions reduction and financial performance of Johannesburg Stock Exchange's SRI companies

by

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THESIS

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DEDICATION

In memory of my late mother, OBAAPAYIN AKOSUA ADDOWAA, and my late father, GYAASE KWAKU WORAE. You guided and inspired me the way to go. I will always remember you. May God Almighty grant your souls eternal peace and rest.

DECLARATION

I declare that the thesis hereby submitted to the University of Limpopo, for the degree of Doctor of Commerce in Accounting has not previously been submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged.

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WORAE T A (MR) **Date**

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ABSTRACT

This research examined the effect of carbon emissions reduction on financial performance of Johannesburg Stock Exchange's SRI companies. Empirical results of corporate fossil energy-based dependence on environment and economic performance thus far have been ambiguous. The major objective of this research was to examine the effect of emissions and energy intensity on market and accounting based performance measures. This research adopted the positivist paradigm approach and therefore used a quantitative causal research approach. Archival data was collected from fourteen JSE's SRI companies for seven years. The research applied a panel data analysis, a total of 98 observations were derived from panel data set. Multiple linear and causal econometric models were applied in the data analyses namely ordinary least squares (OLS), fixed effects and dynamic models. OLS results showed a significant effect of energy usage intensity (ENGINT) on return on assets (ROA), and return on sales (ROS), with carbon emissions intensity (EMSINT) exhibiting a significant effect on return on assets (ROA), and return on sales (ROS). When the study controlled for omitted variable bias and possible orthogonality condition, a significant negative effect of energy intensity (ENGINT) on equity returns (EQRTNS) was found. Impulse response analysis revealed that shocks in energy intensity on average tend to decrease firms' financial value, while shocks in emissions intensity on average increase firms' financial value within the sampled companies. Whilst testing for causality, the Panel Granger causal analysis showed unidirectional effect of EMSINT on EQRTNS, and bidirectional causal relationship between EMSINT and MVE/S at 1% significant level. This research made a contribution by extending the model used by previous researchers through the use of multiple market and accounting based performance measures which were analysed using advanced econometric models: Arellano-Bond DPD model, impulse response function in short PVARs and Bootstrap dynamic panel threshold model. In addition, this thesis suggested a model to advance future research on carbon emissions and firm performance and managerial decision propensity for carbon reduction.

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LIST OF ABBREVIATIONS

A-BOND	Arellano-Bond Estimation
ADF	Augmented Dickey-Fuller
ASSETS/S	Assets Deflated by Sales
CAAA	Clean Air Act Amendments
CDP	Carbon Disclosure Project
CEP	Corporate Environmental Performance
CFP	Corporate Financial Performance
CIIN	Carbon input intensity
COIN	Carbon output intensity
CSP	Corporate Social performance
DPD	Dynamic Panel Data
ENGINT	Energy intensity
EMSINT	Emissions intensity
EQRTNS	Equity Returns
FE	Fixed Effects
GHG	Greenhouse gas
GROWTH	Sales Growth
INDTYPE	Industry type
JSE	Johannesburg Stock Exchange

LEV	Leverage
LN	Natural Logarithm
MGH	Megawatt Hours
Mt	Metric Tonnes
MVE/S	Market Value of Equity deflated by Sales
‘N’	Cross-sectional dimension
OLS	Ordinary Least Squares
OPTINC	Operating income
ROA	Return on Asset
ROS	Return on Sale
R	Statistical software R
R&D	Research and Development
SEM	Structural Equation model
SPVARs	Short Panel Vector Autoregressions
SRI	Socially Responsible Investing
STATA	Statistical software STATA
‘T’	Time series dimension
USD	US Dollar

CHAPTER 1

INTRODUCTION

1.1 Background to the Study

Since their seminal presentations on capital structure effects on a firm's financial value (Miller and Modigliani,1963;1958), a great deal of time has been spent investigating into what influences firms' financial value especially from equity holders' perspective (e.g. Margaritis & Psillaki, 2010; Ebaid, 2009; Schauten & Spronk, 2006; Abor, 2005; Barclay & Smith, 2005). More recently, the issue of fossil-based energy sources' effect on the environment and firms' economic performance have become a pressing reality. Carbon emissions seemed to dominate the global debate due to the climate change, as the oxidised form of carbon is well known as a major greenhouse gas implicated in the projections of global warming (Department of Environment Affairs & Tourism, 2009; Pearce, 2003).

The Carbon Disclosure Project's (2014) Carbon Action Initiative annual report suggests that carbon emissions' reduction continue to generate return on investment of 33% creating United State Dollar (USD$) 15 billion in value.

Goldman Sachs (GS), (2009) sustainability report suggests that carbon emissions' effects on global climate change is driving the redistribution of value from firms that do not control their carbon input/ output successfully. The report cites that equity markets are beginning to recognise the impact the transition to a low carbon global economy is having on companies' competitive positions and long-term valuations.

Barley (2009) cites that credit rating companies have downgraded firms' debt, citing concerns over future business risks due to carbon emissions levels. The claims suggest that firms' energy usage/ emissions performance is critical in the determination of their risks profile, potential liabilities and economic performance.

The question of whether there is a linkage between a firm's ethical behaviour and its 'bottom line' then becomes an important research question, mostly because there is a belief among some scholars that ethics have no place in business, and that businesses only need to appear ethical to preserve legitimacy bestowed by society (Wagner et al., 2002; Friedman, 1970).

The cost-concerned school of thought argues that increased environmental investments and expenditures and associated high environmental performance only add up to firms' cost, decreased earnings and lower firms' market value. On the contrary, the value creation school of thought regards environmental efforts as a way to increase corporate competitive advantages to improve financial returns to the investor (Assabet Group, 2000).

These stances are rooted in the mixed empirical findings on how environmental performance affects firms' financial performance, with some studies reporting a positive relationship (e.g. Bansal & Gao, 2006; Konar & Cohen, 2001; Dowell et al., 2000; King & Lenox, 2000; and Klassen & McLaughlin, 1996), neutral relationship (e.g. Elsayed & Paton, 2005) and negative relationship (e.g. Ziegler et al., 2009; Joshi et al., 2005; Khanna et al., 1998).

The conflicting findings marshalled in support of the view that carbon emissions reduction is a cost burden and detrimental to corporate competiveness (e.g. Walley & Whitehead, 1994; Jaggi & Freedmann, 1992) or that reduction in carbon emissions increases efficiency, saves resources and gives a cost advantage (e.g. Konar & Cohen, 2000; Dowell et al., 2000). This poses a challenge to most companies as some investors are hesitant towards green investments, perceiving such investments as not that viable to yield good returns (Carbon Action, 2013;

Yemshanov et al., 2007). These make impact assessment of transition to low carbon economy on companies' competitive positions and valuation more difficult.

1.2 Statement of the Research Problem

The confronting problem is that there have been mixed, inconsistent and contradictory evidence marshalled in support of the view that environmental efficiency is a cost burden and detrimental to corporate competiveness, or that reducing carbon emissions increases efficiency, saves resources and cost and gives a competitive advantage. If empirical evidence on the environmental efficient effect on financial performance has been consistent, the implication could have been that there is a common underlining factor(s) influencing sustainability performance effect on corporate financial performance. This might have tilted the direction of the sustainability-financial performance debate with its effect on global climate change.

Nonetheless, Barnett and Salomon (2006), Telle (2006), Allouche and Laroche (2005), and McWilliams and Siegel (1999) have expressed doubts about the conflicting and mixed empirical findings, and the conclusions drawn thereof, pointing out theoretical and empirical limitations related to models used in surveys, size and significance of the samples and indicators of sustainability and financial performance. Alternatively, Orsato (2006), Schaltegger and Synnestvedt (2002), and King and Lenox (2000) suggest that focusing on the effect of sustainability engagement 'types' on financial performance and 'when' sustainability performance pays financially, it might have contributed to resolving the ever continued unresolved sustainability/environmental-economic performance conundrum.

As companies' dependence on fossil energy sources and associated Greenhouse Gas (GHG) emissions have been recognised as a major problem, but empirical findings of the fossil-energy sources' dependence effect on the environment and corporate economic performance have been ambiguous, this study bridged the gap by examining the financial implications of: Physical energy usage/ emissions reduction; shocks in energy usage/ emissions reduction, and physical energy usage/ emissions thresholds of Johannesburg Stock Exchange's (JSE's) Socially Responsible Investing (SRI) firms. Furthermore, the focus of this research makes it distinct and unique from previous studies in South Africa (e.g. Mutezo, 2014; Van den Berg et al., 2013; Eccles et al., 2009). The researcher believes this study will provide needed support for policy making and investment decisions of companies and investors in their efforts to achieving a balance between sustainability and financial performance for the good of society.

1.3 Research Questions

The inconsistencies in empirical research findings prompt a number of important questions including:

(i) How does carbon output intensity reflect market-based performance measures of JSE's SRI firms?

(ii) How does carbon output intensity affect accounting-based performance measures of JSE's SRI firms?

(iii) How does carbon input intensity reflect market-based performance measures of JSE's SRI firms?

(iv) How does carbon input intensity affect accounting-based performance measures of JSE's SRI firms?

1.4 Research Aim and Objectives

1.4.1 Aim of the study

Drawing from the background to the study, the carbon emissions reduction effect on the financial performance of JSE's SRI index manufacturing and mining companies from 2008 to 2014 was investigated.

1.4.2 Objectives of the study

In the attempt to achieving the aim of the study, and drawing from the research questions, the study sets up the following specific research objectives to:

i. Examine how carbon output intensity reflects market-based performance measures of JSE's SRI firms.

ii. Assess carbon output intensity effect on accounting-based performance measures of JSE's SRI firms.

iii. Determine how carbon input intensity reflects market-based performance measures of JSE's SRI firms.

iv. Evaluate carbon input intensity effect on accounting-based performance measures of JSE's SRI firms.

1.5 Definitions of Terms

Carbon intensity: Refers to company's physical carbon performance and describes the extent to which firms' business activities are based on carbon related energy usage (carbon input intensity) and emissions (carbon output intensity) for a defined scope and fiscal year (Hoffmann and Busch, 2008).

Carbon input intensity: Also known as energy intensity, measures the ratio between total energy consumption in megawatt hours (in MGW h) and a firm's level of activities (Hoffmann & Busch, 2008).

Carbon output intensity: Also known as emissions intensity, measures the ratio between total GHG emissions in metric tonnes (Mt) and the firm's level of activities (Hoffmann &Busch, 2008).

Return on assets: Is a measure of the success of a firm in utilising assets to generate earnings independent of the sources of financing of those assets (Selling and Stickney, 1989).

Return on sales: Is an accounting-based measure designed to gauge the financial health of a business. It is defined as the ratio of profits earned to total sales receipts (or costs) over a defined period of time (Holmes et al., 2005).

Equity returns: Generally refers to the gain or loss on the security in a particular period. The return may consist of income/ capital gain relative to the investment. In this study equity returns refers to the capital gain relative to the security in a particular time period (Dragomir, 2010).

Market value of equity deflated by sales: The measure refers to the total market value of all of a company's outstanding shares divided by its sales revenue. It is calculated by multiplying the company's current equity price by its number of outstanding shares, and dividing this by sales revenue (Johnston et al., 2008). Market value of equity changes with a change in any of the two inputs, since companies' market value of equity does not consider the growth potentials of a company. This study purposely deflated market value of equity by sales to include effect of firms' potential growth on market value of equity.

Threshold: The concept refers to the magnitude/ intensity that must be exceeded for a certain reaction, phenomenon, result or a condition to occur (Hansen, 1999).

Impulse Response function: Refers to a reaction of any dynamic system in response to some external change (Cao & Sun, 2011).

Accounting-based performance measures: Refer to firms' internal financial performance (Dragomir, 2010). In this study it is measured by return on assets (ROA) and return on sales (ROS).

Market-based performance measures: Refers to a firm's external performance on the stock market (Dragomir, 2010). In this study it is measured by equity returns (EQRTNS) and market value of equity deflated by sales (MVE/S).

1.6 Structure of the Study

The remainder of the thesis is structured as follows:

Chapter 2

This chapter is divided into two main sections. Section 1 discussed theoretical arguments as to why firms behave ethically in their operational activities to create wealth for ownership. The section provides the theoretical foundation underpinning the study, which includes stakeholder, legitimacy, political economy, and resources-based and institutional theories, together with related legal frameworks in South Africa. Section 2 examines empirical literature on sustainability/ environmental performance and economic performance from global and South African perspectives.

Chapter 3

This chapter encompasses the research paradigm/design, type of data and instrument for data collection. Population, sample size and eligibility criteria of the study are similarly spelt out in the chapter. Validity and reliability issues are discussed in the chapter together with data analysis procedures and estimation techniques. Lastly, measures for carbon intensity and financial performance and previously applied statistical models are also discussed in this chapter.

Chapter 4

Chapter 4 presents results and analyses of the study. The chapter is divided into five sub-sections based on the specific objectives of the study.

Chapter 5

Chapter 5 comprises of the summary of the study, contributions from the study, recommendations and conclusion of the study.

1.7 Significance of the Study

This study is significant because it provides needed support for policy makers and investors in their decision making when evaluating sustainability activities relative to economic policies. It also provides a guide to practitioners and policy makers as to how their carbon footprint can be managed without endangering corporate financial performance for the good of society and the environment. The study also serves as a test case for emerging economies that have not instituted Carbon Tax and Emissions Trading Scheme as in the case of South Africa. Thus, the findings shed more light from the perspective of emerging markets without the purported cost and benefits of Emissions Trading Scheme and Carbon Tax in the attempt to managing the carbon footprint. The study is also significant as it bridges the gap in knowledge in the South African literature on how carbon intensity reduction affects corporate financial performance. Finally, the application of varied statistical and econometric concepts/ideas and techniques to a traditional accounting problem is a noteworthy contribution that could attract future researchers to undertake a multidisciplinary research.

CHAPTER 2

THEORETICAL AND EMPIRICAL LITERATURE

2.1 Introduction

This chapter consists of two sections. Section one spells out theoretical arguments behind why firms behave ethically in their operational activities to create wealth for ownership. The chapter provides theoretical foundation underpinning the study including: Stakeholder, Legitimacy, Political economy, Institutional and Resources-based theories together with related legislative frameworks in South Africa that enjoins firms to be ethical in their operations. The second section presents a review of previously related empirical literature. These include previous research findings on the carbon output intensity (emissions intensity) effect on accounting and market-based performance measures, and the carbon input intensity (energy usage) effect on accounting and market-based performance measures.

2.2 Sustainability Accounting Research in Perspective

Although a large number of studies have been undertaken to examine the effect of sustainability performance on corporate economic performance, the studies can be categorised into two general areas: The first area in which these studies focused was on examining theoretical arguments as to why firms behave ethically in their operational activities to create wealth for ownership. For example, DiMaggio and Powell (1983), and Friedman (1970) argue that firms are purely economic institutions whose motive is to provide goods and services but at a price the general public is prepared to pay. In the performance of these functions however, firms are expected to judiciously utilise resources so as to increase the society's wealth. Implied in this, firms whose apparent behaviour is incongruent with societal expectations may thus suffer through consumer and/ or supplier boycotts, or a legislative action to curtail the aberrant behaviour. This counter-action, the authors point out, may affect expected firm's future cash flows and hence the value.

The second area on which these studies have focused was examining “if it pays to be green”, “when it pays to be green”, and sustainability engagements types that pay. In this area, studies have empirically examined effect sustainability performance on firms’ financial performance. These studies have employed sustainability measures such as: emissions intensity, energy usage intensity, carbon investment and expenditure and environmental strengths and concerns among others, with most of these studies utilising financial performance measures such as: return on assets (ROA), return on equity (ROA), market value of equity (MVE), equity returns (EQRTNS), Tobin’s Q, return on sales (ROS), economic value added (EVA) amongst other financial measure (Telle, 2006; Matsumura et al., 2011; King & Lenox, 2000; and Konar & Cohen, 2001).

Nonetheless, empirical findings in this area of research have provided mixed and conflicting findings. With the ‘’cost-concerned school’’ arguing that sustainability investments and high sustainability/ environmental performance represent an increased costs resulting in decreased earnings and lower market value (Busch & Hoffmann, 2011; Matsumura et al., 2011; Ziegler et al., 2009; Joshi et al., 2005; Khanna et al., 1998; Walley & Whitehead, 1994; and Jaggi and Freedman, 1992).

The ‘’value creation school’’ on the other hand regards sustainability efforts as a way to increase corporate competitiveness to improve financial returns to the investors (Bansal & Gao, 2006; Konar & Cohen, 2001; Christmann, 2000; King & Lenox, 2000 ; Konar & Cohen 2000; Dowell et al., 2000; and Klassen & McLaughlin, 1996).

On the contrary, Horvathova (2010), and Elsayed and Paton, (2005) among other researchers found a neutral relationship between sustainability pro-activeness and corporate economic performance.

The conflicting empirical evidence marshalled in support of the view that sustainability pro-activeness is a cost burden and detrimental to corporate competiveness (Walley & Whitehead, 1994; Jaggi & Freedmann, 1992) or that reduction in carbon emissions increases efficiency, saves resources and gives cost advantage (Konar & Cohen, 2000; Dowell et al., 2000), or that sustainability pro-activeness is neutral to firms' economic performance (Horvathova, 2010; Elsayed and Pato, (2005) seem paradoxical. This seeming paradox makes impact assessment of transition to a low carbon global economy on companies' competitive positions and long-term valuations difficult. This makes some investors hesitant towards green investments on the assumption that corporate sustainability investment/ expenditure may not yield positive financial returns (Carbon Action, 2013; Yemshanov et al., 2007).

Notwithstanding, Barnett and Salomon (2006), Telle (2006), and McWilliams and Siegel (1999) amongst other researchers have expressed doubts about the conflicting findings and have pointed out theoretical and empirical limitations related to statistical models used in these surveys, size and significance of the samples together with sustainability and economic performance indicators. Horvathova (2010) suggests that the inconclusiveness of empirical research findings on the impact of sustainability performance on financial performance may be due to underlying factors. The author indicates that the probability of obtaining a negative association between sustainability management practices and financial performance increases when using correlation coefficients exists. While the application of panel data techniques and multiple regressions show a neutral effect on the outcomes.

Furthermore, Schaltegger and Synnestvedt (2002) suggest that focusing on sustainability engagement 'types' and how the 'types' affect economic performance could help tilt the direction of the sustainability-financial performance conundrum. Orsato (2006), and King and Lenox (2000) similarly suggest that investigating into ‘when’ sustainability pro-activeness pays instead of finding answers to the question ‘does it pay to be green’ may be the way forward to finding answers to the sustainability-economic performance conundrum.

Since corporate dependence on fossil energy sources and associated GHG emissions have been recognised as a major problem, while empirical findings on the fossil-energy sources dependence effect on the environment and firms’ economic performance have been ambiguous, this study bridged the gap by examining the financial implications of firms’ physical energy usage intensity (carbon input intensity) and emissions intensity (carbon output intensity); shocks in physical energy usage intensity (carbon input intensity) and emissions intensity (carbon output intensity), and physical energy usage intensity (carbon input intensity) and emissions intensity (carbon output intensity) threshold effect on JSE’s SRI firms. Bridging this gap, it is believed will provide the needed support to policy makers and investors to strike the balance between sustainability pro-activeness and economic performance.

2.3 Theoretical Foundation

This section presents general theoretical arguments and legislative frameworks specifically enjoining JSE’s SRI firms to behave ethically in their operational activities which are relevant and underpin this study.

2.3.1 Legitimacy Theory

This theory suggests that firms should aim to achieve congruence between financial objectives and the accepted social norms. The concept revolves around an implicit contract between firms and society, agreeing to perform socially desirable actions in return for society’s approval of objectives and ultimate survival (Branco & Rodrigues, 2006; Magness, 2006; Guthrie & Parker, 1989). This is because theoretical literature argues that legitimacy is conferred and controlled by those outside the firm. Matsumura et al, (2011), and Dowling and Pfeffer, (1975) argue that firms, being abstract entities created by society, must demonstrate their legitimacy to society to survive in the long run.

Matsumura et al. (2011), and White and Mazur (1994) suggest that firms should not only have to get themselves in environmental shape but should be seen to do so if they are to survive in the long term. Branco and Rodrigues (2006); Magness, (2006); Guthrie and Parker, (1989) argue that since there exists an implicit contract between firms and society, with firms agreeing to perform socially desirable actions in return for society's approval of objectives and ultimate survival, firms should be seen executing their part of this implicit contract.

The theory is applicable to this study because in the attempt to explore whether JSE's SRI companies' engagement in sustainability activities can be said to be out of a pure legitimacy drive or whether financial gains are embedded in environmental activities. If financial gains are found to be the driving force of firms' sustainability efforts, then one can assume that not all firms engage in sustainability activities for legitimacy purposes as inferred in some literature.

2.3.2 Stakeholder Theory

Theoretical literature (Brammer & Millington, 2008; Munilla and Milles, 2005; Phillips, 2003; Freeman, 1984) suggests that firms' success is dependent on the success of management's ability to manage relationships of firms with its stakeholders. The view renders the conventional idea that the success of the firm is dependent solely upon maximising shareholder value insufficient. Jensen and Meckling, (1976) argued that firms are perceived to be a nexus of explicit and implicit contracts between itself and the various interest groups. This explains why firms undertake environmental and other social engagements seriously in the attempt to fulfilling their part of the contract (Cho & Patten, 2007). Stakeholder theory is applicable to this study because firms are regarded as stakeholders to the environment. Hence, the consideration of their sustainability activities is considered alongside their accruable financial benefits as a stakeholder has to benefit from the sustainability that it supports. Amongst empirical studies that have investigated stakeholder effect on firms' sustainability practices and economic performance include; Misani and Pogutz (2015), Vasi and King (2012), Barnett et al. (2012), Zeng et al. (2011), and Bird et al. (2007).

2.3.3 Political Economy Theory

Buhr (1998) argues that accounting systems act as mechanisms to create, distribute and mystify power based on the economic theory of self-interest. Hence, the emergence of pressure groups creates threats to companies who may face increased government intervention in the form of regulatory action which could create ''political costs'' (Cho & Patten, 2007; Deegan, 2002; Williams, 1999; Whittred et al., 1996). Watts and Zimmerman, (1978) cited that to prevent government intervention in the form of regulatory action firms resort to lobbying and putting up socially responsible behaviours. It is against this background that Cho and Patten (2007), and Frost (2000) argue that corporate sustainability pro-activeness and disclosures are "pre-emptive'' and are used to enforce agenda to stave off government's intervention. Political economy is relevant to this piece of work because the survival of the JSE listed firms could be incidental to the ability to pursue economic gains while adhering to socio-political demands of society. For example, JSE and KING III require listed firms to disclose their sustainability/ environmental performance which encourages listed firms to engage in responsible investments, business practices and operations that gear toward their sustainability development.

2.3.4 Resource-Based Theory

It is believed that differences in firms' sustainability performance hinges on the availability and capability of resources acquirement (Barney,1991&1986;

Wernerfelt, 1984), and that firms gain sustained competitive advantage if they possess distinct and valuable resources (Barney, 1991). Cohen and Levinthal (1990), and Direckx and Cool (1989) argue that corporate resources are categorised into those that build a positive reputation over a long period of time that cannot easily be shortened by competitors, or resources built on know-how that can be readily re-combined into new resources, that makes copying by competitors very difficult if not impossible.

Russo and Fouts (1997) argue that firms create sustainable competitive advantage from these resources through opting to reduce pollution by changing design processes that may give a sustainable competitive advantage over firms that only install filtering equipment. Therefore, Branco and Rodrigues (2006) suggest that firms engage in corporate social responsibility due to the competitive advantage they enjoy from social responsibility activities. This confirms that investing in social responsibility activities has consequences for the creation/ depletion of the firm's fundamental intangible resources.

Resource-based theory is applicable to this study as the environment is a seemingly free resource to firms which, although free, should not unsustainably be exploited. Some empirical studies that have examined how resource capacity and availability influence corporate sustainability performance and economic performance include KI-Hoon and Byung (2015), Endrikat et al. (2014), Qi et al. (2014), Eccles et al. (2009), and Wahba (2008).

2.3.5 Institutional Theory

Institutional theory is a concept that explains why and how firms behave in a particular manner. The concept is primarily a sociological view of firms' operational practices and focuses on the relationship between organisations and the environments in which they operate (Scott, 2001; Greenwood & Hinings, 1996;

DiMaggio & Powell, 1991). The theory posits that corporate structures together with operational practices are directed by pressures from interested parties who expect to see particular practices in operation (DiMaggio & Powell, 1991, 1983).

Deegan (2009) posits that corporate practices and policy responses are situational as they respond to social and institutional pressures in order to conform to prevailing socio-political and economic expectations to maintain legitimacy. Selznick (1957) cites that institutionalisation provides and promotes value, stability and persistence of a structure over time and provides platforms for firms' efficiency (Scott, 1987).

Berger and Luckmann (1966) argue that institutions are social structures of reality, and emphasised the symbolic value of institutionalisation citing that organisations adopt certain patterns of behaviour and practice to be considered legitimate in the environments in which they operate rather than to achieve efficiency (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). Therefore, the motive of efficiency is not sufficient to explain similarities among organisation as postulated by Scott (1987). Alternatively, Meyer and Rowan (1977) suggest that organisational structures are the reflection of myths of the firms' environment instead of the demands of their operational activities. This is to say that for firms to be accepted by society, institutional rules, structures and procedures serve as the function of powerful 'myths' that firms adopt, in spite of the fact that the institutionalised rules may sometimes conflict with firms' efficiency (Meyer & Rowan, 1977). Should an organisation choose to enhance internal processes at the expense of society, this may lead to reduced legitimacy and the environment's support. Institutional theory is relevant to this study as it tends to explain why companies attempt to attain the balance between sustainability engagements and economic performance by developing integrated/ multifaceted corporate structures and policies that help to meet stakeholder demands as well as building internal structures to enhance corporate efficiency. Amongst empirical studies that have their basis rooted in the concept of institutionalism and contingency theories sustainability accounting research include Feng et al. (2016), Li (2014), and Dixon-Fowler et al. (2013).

2.3.6 Legislative Framework in South Africa

Regulatory frameworks across nations that enjoin firms to be ethical and carbon emissions conscious in the quest to slow down global climate warming is also said to explain reasons behind firms' sustainability pro-activeness. Amongst regulatory frameworks that enforce environmental related measures to protect the South African environment relevant to this research include; The National Environmental Management Act, 1998, [as amended] which provides the foundation for the development of policy and regulatory frameworks for Environmental Management in South Africa; Minerals and Petroleum Resources Development Act, 28 of 2002 [as amended], which calls for mining firms to develop an environmental management programme and plan (Chapter 2, part III, sections 51 and 52 of this Act require mining companies to provide for financial costs for rehabilitating the environment after cessation of operations and also to provide for financial costs to mitigate environmental disasters should they occur); and the Proposed Carbon Tax Policy of 2013, which seeks among other things to foster early development and/or implementation of cleaner technology that seeks to enhance the development of technologies for capturing and storing carbon.

Furthermore, KING III (2009) enjoins JSE listed firms to disclose the extent to which their activities have impacted the environment. The disclosure of sustainability impact of JSE's SRI firms provides the archival data that is used in the analysis of this study.

2.4 Empirical Literature

This section presents a review of related empirical literature. This includes previous research findings on carbon output intensity (emissions intensity) and accounting/

market-based performance measures, and carbon input intensity (energy usage intensity) and accounting/ market-based performance measures.

2.4.1 Carbon Output Intensity (Emissions) and Financial Performance

In this section carbon output intensity (emissions) and financial performance is reviewed against two sets of financial performance measures (market based performance measures and accounting based performance measures). The first section (2.4.1) reviews the literature on the relationship between carbon output intensity and market-based performance measures. The second section (2.4.2) reviews the literature on the relationship between carbon output intensity and accounting-based performance measures.

2.4.1.1 Carbon Output Intensity and Market-Based Performance Measures

Carbon output intensity, also known as emissions intensity as applied in this study, refers to the level of carbon emitted by firms relative to the levels of their activities. Activities refer to the firms' sales revenue, while market-based performance refers to the firms' performance on the stock market. In this study market-based performance is measured by equity returns (EQRTNS) and market value of equity deflated by sales (MVE/S).

Sustainability accounting research in the past few decades examined carbon intensity's (carbon output intensity and carbon input intensity) effect on corporate economic performance but thus far provided mixed and conflicting findings as exhibited in the findings from the review of this literature. For example, on the issue of how a specific outcome (i.e. carbon emissions) and process dimensions of sustainability performance affect financial performance measured by Tobin's q, found that carbon emissions affect financial performance (Tobin's *q)* non-linearly. Studies have also found that firms achieve the highest financial performance when carbon performance is neither low nor high, but intermediate, and that environmental/ sustainability processes moderate this relationship as they reinforce a firms' financial performance through improved stakeholder management. The conflicting picture shows that firms do not generally internalise costs of poor carbon performance, but those that stand out in both environmental outcomes and processes achieve net financial benefits.

On the issue of value relevance of environmental disclosure and sustainability performance, a study on Malaysian companies which account financial attributes of companies with different environmental disclosure scores and corporate attributes including size, the need for capital, profitability and capital spending, found that high quality environmental disclosure is positively linked to environmental performance and is value relevant. Findings indicate that corporate attributes are positively associated with environmental disclosure quality and high quality environmental disclosures display effective corporate governance and such companies have easy access to capital markets (Misani & Pogutz, 2015; Iatridis, 2013).

Extending Hughes' (2000) work of firm-value relevance of sulphur emission allowances held by publicly-traded U.S. electric utilities which are subject to the Emissions Trading Scheme put into place by the 1990 Clean Air Act Amendments (CAAA), Johnston et al. (2008) supports the reasoning that the emission allowances have two components relative to asset value and a real option value that is valued by the market. On the issue of economic consequences of the Emissions Trading Scheme (ETS) and investor expectations towards the regulatory impact on firm value, it was found that returns on common stock of the largest affected industry (power generation) are positively correlated with rising prices for emission rights (Veith et al., 2009)

Employing median regression to account for the presence of outliers and unobserved firm heterogeneity, Salama (2005) examined the corporate sustainability performance effect on financial performance using panel data for

British companies found that the relationship between sustainability performance and firms' financial performance is stronger when outliers and unobserved omitted variable are accounted for.

Marti-Ballester (2014), comparing financial performance of Spanish pension plans to market benchmarks and taking into account the category to which they belong and differences between socially responsible business strategy and financial performance using 651 system pension plans and employing random effects panel data methodology, found that ethical pension plans which invest in companies that improve their cleaner production methods, achieve financial performance similar to conventional pension plans, while solidarity pension plans significantly outperform conventional pension plans.

Investigating the direct effect of industrial sustainability performance on financial performance and indirect effects of industrial munificence and resource slack on the environmental performance on financial performance link, Qiet et al. (2014), utilising the dataset from Chinese industrial firms, found that improvement in corporate industrial-level environmental performance significantly influences financial performance and that slack resources play a significant role in the environmental performance-financial performance link. The paper however found no significant moderating effect of industrial munificence on the link.

In the context of social responsibility effect on firm value and profitability in the studies that have employed the Durbin–Wu–Hausman (DWH) test and a two-stage least squares (2SLS) estimation found simultaneous and positive relationship with financial performance. Findings from Casino companies show that corporate social responsibility has no simultaneous or particular effect on financial performance, suggesting that Casino companies can increase corporate social responsibility investment to enhance profitability and firm value (Lee and Park, 2009).

Analysing the impact of the variation in carbon emissions on financial and operational performance, Gallego-Alvarez et al. (2014) found that reduction in emissions generates a positive impact on financial performance. After accounting for company size, sector, growth, sustainability index, and legal system, the results showed that companies exhibit greater environmental behaviour in order to obtain higher financial performance.

Investigating into the driving forces (e.g. social/ market driving forces, government incentives) and the associated pollution performance effect on economic performance of SMEs in northern China, Zeng et al. (2011) found that highly polluted SMEs' driving forces are shown to have a significant effect on sustainability performance. The study also found that internal and market driving forces provide a positive effect on the economic performance, while social forces have a negative effect on the SMEs with light pollution. Furthermore, it was found that the internal driving force does show a significant effect on the environmental performance. It was also found that environmental performance and economic performance of SMEs within all pollution classes show a positive relationship. Furthermore, environmental performance seemed to moderately correlate with financial indices, but not with non-financial indices.

On the issue of how shareholder value affects environmental performance measured by stock market reaction associated with announcements of environmental performance in terms of: (i) announcements of Corporate Environmental Initiatives (CEIs) that provide information about self-reported corporate efforts to avoid, mitigate, or offset the environmental impacts of the firm's products, services, or processes, (ii) announcements of Environmental Awards and Certifications (EACs) that provide information about recognition granted by third-parties specifically for environmental performance, showed that although the market does not react significantly to the aggregated CEI and EAC announcements, statistically significant market reactions for certain CEI and EAC subcategories were found. For example, announcements of philanthropic gifts for environmental causes are associated with significant positive market reaction, voluntary emission reductions are associated with significant negative market reaction and ISO 14001 certifications are associated with a significant positive market reaction. The difference between the market reactions to the CEI and EAC categories is statistically insignificant. The findings indicate that the market in general is selective in reacting to sustainability performance announcements (Jacobs et al., 2010).

Studies have also found that markets attach an implicit cost to carbon emissions, even if there is currently no explicit cost confirming the argument that capital markets reward firms that reduce their carbon emissions, and that firm value is negatively associated with carbon emission performance. Using the information release of the Toxic Release Inventory for Events Investigated found that stock markets react negatively to the release of information about high polluting firms. Using reports on environmental clean-up in the Wall Street Journal from 1989 to 1993 showed that the actual stock performance for concerned companies was lower than the expected market adjusted returns. This seemed to indicate that firms' unethical conduct, if discovered and publicised, does negatively affect stock value for an appreciable period of time (Matsumura et al., 2011; Rao, 1996). When financial performance is disaggregated into accounting and market-based measures, studies have shown that increased carbon emissions levels showed a positive effect on accounting-based measures of financial performance and a negative effect on the market-based measures (Matsumura et al., 2011).

Examining the inter-temporal effect of environmental performance on financial performance and firm level data from the Czech Republic, Horvathova (2012) found that while the effect of environmental performance on financial performance is negative for environmental performance lagged by 1 year, but tends positive for a 2 year lag. While empirical mean-variance evidence comparing socially responsible investments (SRI) to conventional investments indicated that there is no significant difference between the two.

Applying socio-political causes of shifts in risk perceptions and consequences of the changes, Vasi and King (2012) applied a social movement theory to explain the effect of environmental activism on firms' perceived environmental risk and actual financial performance. Using environmental activism data from U.S. companies for 2004-2008, the study examines variation in effectiveness of stakeholder activism in shaping perceptions about environmental risk and finds that stakeholder activism against firms affect the perceived environmental risk and negatively affects corporate financial performance (Tobin’s q).

Exploring the environmental research and development investment effect on corporate financial performance utilising panel dataset of 362 firms from 2003–2010, using a fixed effect model, Ki-Hoon et al. (2015) found that carbon emissions persistently decrease firm value. It was also found that the market ‘penalises’ firms′ negative sustainability performance more consistently than its positive performance.

On how the market reacts to the National Emissions Trading Scheme (ETS), Chapple et al. (2009) found that 58 high and low emissions intensity publicly-traded firms in Australia could be affected by the proposed National Emissions Trading Scheme’s (ETS) schedule for 2011, and that the market penalises firms that will be affected by the proposed ETS, and more specifically relative to lower carbon-intensive firms.

On how corporate responsibility relates to corporate financial performance, recent studies have demonstrated that there is no direct relationship between corporate social responsibility and financial performance. They therefore conclude that most previous empirical findings indicating a positive relationship between social and financial performance may be spurious as researchers failed to account for the mediating effects of intangible resources. For example, Surroca et al. (2010) found no relationship between social responsibility and corporate financial performance using a database comprising 599 companies from 28 countries. Having accounted for intangible resources the authors conclude that the relationship is merely an indirect relationship that relies on the mediating effect of a firm's intangible resources.

Employing nine different sustainability measures studies have shown that a high and a low polluter portfolio investor received neither a premium nor a penalty for investing in highly environmentally pro-active firms (Joshi et al., 2005; Khanna et al., 1998; Cohen et al., 1997).

On how stock reacts to the announcements of environmental regulation, Ramiah et al. (2013) found that equities listed on the Australian Stock Exchange over the period 2005–2011 were particularly sensitive to the carbon pollution reduction scheme (CPRS) announcement. It was also found that a move towards a greener nation has a mixed effect on abnormal returns with apparent sector-by-sector differences. Green policies however appear to affect the long-term systematic risk of industries, leading to what is known as the diamond risk phenomenon. The study used data of 89 Australian companies for the period 2006–2009 and employed a panel data methodology.

When the issue of waste and greenhouse gas of Japanese manufacturing firms from 2004 to 2008 is examined, capturing the effects of corporate environmental management on market valuations, Iwata and Okada (2011) found that waste does not have significant effects on financial performance. Greenhouse gas reduction however leads to an increase in market performance in the whole sample, but does not show significant effects on financial performance in dirty industries.

2.4.1.2 Carbon Output Intensity and Accounting-Based Performance Measures

Accounting-based performance in this study refers to firms' internal financial performance and is measured by return on assets (ROA) and return on sales (ROS), while carbon output intensity is as described in the preceding section.

Analysing how Greenhouse gas emissions relate to accounting-based performance (measured by ROA & ROS), Rokhmawati et al. (2015) using annual financial reports and fossil energy consumption data from Indonesian companies found a positive effect of emissions intensity and social reporting scores on return on assets (ROA). Fujii et al. (2012) examined the relationships between sustainability performance and economic performance in Japanese manufacturing firms. Using a sustainability performance indicator measured by carbon emissions and the aggregate toxic risk associated with chemical emissions relative to sales and return on assets (ROA) demonstrated that there is a significant, inverted U-shaped relationship between ROA and sustainability performance calculated by aggregated toxic risk. Furthermore, the study found that the sustainability performance increased return on assets (ROA) through returns on sales (ROS) and capital turnover improvement.

Applying panel data from 1991-2009 from KLD database and THOMSON ONE, Patari et al. (2014) assessed whether investment in corporate social responsibility reflects financial performance in the energy industry using the Granger causality analysis between corporate social responsibility strengths/ concerns and financial performance. The results show that while corporate social responsibility concerns Granger-cause profitability and market value, corporate social responsibility strengthens only Granger-cause market value.

On how environmental performance/ social responsibility disclosure relates firms' economic performance, Angelia and Suryaningsih (2015), using companies that are listed on the Indonesia Stock Exchange, and under PROPER found a significant effect of environmental performance on ROA and ROE for gold ratings, with CSR disclosure showing a significant effect on ROE, but not on ROA. Furthermore, sustainability performance/ corporate social responsibility disclosure showed a significant effect on ROA and ROE.

On the relationship between emissions reduction and the firm's economic performance, Nishitani et al. (2011), employing panel data of Japanese manufacturing firms from 2002-2008, found that firms that have reduced pollution emissions increased their economic performance through the increase in demand for their products and an improvement in productivity.

Testing the assertion that environmental munificence and dynamism moderate discretionary social responsibility effect on economic performance, Goll and Rasheed (2004) sampled 62 firms through questionnaires for discretionary social responsibility data, and archival sources for financial performance (ROA & ROS) and environmental munificence and dynamism using moderated regression analyses and sub-group analyses. The findings showed a significant moderating effect of environmental performance on the social responsibility and financial performance relationship. The findings also indicate that discretionary social responsibility contributes to a firm's financial performance in environment that is dynamic and munificent.

Focusing on whether commitment of companies to stakeholders has a better relationship with financial results and determining the extent and pattern of corporate disclosure in the top listed companies in the ASEAN region, Waworuntu et al. (2014), using correlation analysis showed that there exist a significant negative correlation between environmental commitment (EC) and ROA in the energy sector. The paper finds that companies in the financial services sector provide a very limited amount of environmental disclosures and that their economic disclosure has a positive correlation with ROE and a significant positive relation between EC and ROA. The paper finds a moderate to strong positive correlation between variables when analysed as a whole, while the correlation result varies when broken down into individual countries and sectors.

Investigating into how change in corporate social responsibility relates to change in accounting-based performance measures, Ruf et al. (2001) found support for the assertion that a dominant stakeholder group, such as shareholders, enjoys economic gains when demands of multiple stakeholders are met. The paper also found that change in corporate social responsibility positively affects growth in sales for the current and subsequent period. The implications are that firms gain short-term benefits when they improve corporate social responsibility.

Studying the relationship between corporate social responsibility and financial performance of Islamic banks across thirteen countries utilising a corporate social reporting (CSR) disclosure index covering ten dimensions, Mullin et al. (2014) found a positive association between corporate social responsibility disclosure and financial performance. Further analysis using three stage least squares showed causality between the two endogenous variable runs from financial performance to corporate social responsibility disclosure, the indication that corporate social responsibility disclosure is determined by financial performance.

Analysing the role of corporate social responsibility disclosure (CSRD) in the annual reports on firms' financial performance, Dewi and SE (2015), focusing on mining corporations listed on the Indonesia Stock Exchange during 2013–2015, found that CSRD influences ROE. On the other hand, CSRD does not influence ROA.

Focusing on economic performance of companies listed on the sustainability index in comparison with the performance of companies listed on the Sao Paulo Stock Exchange index using profitability and liquidity ratios and employing cluster and non-parametric analysis, Santis et al. (2016) found no evidence of financial performance differences between companies from each of the indices.

Using Bloomberg's Environmental Social Governance (ESG) Disclosure score of S&P500 firms spanning from 2007-2011, Nollet et al. (2016) employed linear and non-linear models to assess the relationship between corporate social performance and financial performance measured by return on assets (ROA), return on capital (ROC) and Excess Stock Returns (ESR). The linear model suggested a significant negative relationship between corporate social performance and Return on Capital. The non-linear models showed a U-shaped relationship between corporate social performance and Return on Assets and Return on Capital. The findings indicate that in the longer run, corporate social performance effects are positive. Disentangling ESG disclosure score into environmental, social and governance sections, the study found a U-shaped relationship between the governance sub-component and financial performance.

Analysing the relationship between corporate social responsibility and financial performance measured by return on assets (ROA) and Tobin's q, Lioui and Sharma (2012) found significant negative relationship between corporate social responsibility strengths and concerns and firms' ROA and Tobin's q. When the interaction between firms' environmental efforts and research is accounted for, the results showed that while the direct impact of environmental and corporate social responsibility on financial performance is still negative, interaction of corporate social responsibility and research and development has a significant positive effect on financial performance. Corporate social responsibility strengths and concerns seemed to harm financial performance as they are perceived a potential cost. Nonetheless, corporate social responsibility activity is deemed to enhance research and development efforts of firms which are deemed to improve value.

On how environmental management practices (measured by carbon reduction, energy efficiency, and water usage) relate to financial performance (measured by return on equity), Nyirenda et al. (2013), utilising a case-based approach and employing multiple regression statistics confirmed that there is no significant relationship between environmental management practices in South Africa mining firms listed under the SRI and financial performance measured by return on equity (ROE).

2.4.2 Carbon Input Intensity (Energy usage) and Financial Performance Measures

In this section carbon input intensity (energy usage) and financial performance is reviewed against two sets of financial performance measures, that is market-based performance measures, and accounting-based performance measures. The first section (2.4.1) reviews the literature on the relationship between carbon input intensity (energy usage) and market-based performance measures. While the second section (2.4.2) reviews the literature on the relationship between carbon input intensity (energy usage) and accounting-based performance measures.

2.4.2.1 Carbon Input Intensity (Energy usage) and Market-Based Performance Measures

Carbon input intensity, also known as energy usage intensity in this study, refers to the energy usage level of firms relative to their activities. Firms' activities and market-based performance are as described in the preceding section. As highlighted in the earlier section, empirical findings from sustainability accounting research in the subject area thus far have provided mixed and conflicting results.

On environmental responsibility engagement and market value in the Egyptian context, studies demonstrate that the market compensates as it exerts significant positive coefficient on the market value measured by Tobin's q ratio. The finding aligns stakeholder theory and the resource-based theory arguments and provides supporting evidence for studies that have concluded that it pays to be environmentally responsive (Wahba, 2008). Similarly, Wingard and Vorster (2001) found a positive effect of environmental responsibility on corporate economic performance of South African companies on the SRI. Rodriguez and Cruz (2007) also found a strong positive relation between environmental performance and firm financial performance in the Spanish hotel industry.

Considering the rising prices of conventional energy and/or placement of price on carbon emissions to encourage investments in clean energy firms, data from three clean energy indices show that oil prices and technology stock prices separately affect the stock prices of clean energy firms. The result however failed to demonstrate a significant relationship between carbon prices and the stock prices of the firms. Furthermore, on how membership on the sustainability Index reflects in firms' market value of equity using Dow Jones sustainability index, findings indicate that membership in the sustainability performance index has significant explanatory power for stock prices over the traditional summary accounting measures such as earnings and book value of equity (Lourenco et al., 2012; Kumar et al., 2011).

Examining the relationship between socially responsible investment (SRI) and stock investment returns and performance of initial public offerings (IPOs) and seasoned equity offerings (SEOs), empirical tests documented positive and statistically significant excess returns for environmentally-friendly firms and their IPOs and SEOs. It was also found that the equity premium is evident in returns calculated from a variety of benchmarks (Chan and Walter, 2014). Whether corporate virtue in the form of social responsibility pays, meta-analysis of 52 studies representing a total sample size of 33,878 observations examined to what extent environmental responsibility is likely to pay off, although the operationalisation of social responsibility and corporate financial performance moderate the positive association (Orlitzky et al, 2003).

Assessing how management's overall strategy affects environmental disclosure/ environmental performance and economic performance, and endogenising the corporate functions in simultaneous equations, Al-Tuwaijri et al, (2004) found that good environmental performance is significantly associated with good economic performance.

Categorising data into ‘‘hard data’’ and ‘’perceptual data’’ and examining the relationship found that listed firms show responsible business practices and better financial performance than the non-listed firms. Controlling confounding effects of stock-listing, ownership and firm size, a favourable perception of managers towards corporate social responsibility are found to be associated with an increase in financial performance (Mishra & Suar, 2010).

Applying meta-analytic, Dixon-Fowler et al, (2013) reviewed environmental performance’s (EP) and financial performance’s (FP) relationship which revealed potential moderators to the EP-FP relationship including: ‘‘type’’ (e.g. reactive vs. proactive performance), firm characteristics (e.g., large vs. small firms), and methodological issues (e.g. self-report measures) which confirms that small firms benefit more from environmental performance than large firms. Furthermore, US firms seemed to benefit more than international counterparts, with environmental performance showing a strong influence on market-based measures.

Assessing the impact of energy-saving efforts on firms’ value based on carbon emission rights trading scheme of China as an exogenous shock, Ye et al, (2013) found that the Carbon Emission Rights Trading Scheme (CERTS) increases the market value of energy-related firms. It was again found that energy-saving efforts of firms further influence market value and investor reaction.

Investigating the corporate social performance effect on financial performance, Orlitzky and Benjamin (2001) found support for the argument that, the higher a firm’s corporate social responsibility, the lower its financial risk, and indicated that the relationship between social responsibility and risk appears to be one of reciprocal causality; prior corporate social responsibility is negatively related to subsequent financial risk, and prior financial risk is negatively related to subsequent corporate social responsibility. Additionally, CSP is more strongly correlated with measures of market risk than measures of accounting risk.

Examining the link between sustainability performance and stock performance (measured as the average monthly stock returns) of European companies from 1996 to 2001, Ziegler et al. (2007) employed Common Empirical Asset Pricing Models (CEAPM) and using two-fold sustainability performance measures showed that the average environmental performance of an industry has a significantly positive influence on the stock performance. This implies that findings regarding the risk factors of the multifactor model need not hold true for different observation periods, for different stock markets, and for the use of single stocks (instead of portfolios).

Moderating the effect of resource commitment and the consequences of environmental innovation practices, Li, (2014), using data from 148 manufacturers in Pearl River Delta in China, found that institutional pressures (i.e. the government's instruments, overseas customer pressure and competitive pressure) exert a significant positive effect on environmental innovation practices, but not the government's economic incentive instrument and domestic customer pressure. The findings indicate that environmental innovation practices have a significant positive effect on firms' environmental performance, while the effect on financial performance is through the mediating role of environmental performance. The findings further indicate that the relationship between environmental innovation practices and financial performance is moderated by the level of resource commitment. As the resource commitment increases, financial performance yields from environmental innovation practices show improvements.

On how sustainable development affects economic performance of firms, Zhongfu et al, (2011) focused on the environmental information disclosure effect on

Economic Value Added (EVA) and Tobin's q and showed a positive effect of environmental disclosures on Tobin q. The findings also showed that firms that sufficiently disclose environmental information are better economic performers.

Applying a meta-analytical approach to address the inconsistencies in previous empirical findings on the sustainability performance effect on financial performance, Endrikat et al, (2014) showed a positive and partial bidirectional relationship between a firm's environmental performance and financial performance. The findings further suggest a stronger relationship when the strategic approach underlying the firms' environmental performance is proactive rather than reactive.

Focusing on how green research and development (R&D) investment for eco-innovation affects environmental performance and financial performance based on resource-view theories, Ki-Hoon and Byung, (2015) found a negative relationship between green R&D and carbon emissions, with green R&D showing a positive relationship with financial performance at the firm level. The findings support the view that firms that are able to organise unique resources and capabilities and adopt proactive environmental strategies enjoy improved environmental and financial gains.

Investigating into circumstances under which it might pay to be green and categorised industries into 'dirty' and 'proactive', Marilyn and Noordewier, (2016) found that within 'dirty' and 'non-proactive' industries there is a positive marginal effect on firm performance. It was also found that the effect on financial performance of implementing Environmental Management Practices (EMPs) is greater in relatively 'dirty' and 'non-proactive' industry contexts than in relatively 'clean' and 'proactive' contexts.

Estimating how environmental management systems and financial performance is moderated by switching cost and competitive intensity, Feng et al, (2016), employing data from 214 Chinese manufacturing firms and employed hierarchical moderated regression analysis, found a positive relationship between environmental management systems and financial performance. The results also showed that the relationship is negatively moderated by switching cost and positively moderated by competitive intensity. Furthermore, switching cost and competitive intensity showed a negative joint moderating effect on the relationship between environmental management systems and financial performance.

Focusing on the relationship between firms' environmental/ social disclosures and profitability and market value, Qiu et al, (2016) found that past profitability drives current social disclosures, but no such evidence between environmental disclosures and profitability. It was also found that social disclosures is what matter to investors, and that firms that make higher social disclosures have higher market values. Furthermore, it was revealed that a link between social disclosures and market values is driven by higher expected growth rates in the cash flows of such companies, suggesting that firms with greater economic resources make more extensive disclosures which yield net positive economic benefits.

Examining the environmental pro-activeness effect on financial performance of manufacturing firms in India and the UK, Sen et al, (2015) found a positive correlation of environmental proactivity with financial performance of manufacturing based-operational performance and non-manufacturing based operational performance. Their structural analysis however revealed a much stronger positive correlation of financial performance with manufacturing based-operational practices than with the non-manufacturing based operational practices. The findings suggest that these firms should focus more on the manufacturing based operational practices to improve environmental and financial performance.

Muhammad et al, (2015) assessed the environmental performance effect on firms' financial performance of publicly listed companies in Australia. Controlling for unobserved firms' effect, a strong positive association between environmental performance and financial performance was found during the pre-financial crisis in the period 2001-2007. Although studies have documented that social performance is strongly related to firms' financial performance on average, it is also found that measurement and method that characterise particular research often moderate the strength of the relationship between firms' social performance and financial performance (Allouche & Laroche, 2005).

Estimating how firms' positive and negative social responsibility activities affect equity performance, Bird et al, (2007) found scant evidence to suggest that taking a wider stakeholder perspective jeopardises the interest of equity-holders. This implied that the market is not only influenced by the independent corporate social responsibility activities, but also the totality of all corporate activities which varies over time.

Employing eco-efficiency scores and how they relate to financial performance of firms, Guenster et al, (2011*)* found a positive relationship between eco-efficiency and operating performance and market value. The findings further suggest that the market's valuation of environmental performance has been time variant, indicating that the market incorporates environmental information with a drift. Again, the findings indicate that environmental leaders initially did not sell at a premium relative to laggards, with valuation differential increasing significantly over time.

Nelling and Webb, (2009) found that corporate social responsibility and financial performance appeared related when traditional statistical techniques are used. But when time series' fixed effects approach is employed, the relationship between two variables appeared much weaker. The study found little evidence of causality between financial performance and narrower measures of social performance that focus on stakeholder management. The findings further suggest that strong stock market performance leads to greater firm investment in aspects of corporate social responsibility, but corporate social responsibility activities do not affect financial performance. Furthermore, the findings suggest that corporate social responsibility is driven more by unobservable firm characteristics than by financial performance.

On environmental pro-activity relationship with economic performance on a sample of 186 industrial companies, Gonzalez-Benito and Gonzalez-Benito, (2005) support the view that environmental management brings competitive opportunities and further revealed that some environmental practices produce negative effects. It appeared that there is no one single response for the question of whether environmental pro-activity has positive effects on financial performance, and that the relationship must be disaggregated into more specific and concrete relationships.

On the issue of lean manufacturing, environmental management and firms' economic performance, studies have shown that when environmental management practices are measured against market and financial performance, the results show a negative relationship between the two variables. Taking into account firm value and operational performance and using content analysis, results have shown that corporate social responsibility is value destroying relative to market value and neutral in relation to accounting measures (Yang et al., 2011; Crisostomo et al, 2011; Thorburn & Fisher-Vanden, 2011).

Focusing on wealth-protective effects of socially responsible firm behaviour, examining the relationship between social performance (SP) and financial risk/ investors' utility using a panel data sample of S&P 500 companies between the years 1992 and 2009, it was found that social responsibility is negatively but weakly related to systematic firm risk, but SP tends to be positively and strongly related to financial risk (Oikonomou et al, 2012).

Belghitar et al, (2014) re-examined the problem in the context of Marginal Conditional Stochastic Dominance (MCSD), which accommodates any return distribution or concave utility function and found strong evidence that there is a financial price to be paid for socially responsible investing. Indices composed of socially responsible firms are MCSD dominated by trademarked indices composed of conventional firms as well as by indices carefully matched by size and industry with the firms in the SRI indices. Zero cost portfolios created by shortening the SRI index and using the proceeds to invest in the conventional index generates higher average returns, lower variance and higher skewness than either of the two indices standing alone.

Studies that have focused on the interactions between social and financial performance with a set of disaggregated social performance indicators from the environment have found that while scores on composite social performance indicators are negatively related to stock returns, they concede that the poor financial reward offered by such firms is attributable to their good social performance on the environment. It was also found that considerable abnormal returns are available from holding portfolios of the socially least desirable stocks (Brammer et al, 2006).

Johnston, (2005) examined the relations between environmental capital outlays with future abnormal earnings, stock prices and stock returns. Decomposing environmental capital expenditures into estimates of regulatory and voluntary components, the results revealed that regulatory environmental capital expenditures are negatively associated with future abnormal earnings. Market-based tests indicate that the regulatory component of environmental capital expenditure is negatively priced. On the contrary, voluntary environmental capital expenditure and regulatory environmental capital expenditure seemed to show different firm-specific economic consequences.

Studying two equity portfolios that differed in eco-efficiency, Derwall et al, (2005) found that the high ranked portfolio provided substantially higher average returns than its low ranked counterpart over the period 1995 to 2003. It was conceded that differences in portfolio performance could not be explained by differences in market sensitivity, investment style, or industry specific factors. The result is however significant for all levels of transaction cost.

Evaluating corporate social responsibility (CSR)-related shareholder proposals that pass or fail by a small margin of votes and its consequences on the firm's financial performance with the view that CSR is a valuable resource, found that adopting a CSR-related proposal leads to superior financial performance. The effect however seemed to be weaker for companies with higher levels of CSR, indicating that CSR is a resource with decreasing marginal returns (Flammer, 2013).

2.4.2.2 Carbon Input Intensity and Accounting-Based Performance Measures

Carbon input intensity and accounting-based performance are as described in the preceding section of the study.

Assessing the performance impact of ISO 14000 adoption on financial performance of fashion and textiles related industries (FTIs), Lo et al. (2012) found that adoption of ISO 14000 improved manufacturers' profitability (measured by return on assets) in the FTIs over a three-year period. The results reveal that profitability improvement started during the implementation stage and continued at least one year after the firms obtained ISO 14000 certification. Profitability improvement is said to be moderated by improvement in cost efficiency (measured by return on sales).

On the relationship between sustainability performance on organisational processes and economic performance of US companies, Eccles et al. (2014) found that firms that voluntarily adopted sustainability policies are more likely to be the companies that have established processes for stakeholder engagement. Again, their results revealed that high sustainability performing companies significantly outperform their counterparts in the long-term with respect to equity and operational performance.

Analysing how financial performance (measured by ROA, EPS, ROE) relates to corporate social responsibility of the JSE's SRI listed companies from 2004-2010, Mutezo (2014) showed that companies listed as constituents of the JSE SRI exhibited better financial performance than the non-constituents. It was also revealed that high awareness of social responsibility indicated by the JSE SRI membership enhances portfolio's profitability and yields better returns to investors.

Measuring corporate social responsibility as both an equal-weighted corporate social responsibility index and a stakeholder-weighted corporate social responsibility index based on Akpinar et al. (2008) on financial performance (measured by return on equity, return on assets, and Tobin's q), Choi et al. (2010) found a positive and significant relationship between financial performance and stakeholder-weighted corporate social responsibility index, and not in the equal-weighted corporate social responsibility index.

Applying two-stage least square regression model on Global Fortune 500 index companies spanning 2002-2005, Russo and Pogutz, (2009) found a significant short-term relationship between sustainability performance and economic performance (measured by return on assets). Utilising multivariate econometric analysis, and event study methodologies, King and Lenox (2001, 2000), Hart and Ahuja (1996), and Klassen and McLaughlin (1996) found a positive effect of environmental performance on financial performance. Shrivastava (1995) and Schmidheiny,(1992) argued that an environmentally friendly attitude does sustain momentum for increasing efficiency, increasing market share, strengthening brand value and improving corporate competitiveness.

Using external assessments by environmental rating agencies, Russo and Fouts, (1997) showed that there exists a positive relationship between sustainability performance and return on assets (ROA). Examining how energy management systems impact on manufacturing firms' operations, practices and economic performance, Bottcher and Muller (2014), using data from 108 German automotive suppliers and employing partial least squares, showed that energy management exhibits a positive effect on the adoption of low carbon production and economic performance.

Integrating the relationship between environmental management and economic performance, Claver et al. (2007) showed that environmental management focused on prevention logic has a positive net effect on environmental performance. The study also found that firms’ competitive advantage lies in differentiation due to an improved brand image and increased credibility in business relationships resulting in a positive correlation between proactive strategy and performance.

Baird et al. (2012) also showed that there exists a significant corporate social performance effect on financial performance. The findings show that the relation in part is conditioned on firms' industry-specific context. Applying linear mixed models, the study found a significant overall corporate social performance effect as well as significant industry effects between corporate social performance and financial performance, with the un-weighted average effect of corporate social performance on financial performance being negative. The industry analysis showed that over 17% of the industries sampled found their social performance effect on financial performance to be positive. The results also confirmed the existence of disparate corporate social performance dimension-industry effects on financial performance.

Concentrating on how attending to strategic intentions affect financial performance, Ameer and Othman (2012), using the top 100 sustainable global companies from the developed countries and emerging markets found significant higher mean sales growth, return on assets, earnings before tax, and cash flows from operations in some activity sectors of the sample companies compared to the control companies over the period of 2006-2010. Causal evidence reported in the study suggested that, there is a bi-directional relationship between corporate social responsibilities practices and financial performance.

Building on the theoretical argument that firms' ability to profit from social responsibility depends upon its stakeholder influence capacity (SIC), Barnett et al. (2012) bring together contrasting literature on the relationship between corporate social performance and financial performance (FP) and found that firms with low corporate social performance have higher financial performance than firms with moderate corporate social performance (CSP). It was also found that firms with high CSP have the highest financial performance. The findings support the theoretical argument that SIC underlies the ability to transform social responsibility into profit.

Examining the determinants of corporate social responsibility (CSR) and its implications on firms' investment policy, organisational strategy, and performance, using a two-stage least squares, Erhemjamts et al. (2013) showed that CSR-financial performance relation is robust to correct for endogeneity through reverse causation and/ or biases introduced by time varying omitted variables.

Analysing the linkage amongst environmental, operational and financial performance of listed Japanese manufacturing companies, applying Data Envelopment Analysis (DEA), Sueyoshi and Goto (2010) showed that large firms have managerial capabilities to improve their operational and environmental performance. This improvement leads to enhance their financial performance. The study however was able to find a business linkage in small and medium-sized firms.

Using corporate social responsibility as a precedent of environmental supplier development (ESD) and employing partial least squares, Agan et al. (2014) showed that a positive relationship exists between corporate social responsibility and ESD, and a positive influence of ESD on financial performance and competitive advantage of the selected firms. On the relationship between investment in environmental technologies and financial performance, Nehrt (1996) found a positive relationship between timing of investment and profit growth. Chien and Peng (2012) similarly show that green investment guarantees a preserved profitable environment in the long-run, and Schmalensee (2012) confirms that green investments are an attraction and effective strategy capable of offering financial benefits.

Supporting the argument that a firm's environmental performance exhibits a positive impact on financial performance and vice versa, Nakao et al. (2007) suggest that the tendency for realising a two-way interaction is not limited to the top-scoring firms in terms of financial and environmental performance. When scores of the companies that published relevant information in their environmental reports, and their conduct was considered, a statistical causality test with such information as additional input showed a more strongly significant relationship.

Assessing chemical industry companies' environmental expenditures to determine firms that have better financial performance, Wang et al. (2013), using Malmquist Productivity Index (MPI), provide evidence of a significant relationship between environmental expenditures and financial performance. Using a structural equation model (SEM) for the data analysis, Sambasivan et al. (2012) found that sustainability pro-activity is positively related to operational performance, organisational learning, environmental performance, stakeholder satisfaction and financial performance.

Whether pursuing proactive environmental strategies leads to improved financial performance, Clarkson et al. (2011), using longitudinal data from 1990-2003 for the four most polluting industries in the US, showed that positive (negative) changes in firms' financial resources in the prior periods are followed by significant improvements (declines) in firms' relative environmental performance in the subsequent periods. It was also found that significant improvements (declines) in environmental performance in the prior periods can lead to improvements (declines) in financial performance in the subsequent periods after controlling for the impact of Granger causality.

Employing Mannheim Innovation Panel in 2011-2009 of German firms, and differentiating between different types of environmental innovations, and disentangling those aimed at reducing the negative externalities and allowing for efficiency and cost savings, Ghisetti and Rennings, (2014) analysed the extent to which the two environmental innovations types have impacts on firms' profitability with opposite signs found that typology of Environmental Innovation and Driver of Adoption (EIDA) affect the indication of the relationship between competitiveness and environmental performance.

Examining firms that include research and development (R&D) expenditures as business strategies for sustainable development and to identify charitable expenditures as contributions to corporate social responsibility, Lin et al. (2009) found a positive relationship between corporate social responsibility and financial performance. Modifying the model, it was found that while corporate social responsibility does not have much positive impact on short-term financial performance, but does offer a remarkable long-term fiscal advantage.

Exploring the locus of profitable pollution reduction and managers' underestimate of full value pollution reduction, King and Lenox (2002) found that waste prevention often provides unexpected innovation offsets and that onsite waste treatment often provides unexpected costs. Employing a statistical test for the direction and significance of the relationship between various means of pollution reduction and profitability, strong evidence that waste prevention leads to financial gain was established, but they found no evidence that firms profit from reducing pollution by other means. It was also found that benefits of waste prevention alone are responsible for the observed association between lower emissions and profitability.

Breaking pollution control investment into content of the disclosures made in annual reports, i.e. pollution prevention and end-of-pipe solutions, Chien and Peng (2011) showed that firms moving forward proactively with pollution prevention investments have significantly outperformed their counterparts who react sluggishly with end-of-pipe solutions. In addition to the notion that environmental expenditures are not necessarily detrimental to firms, the results suggest that the often conflicting goals of financial reporting, namely representational faithfulness and macroeconomic growth may be harmonised if the accounting standards embody the different features of pollution control investments.

Exploring how eco-innovation impacts on accounting-based measures, using the data on Polish and Hungarian publicly traded companies, Przychodzen and Przychodzen (2014) show that eco-innovators were generally characterised by higher returns on asset and equity, but lower earnings retention. It was also found that companies that introduce eco-innovation were more likely to face lower financial risk exposure and more likely to possess greater free cash flow than conventional firms. The findings also suggest that strong asset and financial capabilities are relevant pre-conditions for the development of eco-innovativeness.

Using sustainable competitive advantage, reputation and customer satisfaction as three probable mediators in the corporate social responsibility-firm performance relationship of 205 Iranian manufacturing and consumer product firms, Saeidi et al. (2015) found that the link between corporate social responsibility and firm performance is a fully mediated relationship. The results show that a positive effect of corporate social responsibility on firm financial performance is as the result of the effect corporate social responsibility has on competitive advantage, reputation, and customer satisfaction. The findings further suggest that reputation and competitive advantage mediate the relationship between corporate social responsibility and financial performance.

Examining the claim that sustainability pro-activeness improves firms' operating performance (measured by return on sales), Telle (2006) found a positive relationship between sustainability performance and return on sales, employing pooled regression. Controlling for firms' specific effect, the result show an insignificant relationship between sustainability performance and return on sales. The paper concluded that the estimated positive effect could be due to omitted variable bias. The findings confirm the claims of Barnett and Salomon (2006), Allouche and Laroche (2005), and McWilliams Siegel (1999) regarding limitations of models applied in the studies.

On how green investment practices affect firm's profitability, Busch and Hoffman (2011) found a negative association between a firm's green investment practices and profitability. Similarly, Makridis (2013) found that green energy adoption and integration of associated technologies revealed that associated financial gains are not guaranteed as compared to traditional systems.

Analysing the existence of a connection between corporate environmental performance and financial performance of Romanian companies using panel dataset spanning from 2005 to 2010, Pintea et al. (2014) found that there is not any significant link between sustainability performance and financial performance.

Examining the causal relationship between corporate social responsibility and financial performance, utilising the Granger causality approach, Makni et al. (2009)

showed that no significant relationships exist between a composite measure of a firm's corporate social responsibility and financial performance, except for market returns. On the application of individual measures of corporate social responsibility, a significant negative effect of the environmental dimension of corporate social responsibility and three measures of financial performance, measured by return on assets, return on equity and market returns was found.

Investigating causality from environmental investment (as a long-term effort) and expenditure (as a short-term effort) to financial performance in the US electricity utility industry, Sueyoshi and Goto (2009) found that the environmental expenditure under the US Clean Air Act has had a negative impact from 1989 to 2001. The negative impact became much more noticeable after the implementation of the Title IV Program (1995) of the US Clean Air Act. The study could not find the influence of environmental investment on financial performance by a statistical test although it indicated a positive impact.

Investigating differential relationships between pollution prevention and end-of-pipe efficiencies with short-run financial performance (measured as return on sales), and controlling for firm size and financial leverage, Sarkis and Cordeiro (2001) found that pollution prevention and end-of-pipe efficiencies are both negatively related to financial performance (return on sales). The negative relationship is larger and more significant for pollution prevention efficiencies.

Determining corporate sustainability practices' effect on financial leakages in the hotel industry in Jordan, using a self-administered survey and applying Confirmatory Factor Analysis (CFA) and Structural Equation Model (SEM), Alzboun et al. (2016) show that sustainability practices do not reduce financial leakage level in the industry hotels in Jordan. On the contrary, financial leakages are predicted to reduce through sustainability practices over time.

Analysing the relationship between corporate social performance (measured by ethical rating) and market and accounting-based ratios using correlation analysis, Soana (2011) showed that there is no statistically significant link between corporate social performance and corporate financial performance.

Examining the appropriateness of the profitability ratios (measured by return on assets, return on equity and basic earning power) in determining the impact of operations strategy on firm performance, Klingenberg et al. (2013) showed that there exists no consistent relationship between return on assets (ROA), return on equity (ROE) and Basic earnings power (BEP) and operations strategy. The findings indicate that firms' profitability is affected by operations and financing and that the impact of an individual operations strategy is difficult to isolate from the firm's other activities. Hence, profitability ratios ROA, ROE and BEP that aggregate all of a firm's activities may not be suitable metrics to determine the effect of Just-in-Time/Lean Manufacturing methods on financial performance.

Examining the relationship between environmental expenditures and innovation and financial performance in a panel of manufacturing industries, Jaffe and Palmer (1997) found that lagged environmental compliance expenditures have a significant positive effect on research and development expenditures. Controlling for unobserved industry specific effects, the study found little evidence that industries' inventive output (measured by successful patent applications) is related to compliance costs.

2.5 Summary of Chapter 2

This chapter provided the theoretical underpinnings to this study together with previously related empirical findings. The discussion on the stakeholder theory indicates that firms' success is dependent on the success of management's ability to manage relationships of firms with its stakeholders. The view renders insufficient the conventional idea that the success of the firm is dependent solely upon maximising shareholder value. Discussion on the legitimacy theory revolves around an implicit contract between firms and society agreeing to perform socially desirable actions in return for society's approval of objectives and ultimate survival. The Political economy theory however suggests that corporate sustainability performance and disclosures are "pre-emptive'' and are used to enforce an agenda to stave off intervention. Discussion on the resource-based theory indicates that firms' sustainability and economic performance depend on the capacity and availability of resources. On this premise, firms that possess distinct and valuable resources may gain sustainable competitive advantages. The discussions on the institutional theory indicated that corporate structures together with operational practices are directed by pressures from interested parties who expect to see particular practices in operation. Corporate practices and policies are hence deemed situational as they respond to social and institutional pressures in order to conform to prevailing socio-political and economic expectations to maintain legitimacy. The chapter also reviewed related previous empirical literature on the effect of carbon output intensity (emissions intensity) and carbon input intensity (energy usage intensity) on firms' economic performance. The review showed inconsistent and contradictory findings, hence making impact assessment of transition to a low carbon global economy on companies' competitive positions and long-term valuations difficult. If empirical evidence on sustainability performance-financial performance relations has been consistent, the implication could have been that there is a common underlining factor(s) influencing the relationships. It has been shown that theoretical and empirical limitations related to statistical models used in most previous studies, significance of sample size and choice of environmental and financial performance indicators might be the underlying factors behind conflicting and contradictory findings.

This study bridged the gap by examining the financial implications of firms: Physical energy usage intensity (carbon input intensity) and emissions intensity (carbon output intensity); shocks in physical energy usage intensity (carbon input intensity) and emissions intensity (carbon input intensity); and physical energy usage intensity (carbon input intensity) and emissions intensity's (carbon output intensity) threshold effect on JSE's SRI firms. Bridging this gap the researcher believes would provide needed support to policy makers and investors in their sustainability-economic performance policy formulation and evaluation.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The chapter spells out the research design, instrument for data collection, data type, analytical tools and procedures used to analyse data. The study employed multi-methods quantitative approach in sourcing and analysing data using a panel data methodology. Analysis of document approach is used to collect carbon output/ carbon input data and financial performance data. The study applied Ordinary Least squares regressions (OLS), Panel Granger causality analysis, Fixed Effects, Arellano-Bond Dynamic panel data estimation, Impulse Response Function (IRF) analysis in short panel vector auto regressions (SPVARs), and Bootstrap threshold regression to answer stated questions of the study utilising statistical software STATA and R.

3.2 Research Design

Creswell and Clark (2011) suggest that a researcher should set out the philosophical assumptions which underlie a study. This it said to include paradigms which define the development of these philosophical assumptions. According to Sandelowski (2000), paradigms are ‘’worldviews’’ that signal distinctive stances such as: Epistemological (The view of knowing and the relationship between knower and to be known), Ontological (The view of reality) Methodological (The view of mode of inquiry), and Axiological (the view of what are valuable positions).

Paradigm, according to Creswell (2009), refers to philosophical assumptions related to a specific view-point in research study, which Morgan (2007) categorises into positivists, constructivists, pragmatists and participatory. The positivist paradigm is associated with a quantitative approach and involves selection of variables which are empirically examined (Creswell, 2005). A Positivist paradigm is employed with the aim of proving or disproving a testable proposition and to emphasise a scientific method of analysis and generalisation of findings. The approach also describes a set of assumptions and considerations leading to specific contextualised guidelines that connect theoretical notions and elements to a dedicated strategy of inquiry supported by methods and techniques for collecting empirical material (Jonker and Pennink, 2010). This procedure allows a study to combine more than one data collection technique with associated analyses techniques, but restricted to a quantitative ‘’worldview’’ (Tashakkori & Teddlie, 2003). Bless and Higson-Smith (2000) emphasised that this approach stresses the importance of determining a relation amongst variables. Therefore, this research applied a positivist paradigm (quantitative approach) as the approach studies the relationship between variables using statistical and econometric techniques/ concepts to determine relationships amongst variables under consideration using a multiple case design.

3.2.1 Case Study Design

According to Yin, (2013; 2009) “A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident”. It is also referred to as the study of a problem which gives a comprehensive view of a case and involves an understanding of process, event or an activity (Creswell, 2009). Case study according Yin, (2013) can be used to explore events or phenomena in the everyday contexts in which they occur. And that, a case study can help to explain causal links and pathways resulting from a new policy initiative. The author further argued that case study approach lends itself well to capturing information on more explanatory ‘how’, ’what’ and ‘why’ questions. Crowe et al, (2011) cited that a case approach offers additional insights into what gaps exist in its delivery or why one implementation strategy might be chosen over another, which the authors believed helps in developing or refining theory. Furthermore, Crowe et al, (2011) argued that case study approach is particularly useful when there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest, in its natural real-life context.

Notwithstanding, critics of the approach have argued against the design on the grounds that it lacks scientific rigour, and provides little basis for generalisation. Crowe et al, (2011) however argued that this concern could be addressed through: the use of theoretical sampling; respondent validation, and transparency throughout the research process. And suggested that transparency can be achieved by detailing steps involved in case selection, data collection, the reasons for the particular methods chosen, and the researcher's background and level of involvement.

According to Crowe et al, (2011) deciding on how to select the case(s) to study is an important activity that merits some reflection, and cited three case study approaches available to researchers. Intrinsic case study, the authors argued involves a case selection that is based on the merit of the case. With this approach, case selection is not done because the chosen case is representative of other cases, but because the chosen case is unique, and of genuine interest to the researcher. With instrumental case study, the authors cited that selecting a 'typical' case can work well. In contrast to the intrinsic case study, a particular case which is chosen is of less importance than selecting a case that allows the researcher to investigate an issue or phenomenon. In collective or multiple case studies, Crowe et al, (2011) argued that a number of cases are carefully selected, which offers the advantage of allowing comparisons to be made across several cases, and as well enabling 'analytical generalisation'. Based on the focus of the study, the researcher thus adopted collective/multiple case study design. Amongst empirical studies that have employed a multiple case design to investigate the carbon intensity effect on corporate financial performance include; KI-Hoon et al. (2015) using 362 firms; Chan and Walker (2014) using 748 US firms; Chapple et al. (2009) using 58 Australia listed firms; Sarkis and Cordeiro (2001) using 482 US firms; King and Lenox (2001) using a panel data set consisting of 652 US firms; and Hart and Ahuja (1996) using 127 US firms. Creswell (2009) cites that in a multiple case design there is no limit as to the number of cross-section dimensions that can be included in a multiple case study.

3.3 Population and Sample

3.3.1 Population

Population consists of all the possible cases (e.g. persons, objects, events) that constitute a known whole. It may also be described as the aggregate or totality of all the objects, subjects or members that conform to a set of specifications (Leedy & Ormrod, 2013; Polit & Hungler, 1999). SRI Index was launched in May, 2004, with fifty-seven companies, and has grown to eighty-two companies by the end of December 2014. Population of this study consisted of all existing listed manufacturing and mining firms on the SRI Index from 2008-2014. On the whole, the population of the study is made up of thirty-one companies, comprising sixteen manufacturing, and fifteen mining companies. Selected companies constituted 45% of the entire population. Manufacturing firms sampled constituted 31 % of manufacturing firms on the SRI index, while mining firms selected constituted 60% of mining firms listed on the SRI index.

3.3.2 Sampling and Sample size

Sampling is the process of selecting a group of subjects for a study in such a way that the individuals represent the larger group from which they were selected (Gay, 1987). There are different types of sampling methods in use, which include probability and non-probability sampling. Whilst probability sampling gives all the population subjects the chance to be selected, non-probability sampling makes selection of the subjects or variables to be included in the sample based on the researcher's eligibility criteria. In this study the researcher applied a non-probability sampling method referred to as purposively sampling; this involves the selection of subjects or variables from the population based on the researcher's judgement (Leedy & Ormrod, 2013; Saunders, 2011).

Carbon input and output data is not consistently common among socially responsible investing companies, not even from CDP database. The researcher therefore collected carbon related data of companies that had consistently reported their energy consumption and emissions performance for not less than seven years. This led to the selection of fourteen manufacturing and mining companies, as these have publicly and consistently reported their energy consumption and emissions performance for a period of about seven years. Inadequate carbon related data of most JSE's SRI manufacturing and mining firms prevented the researcher to include more firms for the purposes study, and this accounted for the 45% sample size. Notwithstanding, accounting and equity related data of the SRI firms were all readily available. Table 3.I showed names and industry of companies selected for this study.

Table 3. I: Sampled Companies and their respective Industry

Name Of Companies	Industry Type
Anglo American Plc	Mining
Anglogold Ashanti	Mining
Arcelor Mittal South Africa	Mining
BHP Billiton	Mining
Exxaro Resources	Mining
Gold Fields Ltd	Mining
Harmony Gold Mining Ltd	Mining
Lonmin Plc	Mining
Merafe Resources	Mining
Murray &Roberts	Manufacturing/Construction
Pretoria Portland Cement Ltd	Manufacturing
Sabmiller Plc	Manufacturing
Sappi Ltd	Manufacturing
Sassol	Manufacturing

3.4 Data and Data Collection Instrument

Data is defined as information obtained in the course of a study (Polit & Hungler, 1999). Data is said to be secondary in as much as it is not new data collected specifically and primarily for the purpose of a study or consultancy being conducted (Crowther & Lancaster, 2009). Instrument for data collection is referred to as the tool employed to collect data for the purposes of a study (Saunders, 2011). This study employed 'analysis of document approach' to source the needed data for the study. Analysis of document approach involves sifting through archival reports and documents to pick the needed data for analysis. Documents sourced to help pick needed data for the study include: Annual reports and accounts of selected JSE's SRI manufacturing and mining firms. Sales, assets, operating income/losses, long-term debt and market value of equity figures were hand-collected from these accounts, mainly from the companies' web-sites. From which accounting-based measures; such as return on assets (ROA), return on sales, market value of equity deflated by sales (MVE/S) and financial leverage (LEV) were computed.

Notwithstanding, companies such as: Anglo American Plc, BHP Billiton, Lonmin Plc, Sabmiller Plc, Sappi Ltd and Anglogold Ashanti, had their annual accounts reported in currency other than in South African Rand. Apart from Anglogold Ashanti, which started reporting in currency other than in South African Rand from 2011, all the remaining five companies had their annual accounts reported in foreign currencies for the period of this study. For the purposes of consistency, the researcher converted all variables from annual accounts required for the analysis but reported in currencies other than the South African Rand. The study followed foreign exchange translation method as provided by International Accounting Standards (IAS) 21 and applied by the firms. That is, using average exchange rate for converting income statements items, and closing exchange rate for balance sheet conversion. These exchanges rates have been provided by these companies in their respective annual reports (see Sabmiller Plc, annual report 2013, pg. 96; Sappi Ltd, annual report 2009, pg.41).

Annual responses from JSE's SRI manufacturing and mining firms to Carbon Disclosure Project (CDP), UK based not-for-profit organisations holding the world's largest repository of corporate climate change data. CDP requests climate change related data from the world's largest companies (measured by market capitalisation). CDP records energy usage data in Mega-watts hours (MGH) and emissions data in metric tonnes (Mt). Carbon output and carbon input data is hand-collected from CDP's database.

Equity price data is hand-collected from Tick-data-market database, a French-based company from which end of year equity price is available and computed equity returns (EQRTNS) and market value of equity deflated by sales (MVE/S). The researcher sourced equity data from Tick-data-market platform because my university does not subscribe to INET BFM, Bloomberg or Data stream. I therefore had to buy the equity data from Tick-data-market. This is also because Tick-data-market allows individuals to buy data from their platform, while other platforms deal with institutions, and made it difficult for the researcher to pick data from those platforms (INET BFM, Bloomberg or Data stream). Equity price, accounting-based measures, carbon energy usage and carbon output data were collected with the support of two research assistants. Data collected from these sources were compared by the research assistants, and supervised by the researcher to confirm authenticity and reliability of the data.

The researcher came across missing data points related to energy usage and carbon emissions of two companies namely; Merafe Ltd and Pretoria Portland Cement. Emissions data was missing from Merafe Ltd reports for the year 2014, whilst energy usage data was missing from Pretoria Portland Cement report in 2009 and 2014. To take care of these missing data points, the researcher applied an approach widely used in statistics and economic research, known as 'interpolation' or 'adjustment' to fill in the missing data points. 'Interpolation' or 'adjustment' is the process of producing time series at a higher frequency than it is actually available (Friedman, 1962; www.statistics.gov.uk/iosmethodology/ time_series_methods.asp). This is where accounting framework demands inputs that are not available as frequently as required. If a suitable series is not available, an independent method of determining higher frequency values need to be applied as in the case of this study. With this approach, missing data at a particular point is determined by first estimating percentage changes in available series, sum up the results and divide summed results by relevant number of time periods. Depending on the missing data point one is filling, the concept of forecasting/ backcasting is then applied (Friedman, 1962; Fiering, 1962; www.statistics.gov.uk/iosmethodology/ time_series_methods.asp). Amongst recent related studies that have applied interpolation to fill in missing data include, Huang et al, (2009); Carr and Wu, (2009).

The study used panel data of selected JSE's SRI manufacturing and mining companies (see Table 3.I) for the periods 2008-2014. Using panel data is best suited for a study of this nature as such a data set: (i) explicitly takes heterogeneity into account by allowing for individual specific variables; (ii) gives more informative data, more variability, less collinearity among variables, more degrees of freedom, more efficiency and is more appropriate in explaining cause-and-effect relationships between variables and among different firms in and across industries over a time period (Baltagi, 1998; El-Khouri, 1989).

3.5 Data Analysis Techniques

This section describes statistical and econometrics techniques and concepts employed in the data analysis to establish the link between sustainability performance and economic performance of JSE's SRI firms. Statistical estimations employed in this study includes OLS, fixed effects estimations, Arellano-Bond DPD estimations, dynamic panel threshold estimations, Impulse response function analysis in short panel vector auto regressions (SPVARs), and panel Granger causality analysis.

3.5.1 Previously Applied Statistical Estimations

In studying the environmental performance effect on the financial performance of firms globally, three major statistical estimators have been previous applied, including: event studies (Joshi et al., 2005; Khanna et al., 1998; Konar & Cohen, 1997); portfolio analysis (Derwall et al., 2005); and multivariate econometric approach (Elsayed & Paton, 2005; King & Lenox, 2002, 2001; Konar & Cohen, 2001; Dowell, 2000). Busch and Hoffmann (2011) argue that there are major limitations associated with the event studies and portfolio analyses. The authors cite that the application of event studies depends on the assumption of the events being new to the market. Implying investors do not have corresponding information and therefore do not expect individual firms to be affected by the event. Secondly, it is argued that the intended purpose of event studies detecting short-term perceptions of financial markets might be misleading in cases where a substantial effect on firm financial performance are investigated, consistent with Hart and Milstein's (1999) argument that resulting effects on firms' financial performance pertain in many cases to long-term competitiveness. Furthermore, Busch and Hoffmann (2011) argue that portfolio analysis offers an advantage over event studies as long-term effects can be observed. Nonetheless, the authors argue that shortcomings remain as portfolio analysis exclusively examines the investor perspective which is subject to further stock market influences. Busch and Hoffmann, (2011) cited this shortcoming that it renders portfolio analysis inappropriate in a situation where accounting-based causal relationships are investigated, and recommend multivariate econometric approach as a superior approach to event studies and portfolio analysis as multivariate approach is able to explore long-term relationships between variables and more so where accounting-based causal relationships are investigated.

Empirical literature indicates that early studies in sustainability accounting research resorted to calculating correlations coefficients in an attempt to establishing the sustainability performance effect on corporate economic performance (Jaggi & Orlitzky, 2001; Freedman, 1992; Bragdon & Marlin, 1972). Telle (2006) however cites a problem associated with correlation studies and argues that a positive sign of a calculated coefficient could be due to confounding variables and there is a possibility that a positive correlation may disappear once confounding variables are controlled for. Raj and Dhal (2010) argue that correlation analysis only measures the degree of linear association between two variables and therefore provides little insight on the dynamic linkages and causality between variables. Leong and Felmingham (2001) cite that correlation coefficients are known to be biased upwards if share price indices have heteroskedastic elements and conclude that the correlation analysis does not provide a sound basis for studies of interdependence.

Drawing from the review of previously applied statistical models, it is evident that multivariate econometric analysis best captures the relationship of variables in this study. Therefore, the researcher resorted to apply varied multiple regression analysis techniques which are described in the following sections according to the research questions examined.

3.6 Causal relationship between Carbon Intensity and Financial Performance

This section examines the causal relationship between carbon intensity (carbon output and carbon input intensity) and financial performance (ROA, ROS, EQRTNS & MVE/S). The causal analysis is performed using Baum's (2010) version Gcause2 to determine how carbon output and carbon input intensity co-move in the short-term. Causality approach is a technique that helps to show how knowledge of past values of one variable 'x' helps to improve the forecasts of another variable 'y'.

In studying causal relationships between panel series, previous studies have employed a panel vector error correction model (PVECM) based on Arellano-Bond (1991). PVECM is however said to be inefficient as it lacks the capacity to account for cross-sectional dependence across the members of the panel and deemed to produce inconsistent parameters unless the slope coefficients are homogeneous (Pesaran et al., 1999).

Hurlin (2008) proposes a model that accounts for heterogeneity, but fails to account for cross-sectional dependence. Konya (2006) proposes a similar approach that is said to account for cross-sectional dependence across members of the panel and heterogeneity based on seemingly unrelated regression (SUR). Because Konya's methodology is said to determine the direction of causality based on the Wald test with series specific bootstrap critical values, the approach is said not to require joint hypotheses for all members of the panel. Hence, the testing procedure is said not to require pre-testing for panel unit root test and co-integration. Notwithstanding, applying the approach using Time Series processor (TSP), statistical software in certain situation is not feasible, especially in a situation where the cross-section dimension 'N' is larger than the time series dimension 'T' as in the case of this study.

Emirmahmutoglu and Kose (2010) propose a new panel causality approach using Meta-analysis in heterogeneous mixed panels based on Fisher (1932). This analysis seeks to obtain a common result combining the results of a number of independent studies which test the same hypothesis. Emirmahmutoglu and Kose, (2010) approach similarly tests for cross-sectional dependence and use a bootstrap procedure in determining direction of causality.

Granger (2003) suggests that causality from one variable to another by imposing a joint restriction for the whole panel is the strong null hypothesis and assumes that lag orders on autoregressive coefficients and exogenous variable coefficients are the same for all cross-section units of the panel, and the panel is balanced. The structure of the test is similar to the unit root test proposed by Im et al. (2003) in heterogeneous panels, indicating that test statistics are based on averaging standard individual Wald statistics of Granger non-causality tests.

To produce consistent and unbiased results from Granger causality test from among variables in panel data requires accounting for a possible cross-sectional dependence across the members of panel. The reason is that a shock affecting an individual panel member may also affect other panel members because of a degree of macro-economic conditions affecting all of them. Under cross-section independence assumption, it is said that individual Wald statistics have an identical chi-squared distribution and average Wald statistic converge to a standard normal distribution when ‘T’ and ‘N’ tend sequentially to infinity.

De Hoyos and Sarafidis, (2006) suggest that in working with short dynamic panel data models, if there is cross sectional dependence in the disturbances, the estimation procedure that depends on IV and GMM, such as Arellano-Bond, (1991) are inconsistent as the cross-sectional dimension grows large, for the fixed panel time dimension. The outcome is important, the authors said, given that error cross section dependence is a likely practical situation and the desirable N-asymptotic properties of the estimators rely upon this assumption. The authors show that the test for cross sectional dependence is important in fitting panel data models and more importantly when the cross-sectional dimension is large and time series dimension is small, a commonly encountered situation in panels.

Kar et al. (2011) argue that testing for cross-sectional dependence in a panel causality study is paramount in selecting an estimation technique. The rationale behind taking into account the cross-sectional dependence is due to the fact that a shock affecting one firm may also affect other firms because of a high degree of socio-legal and market conditions confronting the firms. To establish the existence of cross-sectional dependence, this study carries out two distinct tests based on Breusch-Pagan $_{LM}$ (1980) and Pesaran $_{CD}$ (2004).

Following the extension methodology of the basic Granger model by Hood et al. (2008) based on Hurlin and Venet (2001), series ‘x’ may be said to Granger-cause series ‘y’ if and only if the expectation of ‘y’ given the history of ‘x’, $E(y \mid x_{t-k})$, is different from the unconditional expectation of y, E(y). That is if,

$$E(y \mid y_{t-k}) = E(y \mid y_{t-k}, x_{t-k}), \quad (1)$$

then, x has no effect on y and does not Granger cause y. On the other hand, if

$$E(y \mid y_{t-k}) \neq E(y \mid y_{t-k}, x_{t-k}), \quad (2)$$

One may conclude that x does not Granger cause y, because the expected value of y is different given x, implying that x does not Granger cause y. This study specifies Hurlin and Venet (2001) as:

$$y_{i,t} = a_i + \sum_{k=1}^{p} y^{(k)} y_{i,t-k} + \sum_{k=0}^{p} B_i^{(k)} X_{i,t-k} + v_{i,t} \quad (3)$$

for each of the cross sections *i* and for all *t* in (1, T). In this situation there is a panel model where the regressors are (i) lagged values of the dependent variable ($y_{i,t-k}$) subset by cross-sections *i* and (ii) lagged values of the independent variable ($x_{i,t-k}$) also subset by cross section. The error term is represented by $v_{i,t}$ $y^{(k)}$ and are the autoregressive coefficients, and $\mathcal{B}_i^{(k)}$ are the regression coefficients. The fixed effects are represented by a_i. And *p* representing the number of time periods. For the purposes of sufficient degree of freedom the following are assumed:

i. $y^{(k)}$ is constant,

ii. $\mathcal{B}_i^{(k)}$ is also constant for all $k \in (1,p)$

This assertion that $y^{(k)}$ is constant, precludes variation in the autoregressive coefficient from cross section to cross section. And the second assertion $\mathcal{B}_i^{(k)}$ is also constant for all k ∈ (1,p) which similarly precludes variation in the regression coefficients from time period to time period. Again, whereas the autoregressive slope coefficients are identical for all cross sections, the regression coefficients are allowed to vary across individual cross sections. To test for Granger causality panel framework alternative causal relation are likely to be found. There could exist three possible causal scenarios, thus where:

i. An identical causal relationship exists between x and y in all cross-sections,

ii. No causal relationship exists between x and y in any cross-section.

iii. There is a causal relationship between x and y in some subset of *n* cross sections, but the nature of the relationship is not constant across all the cross sections.

3. 7 Carbon intensity Effect on Financial performance Measures

This section presents statistical methods used to examine the relationship between carbon intensity measured by ENGINT and EMSINT, and financial performance measured by ROA, ROS, EQRTNS and MVE/S of JSE's SRI firms from 2008-2014. In this section the researcher employed Ordinary Least Squares regressions (OLS), Fixed Effects (within) and Arellano-Bond dynamic panel data estimations to establish the carbon intensity effect on the economic performance of JSE's SRI firms.

Definition of Variables

Return on assets (ROA) is a measure of the success of a firm in the utilisation of assets to generate earnings independent of the sources of financing of those assets (Selling and Stickney, 1989).

Return on sales (ROS) is an accounting-based measure designed to gauge the financial health of a business. It may be defined as the ratio of profits earned to total sales receipts (or costs) over a defined period of time (Holmes et al., 2005)

Equity returns (EQRTNS) refers to the gain or loss on the security in a particular period. This return may consist of income and capital gain relative to the investment. In this study equity return refers to the capital gain relative to the security in a particular time period (Dragomir, 2010)

Market value of equity deflated by sales (MVE/S) is the total market value of all of a company's outstanding shares divided by its sales revenue (Johnston et al., 2008). It is calculated by multiplying the company's current equity price by its number of outstanding shares, and dividing this by sales revenue. Market value of equity therefore changes, with a change in any of two inputs. Since companies' market value of equity does not consider growth potentials of a company, this study purposely deflated market value of equity by sales to include the effect of the firms' potential growth.

Emissions intensity (EMSINT) also known as carbon output intensity measures the ratio between total Greenhouse gas emissions in metric tonnes (Mt) and firms' sales revenue (Hoffmann & Busch, 2008)

Energy intensity (ENGINT) also known as carbon input intensity measures the ratio between total energy consumption (in Megawatt-hours) and sales revenue of a firm (Hoffmann and Busch, 2008).

Financial risk (LEV) in this study refers to the relationship between long-term debt and total assets of a firm (Busch& Hoffmann 2011; Dragmoir, 2010).

Operating earnings (OPTINC) refers to the profit before extra-ordinary items and finance cost (Holmes et al., 2005)

LNMVE refers to the natural log of total market value of all of a company's outstanding shares in a period (Busch &Hoffmann, 2011)

Sales growth (GROWTH) in this study refers to the change in sales over the previous fiscal years. The variable is employed to control for growth opportunities not reflected in other variables in the models (Johnston et al., 2005).

INDTYPE represent the Industry dummy that proxies for differences in firms' inherent business risk introduced into models. The vector of the dummy variable indicates the firm's industry membership (Bachoo et al, 2013; Busch & Hoffmann, 2011).

The study used carbon output intensity (EMSINT) and carbon input intensity (ENGINT) to represent sustainability performance and these constitute the primary independent variables. Financial performance constitutes the dependent variable and is represented by accounting and market-based performance measures and are represented by return on assets (ROA), return on sales (ROS), equity returns (EQRTNS), and market value of equity deflated by sales (MVE/S). Operating income (OPTINC), financial risk (LEV), sales growth (GROWTH), assets (ASSETS/S or LNASSETS), LNMVE and industry type (INDTYPE) are used as control variables. Specific variables are employed in the analysis in accordance with the requirements of individual econometric techniques employed to answer specific research questions:

Panel Granger Causality test

Research question: Does carbon output intensity (EMSINT) G-cause market-based performance measures?

Table 3.II: Variables for Panel Granger causality test

Sustainability Performance	Financial Performance Measures
EMSINT	Equity Returns
	Market value of equity/Sales

Research question: Does carbon output intensity (EMSINT) G-cause accounting-based performance measures?

Table 3.III: Variables for Panel Granger causality test

Sustainability Performance	Financial Performance Measures
EMSINT	Return on Assets
	Return on Sales

Research question: Does carbon input intensity (ENGINT) G-cause market-based performance measures?

Table 3.IV: Variables for Panel Granger causality test

Sustainability Measures	Financial Performance Measures
ENGINT	Equity Returns
	Market value of Equity/Sale

Research question: Does carbon input intensity (ENGINT) G-cause accounting-based performance measures?

Table 3.V: Variables for Panel Granger causality test

Sustainability Measure	Financial Performance Measures
ENGINT	Return on Assets

Return on Sales

OLS Estimations:

Research Question: How does carbon output intensity (EMSINT) affect market based performance measures?

Table 3.VI: Variables for OLS analysis

Dependent	Independent variables
Equity Returns (y)	EMSINT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),LNMVE(x_5), GROWTH(x_6), INDTYPE(x_7)
Market value of equity/Sales (y)	EMSINT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6), INDTYPE(x_7),

Research question: How does carbon output intensity (EMSINT) affect accounting-based performance measures?

Table 3.VII: Variables for OLS analysis

Dependent	Independent variables
Return on Assets (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6), INDTYPE(x_7)
Return on Sales (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6), INDTYPE(x_7),

Research question: How does carbon input intensity (ENGINT) affect market-based performance measures?

Table: 3.VIII: Variables for OLS analysis

Dependent	Independent variables
Equity Returns (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6), INDTYPE(x_7)
Market value of	ENGNT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5),

Equity/Sale	(y)	GROWTH(x_6), INDTYPE(x_7),

Research question: How does carbon input intensity (ENGINT) affect accounting-based performance measures?

Table 3.IX: Variables for OLS analysis

Dependent	Independent variables
Return on Assets (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6), INDTYPE(x_7)
Return on Sales(y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6), INDTYPE(x_7),

Fixed Effect estimations:

Research question: How does carbon output intensity (EMSINT) affect market based performance measures?

Table 3.X: Variables for Fixed Effects estimation

Dependent	Independent variables
Equity Returns (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV($_4$),LNMVE(x_5), GROWTH(x_6)
Market value of equity/Sales (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Research question: How does carbon output intensity (EMSINT) affect accounting-based performance measures?

Table 4.XI: Variables for Fixed Effects estimations

Dependent	Independent variables
Return on Assets (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Return on Sales(y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5),

	GROWTH(x_6)

Research question: How does carbon input intensity (ENGINT) affect market-based performance measures?

Table 3.XII: Variables for Fixed Effects estimations

Dependent	Independent variables
Equity Returns (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Market value of Equity/Sale (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Research question: How does carbon input intensity (ENGINT) affect accounting-based performance measures?

Table 3.XIII: Variables for Fixed Effects estimations

Dependent	Independent variables
Return on Assets (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(χ_6)
Return on Sales (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Arellano-Bond DPD estimations:

Research question: How does carbon output intensity (EMSINT) affect market based performance measures?

Table 3.XIV: Variables for Arellano-Bond estimations

Dependent	Independent variables
Equity Returns (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),LNMVE(x_5), GROWTH(x_6)
Market value of	EMISNT(χ_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5),

equity/Sales (y)	GROWTH(x_6)

Research question: How does carbon output intensity (EMSINT) affect accounting-based performance measures?

Table 3.XV: Variables for Arellano-Bond estimations

Dependent	Independent variables
Return on Assets (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Return on Sales(y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Research question: How does carbon input intensity (ENGINT) affect market-based performance measures?

Table 3.XVI: Variables for Arellano-Bond estimations

Dependent	Independent variables
Equity Returns (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Market value of Equity/Sale (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Research question: How does carbon input intensity (ENGINT) affect accounting-based performance measures?

Table 3.XVII: Variables for Arellano-Bond Estimations

Dependent	Independent variables
Return on Assets (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Return on Sales (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Impulse Response Function Analysis:

Research question: How does market-based performance measures respond to carbon output intensity (EMSINT)?

Table 3.XVIII: Variables for IRF analysis

Dependent	Independent variables
Equity Returns (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),LNMVE(x_5), GROWTH(x_6)
Market value of equity/Sales (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Research question: How does accounting-based performance measures respond to carbon output intensity (EMSINT)?

Table 3.XIX: Variables for IRF analysis

Dependent	Independent variables
Return on Assets (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Return on Sales (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_4), GROWTH(x_6)

Research question: How does market-based performance measures respond to carbon input intensity (ENGINT)?

Table 3.XX: Variables for IRF analysis

Dependent	Independent variables
Equity Returns (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Market value of Equity/Sale (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Research question: How does accounting-based performance measures respond to carbon input intensity (ENGINT)?

Table 3.XXI: Variables for IRF analysis

Dependent	Independent variables
Return on Assets (y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Return on Sales(y)	ENGINT(x_1),EMSINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)

Dynamic Panel Threshold estimation:

Research question: How does carbon output intensity (EMSINT) threshold affect market-based performance measures?

Table 3.XXII: Variables for Panel Threshold estimation

Dependent	Independent variables
Equity Returns (y)	EMISNT(x_1), ENGINT(x_2), GROWTH(x_3)
Market value of equity/Sales (y)	EMISNT(x_1), ENGINT(x_2), GROWTH(x_3)

Research question: How does carbon output intensity (EMSINT) affect accounting-based performance measures?

Table 3.XXIII: Variables for Panel Threshold estimation

Dependent	Independent variables
Return on Assets (y)	EMISNT(x_1), ENGINT(x_2), GROWTH(x_3)
Return on Sales (y)	EMISNT(x_1), ENGINT(x_2) GROWTH(x_3)

Research question: How does carbon input intensity (ENGINT) affect market-based performance measures?

Table 3.XXIV: Variables for Panel Threshold Estimation

Dependent	Independent variables
Equity Returns (y)	ENGINT(x_1), EMSINT(x_2), GROWTH(x_3)
Market value of equity/sale (y)	ENGINT(x_1), EMSINT(x_2), GROWTH(x_3)

Research question: How does carbon input intensity (ENGINT) affect accounting-based performance measures?

Table 3.XXV: Variables for Panel Threshold estimation

Dependent	Independent variables
Return on Assets (y)	ENGINT(x_1), EMSINT(x_2), GROWTH(x_3)
Return on Sales (y)	ENGINT(x_1), EMSINT(x_2) GROWTH(x_3)

3.7.1 Carbon Output Intensity effect on Market-Based Measures

Carbon output intensity, also known as emissions intensity as applied in this study, refers to the level of carbon emitted by firms relative to the firms' level of activity. Firms' level of activity in this study refers to firms' sales revenue. Market-based performance refers to the firms' performance on the stock market. The study represents market-based performance by equity returns (EQRTNS) and market value of equity deflated by sales (MVE/S). Market-based performance constitutes the dependent variable, while carbon output intensity (emissions intensity) represents the independent variable.

To answer the question: How does carbon output intensity reflect market-based performance of JSE's SRI firms? The researcher applied ordinary least squares regressions (OLS) on pooled data adopting Telle (2006) and specified the OLS model as:

$$FP_{it} = \alpha + bSUS_{it} + d\,X_{it} + \varepsilon_{it}, \qquad (4)$$

Where:

FP_{it} is financial performance for firm $i = 1,..., N$ in period $t = 1,...,T$. sus_{it} is a vector capturing sustainability performance, X_{it} is a vector of control variables, ε_{it} is the error term. *a* is the constant term, *b* and *d* are vectors that capture the marginal effect of sustainability performance and control variables on financial performance. The vector *sus* may include different kinds of sustainability performance indicators, and in this research it includes carbon output intensity and carbon input intensity.

To estimate the carbon output intensity effect on equity returns (EQRTNS) the study incorporated variables under study into equation (4) and re-specified the model as:

$$EQRTNS_{it} = \alpha + b_1 EMSINT_{it} + b_2 ENGINT_{it} + d_1 OPTINC_{it} + d_2 LEV_{it} + d_3 Ln\ MVE_{it} + d_4 GROWTH_{it} + d_5 INDTYPE + \varepsilon_{it} \quad (5)$$

Where:

$EQRTNS_{it}$ = Equity return, and used to represent financial performance for firm $i = 1,..., N$ in period $t = 1,...,T$. $EMSINT_{it}$ = Emissions intensity, $ENGINT_{it}$ = Energy intensity are the vectors capturing sustainability performance measures carbon output and carbon input respectively. $OPTINC_{it}$,= Operating income, LEV_{it}, = Financial leverage, $LnMVE_{it}$, = Natural log of market value of equity, $GROWTH_{it}$ = Sales growth *and* $INDTYPE_{it}$ = Industry type, are the vectors of control variables. ε_{it} is the error term. *a* is the constant term, *b* and *d* are vectors that capture the marginal effect of sustainability performance and control variables on financial performance. To normalise market value of equity, the study natural logged the variable.

Similarly, to estimate the carbon output intensity effect on Market value of Equity deflated by sales (MVE/S) the study incorporates variables under study into equation (4) and re-specified the model as:

$$MVE/S_t = \alpha + b_1 EMSINT_{it} + b_2 ENGINT_{it} + d_1 OPTINC_{it} + d_2 LEV_{it} + d_3 ASSETS/S_{it} + d_4 GROWTH_{it} + d_5 INDTYPE_{it} + \varepsilon_{it} \quad (6)$$

Where:

MVE/S_{it} = Market value equity deflated by sales, and used to represent financial performance for firm i = 1,..., N in period t = 1,...,T. $EMSINT_{it}$ = Emissions intensity, $ENGINT_{it}$ = Energy intensity are the vectors capturing sustainability performance measures carbon output and carbon input respectively. $OPTINC_{it}$,= Operating income, $LEV_{it,}$ = Financial leverage, $ASSETS/S_{it}$ = Assets deflated by sales, $GROWTH_{it,}$ = Sales growth and $INDTYPE_{it}$ = Industry type, are the vectors of control variables. ε_{it} is the error term. *a* is the constant term, *b* and *d* are vectors that capture the marginal effect of sustainability performance, and control variables on financial performance.

3.7.2 Carbon Output Intensity effect on Accounting-Based Measures

Carbon output intensity, also known as emissions intensity in this study refers to carbon emissions levels of firms relative to their activities. Firms' level of activities refers to sales revenue. Accounting-based performance is as described in the preceding section. The study measures accounting-based performance as before, and it is represented by return on assets (ROA) and return on sales (ROS), and constitute the dependent variables. Carbon output intensity as indicated earlier constitutes an independent variable.

To answer the question: How does carbon output intensity affect accounting-based performance of JSE's SRI firms? The study employed the same statistical estimations as specified in equation (4). Incorporating variables under study into equation (4), the model is re-specified as follows:

$$ROA_{it} = \alpha + b_1 EMSINT_{it} + b_2 ENGINT_{it} + d_1 OPTINC_{it} + d_2 LEV_{it} + d_3 LnASSETS_{it} + d_4 GROWTH_{it} + d_5 INDTYPE_{it} + \varepsilon_{it} \quad (7)$$

Where:

ROA_{it} = Return on assets, is used to represent financial performance for firm i = 1,..., N in period t = 1,...,T. $EMSINT_{it}$ = Emissions intensity, $ENGINT_{it}$ = Energy intensity are the vectors capturing sustainability performance, $OPTINC_{it}$= Operating income, LEV_{it} = Financial leverage, $LnASSETS_{it}$,= Natural log of Assets, $GROWTH_{it}$ =Sales growth ,$INDTYPE_{it}$ = Industry type, are the vectors of control variables, ε_{it} is the error term. a is the constant term, b and d are vectors that capture the marginal effect of sustainability performance and control variables on financial performance. The study normalised Assets by natural logging the variable.

To estimate emissions intensity effect on return on sales (ROS) the study incorporate variables under study into equation (4) and re-specified the model as:

$$ROS_{it} = \alpha + b_1EMSINT_{it} + b_2ENGINT_{it} + d_1OPTINC_{it} + d_2LEV_{it} + d_3ASSETS/S_{it} + d_4 GROWTH_{it} + d_5INDTYPE_{it} + \varepsilon_{it} \quad (8)$$

Where:

ROS_{it} = Return on sales, and represents financial performance for firm i = 1,..., N in period t = 1,...,T. $EMSINT_{it}$ = Emission intensity, $ENGINT_{it}$ = Energy intensity are the vectors capturing sustainability performance emissions intensity and energy intensity respectively. $OPTINC_{it}$, = Operating income, LEV_{it} = Financial leverage $ASSETS/S_{it}$ = Assets deflated by sales, $GROWTH_{it}$ = Sales growth and $INDTYPE_{it}$ = Industry type, are the vectors of control variables. ε_{it} is the error term. a is the constant term, b and d are vectors that capture the marginal effect of sustainability performance, and control variables on financial performance.

3.7.3 Carbon Input Intensity Effect on Market-Based Performance Measures

In this study carbon input intensity (energy intensity) also represents an independent variable. Market-based performance is represented by equity returns

(EQRTNS) and market value of equity deflated by sales (MVE/S) and constitutes a dependent variable as indicated in preceding sections.

To answer the question: How does carbon input intensity reflect EQRTNS of JSE's SRI firms?; the study again employed statistical estimations applied in equation (4). And incorporating variables under study into equation (4), the model is re-stated as:

$$EQRTNS_{it} = \alpha + b_1 ENGINT_{it} + b_2 EMSINT_{it} + d_1 OPTINC_{it} + d_2 LEV_{it} + d_3 LnMVE_{it} + d_4 GROWTH_{it} + d_5 INDTYPE_{it} + \varepsilon_{it} \quad (9)$$

Where:

$EQRTNS_{it}$ = Equity returns, and represents financial performance for firm i = 1,..., N in period t = 1,...,T. $ENGINT_{it}$ = Energy intensity, $EMSINT_{it}$ = Emissions intensity are the vectors capturing sustainability performance measures carbon input and carbon output respectively. $OPTINC_{it}$,= Operating income, $LEV_{it,}$ = Financial leverage, $LnMVE_{it,}$ = Natural log of market value of equity, $GROWTH_{it}$ = Sales growth *and* $INDTYPE_{it}$ = Industry type, are the vectors of control variables. ε_{it} is the error term. *a* is the constant term, *b* and *d* are vectors that capture the marginal effect of sustainability performance and control variables on financial performance. To normalise market value of equity as before, the study natural logged the variable.

To estimate the carbon input intensity effect on market value of equity deflated by sales (MVE/S) the study incorporate variables under study into equation (4) and re-specified the model as:

$$MVE/S_t = \alpha + b_1 ENGINT_{it} + b_2 EMSINT_{it} + d_1 OPTINC_{it} + d_2 LEV_{it} + d_3 ASSETS/S_{it} + d_4 GROWTH_{it} + d_5 INDTYPE_{it} + \varepsilon_{it} \quad (10)$$

Where:

MVE/S_{it} = Market value equity deflated by sales, and it is used to represent financial performance for firm i = 1,..., N in period t = 1,...,T. $ENGINT_{it}$ = Energy intensity, $EMSINT_{it}$ = Emissions intensity are the vectors capturing sustainability performance measures carbon input and carbon output respectively. $OPTINC_{it}$,= Operating income, LEV_{it}, = Financial leverage, $ASSETS/S_{it}$ = Assets deflated by sales, $GROWTH_{it}$, = Sales growth and $INDTYPE_{it}$ = Industry type, are the vectors of control variables. ε_{it} is the error term. a is the constant term, b and d are vectors that capture the marginal effect of sustainability performance, and control variables on financial performance.

3.7.4 Carbon Input Intensity effect on Accounting-Based Measures

Carbon input intensity (Energy intensity) is described as in the preceding sections and represents the independent variable. Accounting-based performance is also as described in preceding sections.

To answer the question: How does carbon input intensity affect ROA of JSE's SRI firms? The study employed statistical estimations as before (equation 4), and putting variables under-study into equation (1) the study re-stated the model as:

$$ROA_{it} = \alpha + b_1 ENGINT_{it} + b_2 EMSINT_{it} + d_1 OPTINC_{it} + d_2 LEV_{it} + d_3 LnASSETS_{it} + d_4 GROWTH_{it} + d_5 INDTYPE_{it} + \varepsilon_{it} \quad (11)$$

Where:

ROA_{it} = Return on assets, and represents financial performance for firm i = 1,..., N in period t = 1,...,T. $ENGINT_{it}$ = Energy intensity, $EMSINT_{it}$=Emissions intensity are the vectors capturing sustainability performance, $OPTINC_{it}$, = Operating income, LEV_{it} = Financial leverage, $LNASSETS_{it}$ = Natural log of assets, $GROWTH_{it}$ = Sales growth and $INDTYPE_{it}$ = Industry type, are the vectors of control variables. ε_{it} is the error term. a is the constant term, b and d are vectors that capture the marginal effect of sustainability performance, and control variables on financial performance. As indicate earlier, the study normalised Assets by natural logging it.

To answer how does carbon input intensity affect ROS of JSE's SRI firms, the study employed statistical estimations as before (equation 4), and incorporating variables under study into equation (4) the study re-stated the model as:

$$ROS_{it} = \alpha + b_1 ENGINT_{it} + b_2 EMSINT_{it} + d_1 OPTINC_{it} + d_2 LEV_{it} + d_3 ASSETS/S_{it} + d_4 GROWTH_{it} + d_5 INDTYPE_{it} + \varepsilon_{it} \quad (12)$$

Where:

ROS_{it} =Return on assets, which represents financial performance for firm i = 1,..., N in period t = 1,...,T. $ENGINT_{it}$ = Energy intensity, $EMSINT_{it}$ = Emissions intensity are the vectors capturing sustainability performance measures respectively. $OPTINC_{it}$ = Operating income, LEV_{it} = Financial leverage, $ASSETS/S_{it}$ = Assets deflated by sales, $GROWTH_{it}$ = Sales growth, and $INDTYPE_{it}$ = Industry type, are the vectors of control variables. ε_{it} is the error term. a is the constant term, b and d are vectors that capture the marginal effect of sustainability performance, and control variables on financial performance.

3.8 Addressing Omitted Variable Bias

Because relationships of variables under study are characterised by joint endogeneity, that is, most explanatory variables in the model are either simultaneously determined with the dependent variable or have bidirectional causal relationships, the presence of unobserved firm specific effects is evident. Hence, ignoring such effects might have led to inconsistent estimates, as firm specific effects are likely to be correlated with the explanatory variables (Baum, 2013).

Telle (2006) cited that although equations (5), (6), (7), (8), (9), (10), (11) and (12) on their individual own controls for several apparently relevant factors, omitted unobserved variables could still be the main reason for the estimated effect. If omitted variables that influence financial performance (e.g. quality of management, employee motivation, technology), are correlated with sustainability performance, OLS regressions (5), (6), (7), (8), (9), (10), (11) and (12) that omit such variables would produce biased and inconsistent estimates. The omitted variable bias is not unlikely to plague the firm level studies of the effect of sustainability performance on financial performance.

Telle (2006) pointed out that in the attempt to address the problem of omitted variable bias, the apparent procedure is to measure the omitted variable and incorporate it into a model. Moreover, quantitative data, such as ‘quality of management’, employees, motivation, and level of technology are hardly available and difficult, if not impossible to measure. The author argues that because of the difficulties, instrumental variable estimation may be applied. Telle, argued that a variable is a valid instrument for sustainability performance if it is correlated with the sustainability performance variable and uncorrelated with the error term. Because it is often difficult to come up with good instruments, the author concluded that, there is a way to address the problem of omitted variables that is easy to apply if panel data are available.

Telle, (2006) cited King and Lenox (2001) as the first study to have controled for unobserved firms’ specific effects to estimate environmental performance relations with financial performance applying a panel data set of 652 US firms, which found a positive effect of sustainability performance on financial performance. King and Lenox (2001) however concluded that they are unable to rule out possible confounding effects as causes of their positive results.

This study accounted for estimated effect resulting from firms’ specific unobserved omitted variable bias utiliseing a Fixed Effects (within) model. This is after random effect estimation failed to produce *Wald chi2 and Prob > chi2 figures* from the estimated results.

Fixed effect model assumes that individual heterogeneity is explained by the different intercept terms, while the Random effect model handles this using random disturbance term u_i which is presumed constant through time. To account for a firm's specific unobserved omitted variable bias the researcher re-estimated equations (5), (6), (7), (8), (9), (10), (11) and (12) employing a fixed effect model, adopting Baum (2013), and specified the fixed effect model as:

$$FP_{it} = \alpha_i + \beta CI_{it} + dW_{it} + u_i \qquad (13)$$

Where:

FP_{it} is financial performance for firm i = 1,..., N in period t = 1,...,T, CI_{it} is a vector capturing sustainability performance, a_i denotes the intercept of CI_{it} and X_{it}. W_{it} could include the same variables as X_{it} in equations (5), (6), (7), (8), (9), (10), (11) and (12), and u_i is an error term. In this instance u_i controls for unobserved firm characteristics (like time invariant elements such as; management quality, employee motivation and level of technology). The extent that an omitted variable is constant over time the procedure amends the problem of omitted variable bias, according to Baum (2013).

3.9 Addressing Omitted Variable Bias and Orthogonality Conditions[1]

Baum (2013) suggests that in the context of panel data unobserved heterogeneity is properly dealt with by applying the within (demeaning) transformation as in Fixed/Random effects models, and emphasised the ability of first-differencing in removing unobserved heterogeneity by estimators that have been developed for dynamic panel data estimations, that contains one or more lagged dependent variable allowing for the modelling of a partial adjustment mechanism. Nickell, (1981) argued that there is always the possibility of correlation between the error

[1] This line of argument is based extensively on Nickell Bias

term and regressors in OLS and Fixed/Random Effect estimations. Nickell, (1981) further stated that a problem associated with Fixed effect models in the context of a dynamic panel data model particularly in the “small T, large N" context is present. The problem, he argues, arises because the demeaning process which subtracts the individual’s mean value of y and each X from the respective variable creates a correlation between regressors and error. The resulting correlation, the author cites, creates a bias in the estimate of the coefficient of the lagged dependent variable which is not mitigated by increasing N.

The author cites that the demeaning operation creates a regressor which cannot be distributed independently of the error term. If the error process is auto-correlated, the problem is even more severe given the difficulty of deriving at a consistent estimate of the auto regressive (AR) parameters in that context. The same problem, the author argues, also affects one-way random effect estimation. That, u_i error component enters every value of y_{it} by assumption so that the lagged dependent variable cannot be independent of the composite error process. Nickell, (1981) suggested that one solution to this problem involves taking first the differences of the original model. This Nickell, (1981) argued removes both the constant term and the individual effect. Nonetheless, the author cited that there could still be correlation between the differenced lagged dependent variable and the disturbance process.

Owing to the low power associated with OLS and Fixed Effect estimators, Baum (2013) recommended for dynamic panel models, such as Arellano-Bond dynamic panel data estimations, considered more efficient and superior as it is capable to account for omitted variable bias, possible orthogonality conditions and handles panel data in which the cross-sectional dimension is larger than the time series dimension.

Therefore, the researcher applied the estimator (Arellano-Bond estimation) to examine the carbon intensity (carbon output and carbon input intensity) relationship with accounting-based performance measured by return on assets (ROA) and return on sales (ROS) and that of the market-based performance measured by equity returns (EQRTNS) and market value of equity deflated by sales (MVE/S) of JSE's SRI firms, and specified the Arellano-Bond dynamic panel data model is thus specified as:

$$Y_{it} = X_{it}\beta_1 + W_{it}\beta_2 + V_{it} \quad (14)$$

$$V_{it} = u_i + e_i$$

Where:

X_{it} includes strictly exogenous regressors; W_{it} is predetermined regressors (which may include lags of y) and endogenous regressors, all of which may be correlated with u_i, the unobserved individual effect. First-differencing the equation removes the u_i and its associated omitted-variable bias. Default of the estimation is the two-step process, but as the standard error of this process is bias, the study computes the estimation statistic using the one-step process. In conclusion, to account for omitted variable bias, possible orthogonality conditions and to take care of cross-sectional and time series dimensions in-balances, the researcher re-estimated equations (2), (3), (4), (5), (6), (7), (8) and (9) applying Arellano-Bond estimation using statistical software STATA.

3.10 Panel Unit Root Test

Since panel regressions in which the series are non-stationary could lead to spurious results, the study performed stationary test to determine if the series are stationary or not at level utilising a "Fisher type" unit root test based on the Augmented Dickey-Fuller approach (ADF). A series is said to be stationary if the mean and variance of the series do not systematically differ over the time period. A Fisher type test presumes the data are generated by an autoregressive (1) process, and that, for higher-order processes, the first-differenced and lagged-level data are replaced by the residuals from regressions of those two series on the first lags of the first-differenced data (Levin, Lin and Chu, 2002). Since demeaning requests that unit root first subtract the cross-sectional averages from the series, when specified, each time period unit root computes the mean of the series across panels and subtracts this mean from the series. This procedure, Levin et al. (2002) argue, mitigates the effect of cross-sectional dependence. This approach was utilised in the dynamic panel estimations (Arellano-Bond estimations, Threshold regressions and Impulse response function analysis in short panel autoregressions). This is the reason for differences in observations under OLS, fixed effects and Arellano-Bond results (see pp.102, 104,106), based on the concept of first differencing (Arellano-Bond, 1991).

3.11 Marginal Means (eyex)

Because some of the coefficients produced from estimations are too large (see appendix: 2 i, ii & iii) the study applied margins at means procedure to normalise the coefficients by applying eyex option of margins to estimate elasticities of variables in the varlist. ‘’Margins are statistics calculated from predictions of a previously fit model at fixed values of some covariates and averaging or otherwise integrating over the remaining covariates. Capabilities include estimated marginal means, least-squares means, average and conditional marginal and partial effects (which may be reported as derivatives or as elasticities), average and conditional adjusted predictions, and predictive margins’’ (StataCorp, 2011).

3.12 Carbon Intensity and Financial Performance: Impulse Response Analysis in Short Panel Vector Autoregressions

It is important for management to be aware as to ‘when’ and ‘for how long’ do ‘green’ activities pay financially. The appropriate statistic that may indicate ‘’when’’ and ‘for how long’ a green activity may be value driven or value destroying is the impulse response function statistic. In this section the study examined the response of accounting and market-based performance indicators (ROA and ROS EQRTNS, MVE/S) to shocks in sustainability performance measured by emissions intensity (EMSINT) and energy usage intensity (ENGINT) utilising Impulse

Response Function (IRF) analysis in short panel vector auto regressions (SPVARs).

The impulse response approach tracks the impact of any variable on others in a system and serves as a tool in empirical causal analysis. This research performed IRF analysis adopting Cao and Sun (2011). The researcher performs this analysis (Impulse Response) on the assumption that the slope coefficients of the series are the same across different cross-sectional units and that there is no cross sectional dependence after controlling for fixed time effects. Cao and Sun, (2011) argued that this assumption permits long-horizon forecasts, comparable to time series length, which is consistent with Binder et al.'s (2005) use of short PVARs to infer long run properties of the underlying time series.

3.12.1 Impulse Response Function's For Reduced Form

Cao and Sun (2011) cited that because the impulse response function does not depend on the index *i* and fixed effects in the system, the subscript *i* is omitted in considering the panel reduced-form vector auto regressions (PVAR) model, which may be stated as:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t \quad \text{for } t = 0, \ldots T, \qquad (15)$$

The impulse response function matrix is defined to be:

$$\phi_j = \frac{\partial y_t + j}{\partial u_t'}$$

Where:

The (k, ℓ) *-th* element of ϕ_j describes the response of k-*th* element of y_{t+j} to one unit impulse in ℓ - *th* element of y_t with all other variables dated *t* or earlier held constant.

To determine how accounting and market-based performance indicators, measured by ROA, ROS, EQRTNS and MVE/S respond to shocks in sustainability indicators, measured by carbon output intensity (EMSINT) and carbon input intensity (ENGINT) the study utilised variables applied in equations (2) - (9) without the industry dummy (INDTYPE) as indicated in Tables 3.XVIII-3.XXI.

3.13 Carbon Intensity and Financial Performance: Dynamic Panel Estimation

In the attempt to examine how firms' carbon emissions reduction affects financial performance, an important research question worth asking is, is there a 'tipping point' in firms' carbon emissions reduction beyond which financial performance improves significantly? Threshold statistics measure a 'tipping point' beyond which it becomes disadvantageous to continue with a certain line of operational performance or it becomes evident that an advantage exists to maintain the status-quo. To investigate and estimate if there exist such a 'tipping point' the researcher applied Panel dynamic threshold models adopting Seo and Shin (2014) utilising statistical software R.

Hansen (1999) estimated and tested threshold effects in static panels with fixed effects and homogeneous slopes with panels where 'T' is short and 'N' is large. Hansen, (1999) approach eliminates individual specific effects by demeaning, but not to be extended to panels with heterogeneous slopes.

Chudik et al. (2015) applied panels with large 'N' and 'T', which allow them to deal with simultaneity, heterogeneous dynamics, error cross-sectional dependence and to maintain homogeneity of the threshold parameters. Dang et al. (2012) argued that GMM estimators applicable to the dynamic panel threshold models provide consistent estimates of heterogeneous speeds of adjustment as well as a valid testing procedure for threshold effects in short dynamic panels with unobserved individual effects.

Seo and Shin (2014) allowed for dynamics and threshold effects, assuming slope homogeneity and used instruments to deal with endogeneity once the fixed effects are eliminated by first-differencing. To overcome the problem of exogeneity of regressors and, or the transition variable that may hamper the usefulness of threshold regression models in a general context as postulated by Seo and Shin (2014), the researcher employed a dynamic panel model based on first difference (FD) transformation and bootstrap methodology in determining statistical significance of emissions intensity (EMSINT) and energy intensity (ENGINT) threshold effects on the accounting and market-based performance indicators measured by ROA, ROS, EQRTNS and MVE/S of JSE's SRI firms to simulate the asymptotic distribution of the Likelihood ratio test. Following Seo and Shin (2014), the study specified the threshold model as:

$$y_{it} = (1, x'_{it})\,\phi_1 1(q_{it} \leq \text{٢}) + (1, x'_{it})\,\phi_2 1(q_{it} > \text{٢}) + \varepsilon_{it},\; i = 1, \dots, n;\; t = 1, \dots, T, \qquad (16)$$

Where:

y_{it} is a scalar stochastic variable of interest, x_{it} is the k_1 x 1 vector of time varying regressors, which may include the lagged dependent variable, 1(**.**) is the indicator function, and q_{it}, is the transition variable. ٢ is the threshold parameter, and ϕ_1 and ϕ_2 are the slope parameters associated with different regimes. ε_{it} is the regression error, consisting of the error components:

$$\varepsilon_{it} = a_i + v_{it} \qquad (17)$$

Where a_i is the unobserved individual fixed effect and v_{it} is a zero mean idiosyncratic random disturbance. v_{it} is assumed to be the martingale difference,

$$E(v_{it} \mid F_{t-1}) = 0$$

Where:

F_t is a natural filtration at time t. It is worth mentioning that it is not assumed x_{it} or q_{it} to be measurable with respect to F_{t-1}, thus allowing endogeneity in both the regressor, x_{it} and the threshold variable, q_{it}. The author cited that efficient estimation depends on whether q_{it} is exogenous or not. Nickell (1981) cited downward biasness of the linear dynamic panel's fixed effects estimation of autoregressive parameters. To deal with the correlation of regressors with individual effects as in the dynamic panel threshold regression equation (16), the researcher applied Arellano-Bond dynamic panel data estimator and considered the first-difference transformation of equation (16) as:

$$\Delta y_{it} = \beta' \Delta x_{it} + 'x'_{it} 1_{it} (\text{٢}) + \Delta\varepsilon_{it}, \qquad (18)$$

Where Δ is the first difference operator,

$$\underset{k1x1}{\beta} = (\phi_{12, \ldots,} \phi_{1, k1} + 1)', \quad \underset{(k1+1)x1}{\breve{o}} = \phi_2 - \phi_{1,} \text{ and}$$

$$\underset{2x(1+k1)}{xit} = \begin{pmatrix} (1, & x'it) \\ (1, & x'i,t-1) \end{pmatrix} \text{ and } \underset{2x1}{1it\,(\text{٢})} = \begin{pmatrix} 1\,(qit > \text{٢}) \\ -1\,(qit-1 > \text{٢}) \end{pmatrix}$$

Extending equations (17 & 18) into the dynamic panel data framework with threshold, this study re-stated the threshold model as:

$$y_{it} = (1, x'_{it})\, \phi_1 1(q_{it} \leq \text{٢}) + (1, x'_{it})\, \phi_2 1(q_{it} > \text{٢}) + (1, x'_{it})\, \phi_3 1(q_{it} > \text{٢}) + a_i + v_{it} \qquad (19)$$

The model used emissions intensity (EMSINT) as the transition variable if carbon input intensity (ENGINT) and GROWTH are used as regressors. Alternatively, if ENGINT is used as the transition variable, EMSINT and GROWTH are used as regressors. The researcher introduced GROWTH in the model to allow for effect of changes in growth opportunities (see Table 3.XXII- XXV) for variables used in the estimations).

Hansen (1999) suggests that in determining the threshold effect of a variable on another, it is important to determine whether the threshold effect is statistically significant, and cites that under H_0 (There is no threshold) the threshold ٢ is not identified, hence classical tests have non-standard distributions which is traditionally known as ‘Davies’ Problem' (Davies, 1987, 1977).

3.14 Measure of Financial Performance

The study uses accounting and market-based measures as proxies for financial performance. Dess and Robinson (1984) argued that it may be difficult to obtain an objective and reliable single measure of firms' financial performance, mostly because of complex interactions surrounding corporate governance architecture, financial and marketing processes. Hence, Griffin and Mahon (1997) recommend that it is more appropriate to use more than one "convenient" financial measure in order to encompass information on a broader set of performance issues.

Griffin and Mahon argued that, while it is a common place that accounting indicators are considered to capture the performance characteristics of the quasi-controlled internal environment of the company, market-based indicators rely on the aggregated nature of information impounded in stock price. Dragomir (2009) argues that in assessing a firm's financial performance, stakeholders cannot simply rely on stock price changes to provide necessary information about the source of changes to firm value. This is because the accounting system facilitates boards' efforts to separate controllable from uncontrollable events, while stock returns aggregate the implications of all events. It is on this premise that this study employed three financial performance measures, return on assets, stock returns and market value of equity as proxy for firm's financial performance.

3.14.1 Return on Asset (ROA)

The return on assets is a measure of the success of a firm in using assets to generate earnings independent of the sources of financing those assets (Selling and Stickney, 1989). As an earnings-based performance metric, return on assets is measured as income before extraordinary items are scaled by lagged total assets. Bowen et al, (2008) argued that return on assets as a measure of financial performance suffers less from the timeliness problems. Yet, because accruals reverse over time, use of accounting discretion in the past might be correlated with the use of accounting discretion in the future, and hence with future return on assets. The study considered data mining issues relating to return on assets; such as the application of the average of accounting-based measures over several periods as suggested by Balabanis et al. (1998) and McGuire et al. (1988), and applied the average of reporting exchange rates in relations to total assets and operating income of companies that report in currencies other that South African Rand. The study computed return on assets following Selling and Stickney, (1989) as:

$$ROA = \frac{\text{Net income} + (1 - \text{tax rate})(\text{interest expense})}{\text{Total assets}}$$

3.14.2 Return on Sales (ROS)

Return on sale is an accounting-based measure designed to gauge the financial health of a business. The measure may be defined as the ratio of profits earned to total sales receipts (or costs) over a defined period of time. The study estimates a profit margin for firm $_i$ in year $_t$ as profit before interest charges and tax, investment income and a firm's share of the profits of associated undertakings excluding deflated sales revenue for firm $_i$ in year $_t$ (Telle, 2006; Holmes et al., 2005; Hart and Ahuja,1996). Following Holmes et al. (2005), the study estimates the profit margin as:

$$ROS = \frac{\text{Operating Earnings}}{\text{Sales}}$$

3.14.3 Equity Returns (EQRTNS)

Bowen et al. (2008) argue that using stock returns as a measure of a firm's performance may result in lower power in discriminating between efficient contracting and opportunism because such a test is a joint test of stock market efficiency and contracting efficiency. The authors argue that if opportunism were the true state of the world, on average, investors in an efficient stock market might anticipate such opportunism and factor it into the existing stock price. As a result, future stock returns could be unrelated to accounting discretion even in the presence of managerial opportunism. Bowen et el, (2008) cited that there is still an advantage in using stock returns as a performance measure as recent empirical evidence in Gompers et al. (2003) suggests that the stock market does not instantaneously impound information about governance (although Core et al. 2006 challenge this finding). The authors find that a trading strategy that assumes long or short positions in well or poorly governed firms would earn abnormal future stock returns. In estimating stock returns for a period, the study adopts Murray et al.'s (2006) estimation which is calculated as:

$Rt_{i,t} = P_{i,t} / P_{i;t-1}$

Where:

$Rt_{i,t}$ is the return earned by company $_i$ during year $_t$;

$P_{i,t}$ is the price of a share $_i$ at the end of year $_t$; and

$P_{i,t-1}$ is the price at the beginning of the year.

3.14.4 Market Value of Equity Deflated By Sales (MVE/S)

Studies that examine carbon and other environmental emissions levels relations with firm value (measured as market value of equity) are sparse. Chapple et al. (2009), and Matsumura et al, (2011) examine the association between carbon emissions and firms' value, and conclude that the market penalises highly polluted firms. Hughes, (2000); Johnston et al, (2008) examine the relationship between sulphur and firms' value, and also conclude that market penalises the high-polluting utilities in certain circumstances. In Johnston et al, (2008), market value of equity deflated by sales (MVE/S) is measured as a closing equity price of a company, multiplied by shares outstanding (i.e. closing equity price on the reporting date multiplied by shares outstanding) divided by the annual sales revenue. Since companies' market value of equity does not consider the growth potentials of a company, this study purposely deflated market value of equity by sales to include the effect of growth on market value of equity. The study observed that 43% of the sampled firms have December fiscal year end.

3.15 Measure of Carbon Intensity Performance

Carbon intensity relates to a company's physical carbon performance and describes the extent to which firms' business activities are based on carbon related energy usage (input) and associated emissions (output) for a defined scope and fiscal year (Hoffmann and Busch, 2008). Though South Africa has not implemented the Carbon Tax law and Emissions Trading Scheme (ETS), companies operating in jurisdiction are faced with ever increasing pressure from stakeholders to measure and disclose their carbon emission levels. Given the European Union's experience, investors globally recognise that companies with high emissions and energy-consumption levels face risks from emerging regulations prompted by concerns about global climate changes. Consequently, costs of complying with increasing regulatory requirements related to emissions and consumption are expected to be economically significant and experts agree that the firms' carbon intensity will dictate which ones will face the greatest costs of regulatory compliance (PricewaterhouseCoopers, 2009)

3.15.1 Carbon Input Intensity (Energy Usage) Performance

This study adopted Busch and Hoffmann, (2011) and Dragomir, (2009) carbon intensity measures as proxies for carbon emissions reduction, operationalised by carbon input intensity (energy intensity) and carbon output intensity (emissions intensity). Energy intensity is measured as the ratio between energy consumption (in Megawatt-hours) and sales revenue (in Rand) based on Hoffmann and Busch (2008). Energy intensity (ENGINT) is measured as:

$$CIIn_{i,t} = \sum_{k=1}^{kI} CIk,t \text{ / Sales Revenue}$$

Where:

k = 1... KI is the index for the *K*I different inputs and *t* is the fiscal year of analysis. Energy intensity ($CIIn_{i,t}$) is derived for a chosen scope *i* = 1, 2 and fiscal year *t* when a business metric (sales revenue) is taken into account.

3.15.2 Carbon Output Intensity (Emissions) Performance

Carbon output intensity (emissions intensity) is measured as the ratio between total GHG emissions (in Tonnes) and sales revenue (in Rand). Following Hoffmann and Busch (2008), emissions intensity (EMSINT) is derived analogously from the energy intensity (ENGINT) formulae above and is estimated as:

$$CoIn_{i,t} = \sum_{k=1}^{kI} Cok,t \text{ / Sales Revenue}$$

3.16 Control Variables

Hoffmann and Busch (2011**),** Ullmann (1985), and Waddock and Graves (1997) argue that firm size and financial risk (leverage) are two factors that affect firms' financial performance. Waddock and Graves (1997) argue that larger firms exhibit more socially responsible behaviour than smaller firms. The authors argue that the relationship may be especially true for climate-relevant aspects in view of the media hype in recent years. Waddock and Graves (1997), and Hoffmann and Busch (2011) argue that management's risk tolerance influences activities such as recycling, waste-reduction efforts and investment in pollution control equipment. The authors concluded that this influence might also apply to carbon risk management.

Following Hoffmann and Busch (2011), financial risk is employed as a control variable and is proxy of leverage. The study measures leverage as long-term debt to total assets (Dragmoir, 2010). Matsumura et al. (2011) argue that market value of a firm is a function of the firms' operating income. The authors cite that firms with higher operating income (OPTINC) are most invariably valued more by the market. The study employed operating income as a control variable, and it is measured in the study as profit before extra-ordinary items and finance cost. Following Johnston et al. (2008), sales growth is employed to control for growth opportunities not reflected in other variables in the models. Sales growth is measured as change in sales over the previous eight fiscal years. For the purposes of the non-dynamic estimation, especially with the OLS estimations, industry dummy to proxy for differences in firms' inherent business risk is introduced into various models. The vector of dummy variable indicates firm industry membership (Bachoo et al., 2013; Busch & Hoffmann, 2011) with 1 representing a mining company, otherwise 0.

3.17 Validity and Reliability

To accurately measure what this study intends to measure and to make sure findings of this study accurately represent what is really happening in a real situation and to be generalised beyond the sample used in the study, the study evaluated parameters under study and made sure discrepancies involving the parameters were reduced. The study considered only JSE manufacturing and mining companies under the Socially Responsible Investment index and meeting the study's eligibility criteria. The study validated its final results by examining equity price, financial statements, energy consumption and emissions data to avoid misrepresentations and biases.

3.18 Ethical Consideration

This research involves the examination of corporate annual environmental, financial and accounting performance data of JSE's SRI firms which are in the public domain. And thus, it is not protected by copyright, nor does it demand fees and license to access. Hence, information extracted from these sources for the purposes of this research is not used in any way for the personal gains of the researcher. The study also adhered to approved academic standards and requirements for undertaking business research.

3.19 Summary of Chapter 3

Literature on the environmental performance effect on accounting and market-based measures has been reviewed covering methodologies such as: Event studies; Portfolio analyses; Correlation analysis; Pooled data estimations; Fixed Effects/Random Effects estimations in spite of their inherent limitations. To account for some of these shortcomings, alternative estimations techniques were employed together with what has been previously applied in an attempt to obtain robust and comprehensive results. Amongst the information used, some of the previously applied techniques include: Arellano-Bond dynamic panel data estimations, Impulse response function analysis in SPVAR, Dynamic panel threshold estimations, and Panel causality estimations. To the best of the researcher's knowledge, the study is the first in the area of quantitative environmental accounting research in South Africa to have applied estimations to establish the carbon intensity effect on financial performance. Specifically, this is the first study in the quantitative environmental accounting research to apply impulse response function analysis in short PVARs where the cross sectional dimension (N) is large, fourteen (14) companies, and a time series dimension (T) of seven years.

CHAPTER 4

EMPIRICAL RESULTS AND ANALYSIS

4.1 Introduction

This chapter presents the empirical results and analyses of the study. Section 4.1 of the chapter presents descriptive statistics, correlation analysis, cross-sectional dependence test, panel Granger causality test, Ordinary least square regressions results, fixed effects and Arellano-Bond estimations. Section 4.2 of the chapter presents results and analysis from Impulse response function analysis in SPVARs, while section 4.3 presents results and analysis from bootstrap dynamic panel threshold estimations.

4.2 Carbon Intensity effect on Financial Performance Measures

This section of the study uses OLS to estimate the emissions intensity (EMSINT) and energy intensity (ENGINT) effect on accounting and market-based measured by ROA, ROS, EQRTNS and MVE/S applying statistical software STATA. Table 4.I reports the summary statistics for all the variables under study. The results indicate positive mean value of all variables except EQRTNS. MVE exhibited a mean of 6.9900, while LEV showed the mean of .1585022 and a standard deviation of .1270558. OPTINC exhibited the highest standard deviation of 4.9000. ROA showed the mean of 0.0913539, with ROS showing the mean of 0.1083256. And indication that JSE's SRI firms' earn less from Asset utilisation than from Sales turnover. EQRTNS showed a mean of - 0.035142, while ROA showed a mean of .0913539 signifying that more is earned on ASSETS than on equity.

Table 4.I: Descriptive statistics

Variable	Obs	Mean	Std Dev	Min	Max
Roa	98	.0913539	.1203229	-.2522224	.5123511
Ros	98	.1083256	.3089163	-2.34975	.5515416
Eqrtns	98	-.035142	.3297333	-.9935201	.7615842
Mve	98	6.99000	1.6400	1.0600	8.8000

Lev	98	.1585022	.1270558	.0028928	.4958963
Optinc	98	2.1100	4.9000	-2.3500	2.4300
Engint	98	.0008762	.0017926	.0000159	.0080242
Emsint	98	.0004165	.0006928	8.1400	.0032496
Assets	98	1.7400	2.7900	3.4000	1.5700
Growth	98	.0647804	.2202041	-.9445391	.6797312

Note: Roa, Ros, Eqrtns, Engint, Emsint, Lev, Growth are measured in percentage, while Mve, Optinc and Assets are measured in Rand and in billions.

Table 4.II reports Pair-wise correlation between variables applied in the regression models (except INDTYPE). Consistent with some previous correlation studies (e.g. Orlitzky, 2001) the result exhibited positive relationships between carbon intensity (EMSINT and ENGINT) and return on assets (ROA). On the contrary, carbon intensity (EMSINT and ENGINT) showed negative association with market market-based indicators, measured by market value of equity deflated by sales (MVE/S) and equity returns (EQRTNS). Although, the calculated correlation could be due to confounding variables as cited by Telle (2006), the correlation result showed some level of consistency with other multivariate econometric results of this study.

Table 4.II: Pairwise Correlation

	Roa	**Ros**	**Eqrtns**	**Mve/s**	**Lev**	**LnMve**	**Optinc**
Roa	1.0000						
Ros	0.6103	1.0000					
Eqrtns	0.0965	0.1649	1.0000				
Mve/s	-0.1983	-0.7394	-0.0117	1.0000			
Lev	0.1517	0.1248	0.1437	-0.0814	1.0000		
LnMve	-0.1578	-0.0609	0.1842	0.3881	0.2840	1.0000	
Optinc	0.3706	0.3176	0.2395	-0.0934	0.1044	0.1457	1.0000
Emsint	0.1829	0.0389	-0.0124	-0.0129	0.0230	-0.2695	-0.1711
Engint	0.1087	0.0324	-0.0297	-0.0218	0.0648	-0.1859	-0.1586
LnEmsint	0.2312	-0.0091	-0.1035	-0.0513	-0.1062	-0.5924	-0.1922
LnEngint	0.2005	-0.0159	-0.0909	-0.0691	0.0055	-0.5199	-0.2080
Assets/s	-0.2296	-0.8060	-0.0860	0.9186	-0.0790	0.1292	-0.0561
LnAsset	-0.0488	0.1099	0.2033	0.0248	0.0789	0.4773	0.6336
Growth	0.2222	0.4805	0.1937	-0.4358	-0.0291	0.0126	0.1229

	Emsint	**Engint**	**LnEmsint**	**LnEngint**	**Assets/s**	**LnAsset**	**Growth**
Emsint	1.0000						
Engint	0.9755	1.0000					
LnEmsint	0.7561	0.6728	1.0000				
LnEngint	0.7881	0.7747	0.8931	1.0000			
Assets/s	-0.0254	-0.0535	0.0617	-0.0016	1.0000		
LnAsset	-0.6075	-0.5637	-0.5676	-0.5742	0.0495	1.0000	
Growth	0.0566	0.0718	-0.0718	-0.0739	-0.4619	0.0313	1.0000

4.2.1 Causal Analysis between Carbon Intensity and Financial Performance

To establish the existence of cross-sectional dependence or otherwise, two distinct tests were carried out and the results reported in Table 4.III. The results rejected the null of no cross-sectional dependence across members at 1% significant level from seven out of eight variables tested. Evidence of cross-sectional dependence across the SRI's manufacturing and mining firms' variables indicate that a shock to either the financial performance measures or carbon intensity in a firm is likely to be transmitted to other firms. This could be explained from the point of view that the firms are confronted with similar socio-economic and political challenges.

Table 4.III: Cross-sectional dependence tests

TEST	ROA	ROS	EQRTNS	MVE/S
CD_{LM}	139.096, (0.0009)	169.613,(0.0000)	4.909,(0.0000)	243.021, (0.0000)
CD	5.829, (0.0000)	6.287, (0.0000)	0.488 (0.6255)	4.909, (0.0000)

Note: Figures in brackets denote p-values, and the other, the test statistics. LM test and CD test represent cross-sectional dependence tests of Breusch-Pagan (1980) and Pesaran (2004).

Panel Granger causality results are reported in Table 4.IV and 4.V respectively. Results from Table 4.IV show that energy intensity (ENGINT) does not Granger-cause financial performance. It was also found that financial performance (FP) does also not Granger-cause energy intensity (ENGINT). As regards the causality from emissions intensity (EMSINT) to financial performance (FP), results in Table 4.V shows unidirectional causality of emissions intensity (EMSINT) to equity returns (EQRTNS) at 1% significant level. The results also show bidirectional causality between emissions intensity (EMSINT) and market value of equity deflated by sales (MVE/S) at 1% significant levels. It is therefore possible to conclude that prior improvement in EMSINT leads to subsequent improvement in EQRTNS. It is also true to say that while prior improvement in EMSINT leads to subsequent improvement in MVE/S, prior performance in MVE/S also leads to subsequent improvements in EMSINT of the SRI's manufacturing and mining firms.

Table 4.IV: Panel Granger causality tests

Variable	H_0: ENGINT does not Granger cause FP		H_0: FP does not Granger cause ENGINT	
	Chi2	P-value	Chi2	P-value
ROA	0.62	0.4297	0.12	0.7240
ROS	0.51	0.4736	0.30	0.5844
EQRTNS	0.13	0.7137	0.14	0.7124
MVE/S	0.43	0.5103	1.54	0.2147

Note: *, ** and *** denote the significance for at 0.1, 0.05 and 0.01 levels respectively.

Table 4.V: Panel Granger causality tests

Variable	H_0: EMSINT does not Granger cause FP		H_0: FP does not Granger cause EMSINT	
	Chi2	P-value	Chi2	P-value
ROA	0.35	0.5554	0.25	0.6173
ROS	0.29	0.5905	0.29	0.6249
EQRTNS	17.02	0.0000***	2.16	0.1420
MVE/S	17.54	0.0000***	11.13	0 .0008***

Note: *, ** and *** denote the significance for at 0.1, 0.05 and 0.01 levels.

Discussion:

The results in Table 4.IV show that ENGINT does not Granger-cause financial performance (ROA, ROS, EQRTNS & MVE/S), neither does financial performance Granger cause ENGINT. The implication is that the lags of ENGINT do not improve a forecast of financial performance measured by ROA, ROS, EQRTNS and MVE/S. It also means that the lags of financial performance do not improve a forecast of ENGINT. Results in Table 4.V however showed a unidirectional relationship between EMSINT and EQRTNS at 1% significant level. Impliedly, the lags of EMSINT do improve a forecast of financial performance (EQRTNS). A bidirectional relationship between EMSINT and MVE/S at 1% significant level was also found. This indicates that the lags of EMSINT do improve a forecast of financial performance (EMSINT), and vice versa. It is therefore possible to conclude that prior improvement in EMSINT leads to subsequent improvement in EQRTNS. It is also true to say that as prior improvement in EMSINT subsequently improves MVE/S, prior performance in MVE/S subsequently improves EMSINT of the INDEX firms. The results in Table 4.V indicate the rejection of the null of no cross-sectional dependence across the members of panel at 1% significant level. This could imply that a shock to either the financial performance or carbon intensity in a firm is likely to be transmitted to other firms. This could be explained from the point of view that these firms are confronted with similar socio-economic and political conditions.

4.2.2 Carbon Intensity effect on Accounting and Market-Based Measures: OLS estimations

To comply with the homoscedasticity assumption of pooled data estimation, the researcher performed a heteroskedasticity test using Breusch-Pagan/Cook-Weisberg test for heteroskedasticity. Test fitted values of ROS, ROA, EQRTNS and MVE/S (prob>chi2) are all greater than 5 (Hayes & Cai, 2007). The researcher also performed a multicollinearity test using variance inflation factors. The results show mean VIF of 2.82; 3.18; 2.98 and 8.07 for ROS, ROA, EQRTNS and MVE/S respectively. Table 4.VI reports pooled data results of carbon output intensity and carbon input intensity effect on ROA, ROS, EQRTNS and MVE/S. The results showed a significant effect of the sustainability measure ENGINT on ROA and ROS at level p> 0.000 and p> 0.008, with ENGINT showing negative relationship with ROA and ROS. The measure EMSINT similarly showed significant effect on ROA and ROS at level p> 0.000 and p> 0.006, but a negative effect on ROA and ROS. ENGINT again showed a significant effect on MVE/S at level p> 0.027, but showed a positive effect on MVE/S. EMSINT similarly showed a significant effect on MVE/S, at the level p>0.041, exhibiting a negative effect on the market–based measure MVE/S. OPTINC showed a significant effect on ROA, ROS and EQRTNS at level p> 0.000, 0.000 and 0.024 respectively, and a positive effect on all the measures. ASSETS also showed significant effect on ROA, ROS and MVE/S at p> 0.024 and p> 0.000 and p> 0.000, showing negative effect on ROA and ROS, but a positive relationship with the market-based measure, MVE/S. GROWTH also showed significant effect on ROA and ROS at level p> 0.083 and p>0.095, exhibiting positive effect on the .two accounting-based measures. Because coefficients produced from some of the OLS estimation are large (see appendix) the study applies margins atmeans procedure to bring down the coefficients applying eyex option of margins atmeans to estimate elasticities of variables in the variable list (StataCorp, 2011).

Table 4 VI: Pooled Data results with ROA_{it}, ROS_{it}, $EQRTNS_{it}$ and MVE/S_{it} as dependent variables

Model 1

Delta Method

Variable	**ey/ex**	**Std-Err**	**z**	**P>|z|**
Emsint	1.181975	.3164713	3.73	0.000
Engint	-.8897372	.2435079	-3.65	0.000
Optinc	.3475794	.0690451	5.03	0.000
Lev	.1369644	.1360852	1.01	0.314
LnAsset	-6.682856	2.968473	-2.25	0.024
Growth	.0527726	.0304131	1.74	0.083
indtype	-.5038317	.1557549	-3.23	0.001
Obs=98, F(7,90) =12.16, Prob>F =0.000, R-Squared=0.4861				

Model 2

Delta Method

Variable	**ey/ex**	**Std-Err**	**z**	**P>|z|**
Emsint	1.239902	.4477549	2.77	0.006
Engint	-.9503387	.3607048	-2.63	0.008
Optinc	.3310326	.0818202	4.05	0.000
Lev	.1858781	.2020815	0.92	0.358
Assets/s	-1.431419	-1.4314419	-.6.03	0.000
Growth	.0850021	.0508776	1.67	0.095
Indtype	.224118	.2234676	1.00	0.316
Obs=98, F(7,90)=40.70, Prob>F=0.000, R-Squared= 0.7599				

Model 3

Variable	**Coef.**	**Std-Err**	**t**	**P>|t|**
Lnemsint	.0568116	.0612551	0.93	0.314

Lnengint	-.0290324	.0552625	-0.53	0.526
Optinc	1.6000	6.88000	2.33	0.024
Lev	-.0038448	.0364043	-0.11	0.551
Lnmve	.0251036	.0164095	1.53	0.124
Growth	.0228819	.1481452	1.50	0.143
indype	-.1537693	.0762562	-2.02	0.079
_cons	-.4058411	.3706471	-1.09	0.247
Obs=98, F(7,90)=2.26, Prob>F=0.0322, R-Squared= 0.1526				

Model 4
Delta Method

Variable	**ey/ex**	**Std. Err**	**z**	**P>|z|**
Emsint	-.5813349	.2847642	-2.04	0.041
Engint	.5134729	.2323989	2.21	0.027
Optinc	-.027996	.0449743	-0.62	0.534
Lev	-.0266335	.136436	-0.20	0.845
Assets/s	1.5936575	.1763086	9.04	0.000
Growth	-.010177	.0336206	-0.30	0.762
indtype	-.39433	.1556425	-2.53	0.011
Obs=98, F(7,90)=81.29, Prob>F=0.000, R-Squared= 0.8528				

Note: Model 1, Model 2, Model 3 and Model 4 have ROA, ROS, EQRTNS and MVE/S as dependent variables respectively.

4.2.3 Carbon intensity effect on Accounting and Market-Based Measures: Fixed Effect estimation

Panel Unit Root Tests

As indicated earlier in section 3.10, because panel regressions in which the series are non-stationary can lead to spurious results, a stationary test to determine if the series are stationary or not at level employing “Fisher type” panel unit root test based on Augmented Dickey-Fuller (ADF) was performed. Though some series are not stationary at level 1(0), all series are stationary at first-difference 1(1).

Table 4.VII report results of the carbon output/ carbon input intensity effect on ROA, ROS, EQRTNS and MVE/S after the firm’s unobserved omitted variable bias is control for. The results from the fixed effects estimation showed an all insignificant effect of sustainability measures (EMSINT& ENGINT) on ROA, ROS, EQRTNS and MVE/S. The results also showed that after controlling for a firm’s omitted variable bias, direction of association between sustainability measures (EMSINT& ENGINT) and ROA, ROS, EQRTNS & MVE/S changed, except with the

association between the sustainability measure (ENGINT) and EQRTNS. OPTINC showed a significant effect on ROA and ROS at levels p> 0.000 and p> 0.000, exhibiting positive effect on ROA and ROS. LnASSET/ASSETS showed a significant effect on ROA, ROS and MVE/S at level p>0.007, p>0.000 and p>0.000, and showed negative effect on ROA and ROS and a positive effect on MVE/S. LnMVE also showed a significant effect on the EQRTNS exhibiting a positive effect on EQRTNS. Notwithstanding, results from Table 4.VII showed an improvement in coefficient of determination (R^2) in model 2, 3 and 4, when firms' unobserved omitted variable bias is accounted for. This indicates an increase in percentage contribution from independent variables when omitted variable bias was accounted for. Again, because coefficients produced from estimations are large the study applied margins atmeans procedure described in the preceding section to normalised the coefficients (see Appendix: XXXXVII).

Table: 4.VII: Fixed Effects results with ROA_{it}, ROS_{it}, $EQRTNS_{it}$ and MVE/S_{it} as dependent variables

Model 1

Delta Method

Variable	ey/ex	Std-Err	z	P>|z|
Emsint	-.2887077	.4825336	-0.60	0.550
Engint	.1374969	.4783928	0.29	0.774
Optinc	.47054394	.1412988	3.33	0.001
Lev	-.3445976	.250607	-1.38	0.169
Lnasset	-33.791	12.48252	-2.71	0.007
Growth	.042844	.0297679	1.44	0.150

Obs=98, F (6, 78)= 4.75, Prob>F =0.0004, R-sq: within= 0.2675

Model 2

Delta Method

Variable	ey/ex	Std-Err	z	P>|z|
Emsint	-.0270618	.6495017	-0.04	0.967
Engint	.1790759	.6599864	0.27	0.786
Optinc	.7435502	.2033618	3.66	0.000
Lev	-.268324	.3386351	-0.79	0.428
Assets/s	-1.557325	.2170734	-7.17	0.000
Growth	.0497849	.0451618	1.10	0.270

Obs=98, F (6, 78 =56.55, Prob>F=0.0000, R-sq: within = 0.8131

Model 3

Variable	Coef.	Std-Err	t	P>|t|

Lnemsint	-.0324097	.1052902	-0.31	0.758
Lnengint	-.13057	.0841415	-1.55	0.125
Optinc	1.46000	2.17000	0.67	0.502
Lev	.5308853	.5393001	0.98	0.328
Lnmve	.3402628	.0910796	3.74	0.000
Growth	.1146952	.1528924	0.75	0.455
_cons	-10.67433	2.770349	-3.85	0.000
Obs=98, F(6, 78) = 3.29, Prob>F=0.0062, R-sq: within= 0.2019				

		Model 4 Delta Method		
Variable	**ey/ex**	**Std. Err**	**z**	**P>|z|**
Emsint	.2965897	.2367357	1.25	0.210
Engint	-.0511902	.2400678	-0.21	0.831
Optinc	.0803762	.0663485	1.21	0.226
Lev	.0835742	.1227191	0.68	0.496
Assets/s	1.421648	.0737938	19.27	0.000
Growth	.003361	.0162873	0.21	0.837
Obs=98, F(6, 78)= 317.90, Prob>F= 0.0000, R-sq: within= 0.9607				

Note: Model 1, Model 2, Model 3 and Model 4 have ROA, ROS, EQRTNS and MVE/S as dependent variables respectively.

4.2.4 Carbon Intensity effect on Accounting and Market-Based Measures: Arellano-Bond estimation

Tables 4.VIII report results of the carbon output/carbon input intensity effect on ROA, ROS, EQRTNS and MVE/S after the study controlled for firms' omitted variable bias and a possible orthogonality condition utilising Arellano-Bond dynamic panel data estimation. The results showed a significant effect of sustainability measure 'carbon input intensity effect on market-based EQRTNS at level p> 0.002. Similarly, LNASSET/ ASSETSS showed a significant effect on ROA, ROS and MVE/S, with OPTINC showing a significant effect on ROA, ROS and EQRTNS. GROWTH exhibited a significant effect only on ROA, so also is LEV which exhibited significant effect on ROA, ROS and MVE/S. LNMVE and $EQRTNS_{t-1}$ exhibited significant effect on EQRTNS. MVE/S_{t-1} similarly showed significant effect on MVE/S. Because coefficients produced from Arellano-Bond estimations are large (see Appendix: XXXXVII) the study applies margins atmeans procedure as described in the preceding section. It was also found that while the lag of the market-based indicators ($EQRTNS_{t-1}$ or MVE/S_{t-1}) significantly affects

EQRTNS and MVE/S in the Arellano-Bond estimations, the same cannot be said of the accounting-based measures.

Table 4.VIII: Arellano-Bond results with ROA_{it}, ROS_{it}, $EQRTNS_{it}$ and MVE/S_{it} as dependent variables

Model 1

Delta Method

Variable	ey/ex	Std-Err	z	P>|z|
L1. Roa	.1051162	.1258711	0.84	0.404
Engint	-.54406	.5606529	-0.97	0.332
Emsint	.5427359	.5492298	0.99	0.323
Optinc	.4385364	.1547653	2.83	0.005
Lev	-.7623853	.3855701	-1.98	0.048
Lnasset	-37.15372	14.75418	-2.52	0.012
Growth	.0996031	.0295366	3.37	0.001

Obs=70, Wald chi2 =31.69, Prob>chi2 =0.0000, Sargan = prob >chi2 = 0.0075

Model 2

Delta Method

Variable	ey/ex	Std-Err	z	P>|z|
L1. Ros	-.1658709	.1769095	-0.94	0.340
Engint	-.4271475	.9099432	-0.47	0.639
Emsint	.6046664	.8815802	0.69	0.493
Optinc	.6851699	.2557497	2.68	0.007
Lev	-1.293472	.621583	-2.08	0.037
Assets/s	-1.953175	.2851353	-6.85	0.000
Growth	.0685088	.0550959	1.24	0.214

Obs=70, Wald chi2 =313.47, Prob>chi2 =0.0000, Sargan = prob >chi2 = 0.0067

Model 3

Variable	Coef.	Std-Err	t	P>|t|
L1. Eqrtns	-.2307569	.0929779	-2.48	0.013
Lnengint	-.2570587	.0826096	-3.11	0.002
Lnemsint	-.0174331	.1109119	-0.16	0.875
Optinc	3.6100	1.7900	2.02	0.044
Lev	.0569395	.6702148	0.08	0.932
Lnmve	.4844929	.0835467	5.80	0.000
Growth	-.1836034	.1686687	-1.09	0.276
_cons	-15.39804	2.475597	-6.22	0.000

Obs=70, Wald chi2=61.14, Prob>chi2 =0.0000, Sargan = prob >chi2= 0.0735

Model 4

Delta Method

Variable	ey/ex	Std. Err	z	P>|z|
L1.Mve/s	.1846434	.1075111	1.72	0.086
Engint	-.0876682	.2273712	-0.39	0.700

Emsint	.4045871	.2338853	1.73	0.084
Optinc	.0926753	.0601782	1.54	0.124
Lev	.3502018	.1710599	2.05	0.041
Assets/s	1.355761	.0519263	26.11	0.000
Growth	-.0082349	.0133326	-0.62	0.537
Obs=70, Wald chi2 =3050.33, Prob>chi2 =0.0000,Sargan = prob >chi2 = 0.0002				

Note: Reduction in the observations in Table 4.IV is as the result of first differencing in the modeling process; Model1, Model 2, Model 3 and Model 4 have ROA, ROS, EQRTNS and MVE/S as dependent variables respectively.

Discussion:

OLS results from this study confirms previous studies (Busch and Hoffmann, 2011; Telle, 2006) on the sustainability performance effect on ROA and ROS. With carbon input intensity (ENGINT) association with ROA, ROS and EQRTNS indicating that improvement in ‘carbon prevention’ is value destroying and makes firms’ uncompetitive. This shows that continuous improvement in ‘carbon efficient technologies’ to minimise energy consumption is not prudent for the purpose of wealth creation. Notwithstanding, improving the measure relative to MVE/S seems to value drive and enhances corporate competitiveness although without a significant effect. The result also shows that improvement in carbon output intensity (EMSINT) seems to enhance a firm’s competitiveness relative to ROA, ROS and EQRTNS. When the study accounts for omitted variable bias all the estimations show an insignificantly effect of sustainability measure ‘’carbon output intensity/ carbon input intensity’’ on ROA, ROA, EQRTNS and MVE/S. Although not significant, the negative relationship between carbon input intensity and ROA/ ROS dissolves when firms’ unobserved omitted variable bias is accounted for. Again, the positive relation between the sustainability measure and MVE/S dissolves when firms’ heterogeneity is control for. Similarly, carbon output intensity relationship with MVE/S dissolves when the unobserved omitted variable is controled for, so also is the relationship between the sustainability measure and ROA/ EQRTNS. When the study controls for a firm’s omitted variable bias and possible correlation between the error term and regressors, the sustainability measure ‘carbon input intensity’ showed a significant effect on the market-based measure ‘EQRTNS’. The study also found consistencies between the direction of association of the sustainability measure ‘carbon input intensity’ and ROA, ROS/ EQRTNS with OLS results. Furthermore, the carbon output intensity association with ROA/ROS shows consistency with OLS results. OLS and Arellano-Bond estimations emphatically indicate that improvement in sustainability measure ‘carbon input intensity’ is value destroying and makes companies non-competitive. Furthermore, results from the two estimators confirm that improvement carbon output intensity value drives and enhances competitiveness in JSE’s SRI firms especially with accounting-based performance measures. The study concludes that for the purpose of wealth creation, JSE’s SRI firms should get themselves more into carbon output control activities, i.e. end-of-pipe rather than carbon input prevention. Notwithstanding, the study is not able to establish how the effect might have been if South Africa had instituted Carbon Tax Policy and Emissions Trading Scheme. This result confirms Telle’s (2006) suggestion that variables often omitted in previous studies are not unlikely to be important when possible causal channels between sustainability performance and financial performance are to be described. The low power associated with OLS estimations tends to render the effect estimated in most previous studies unreliable and contestable.

4.3 Carbon Intensity effect on Financial Performance: Impulse Response Function Analysis in Short Panel vector autoregressions

This section reports the response of financial performance indicators to shocks in carbon output intensity and carbon input intensity. This analysis was performed using Impulse response function analysis in short panel vector auto regressions (SPVARs) using statistical software STATA.

4.3.1 Carbon Intensity effect on Accounting-Based Measures: Impulse Response Analysis

Carbon intensity as stated in the preceding sections refers to a company’s physical carbon performance and describes the extent to which firms’ business activities are based on carbon related energy usage, i.e. carbon input intensity and emissions, and i.e. carbon output intensity for a defined scope and fiscal year (Hoffmann and Busch, 2008).

Hence, the first part of this section focuses on examining how accounting-based performance indicators, i.e. ROA and ROS respond to shocks in carbon output intensity (EMSINT) and carbon input intensity (ENGINT). Figure 4.I shows that when the impulse is from the sustainability measure carbon input intensity (ENGINT), return on assets (ROA) respond negatively for up to 4 years, after which ROA reverts gradually to the original state. ROA in the response to shock in ENGINT shows the highest negative effect in the first 2 years. Figure 4.II showed that when the impulse is carbon output intensity (EMSINT) every response of return on assets (ROA) is all positive at each time responsive period, with the highest positive response exhibited in year 2 to the first part of year 4, and begins to reversion tendencies from year 6. Impulses from the control variables: OPTINC and LNASSET indicate negative responses of ROA at each time responsive period (Appendix I &V). ROA however shows obvious positive and negative fluctuations from year 2 to year 4, and a smooth positive response through to year 8 when the impulse is from GROWTH (Appendix III). ROA further showed positive responses to shocks in LEV for the first year, subsequent positive response with year 2 exhibiting the highest negative effect and smooth positive response from year 4 to year 6.

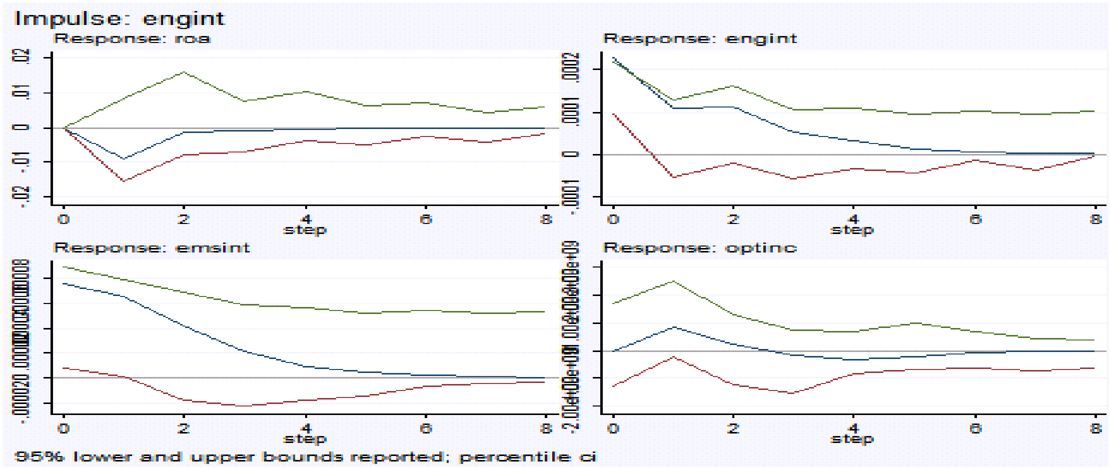

Figure 4.I: Response of ROA to Shocks in ENGINT

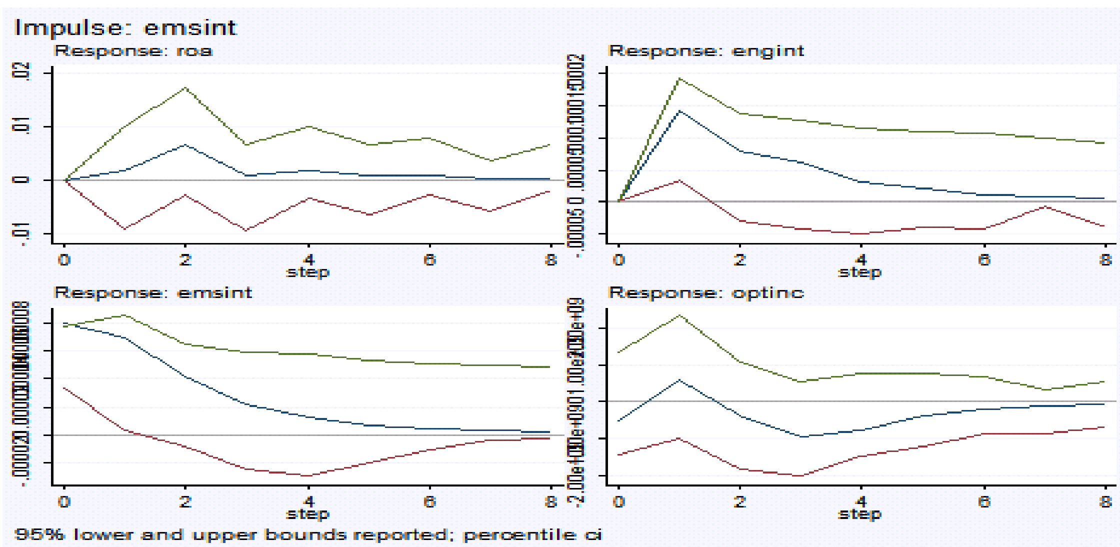

Figure 4.II: Response of ROA to Shocks in EMSINT

Figure 4.III shows that when the impulse is the sustainability measure carbon input intensity (ENGINT) the response of ROS is negative at each time responsive period, with year 2 exhibiting the highest negative response. ROS seemed to show reversion tendency close to the end of the eighth year. When the impulse is the measure carbon output intensity (EMSINT), Figure 4.III shows an obvious positive response of ROS in the first year, and subsequent negative responses from year 2 to year 6, and another positive response from year 6 to through year 8 where the variable tends to stabilise. When the impulse is from ASSETS/S the results show

each response of ROS is negative at each time responsive period, with year 6 through year 8 showing obvious highest negative responses (Appendix IX). When the impulse is OPTINC, response of ROS shows obvious highest positive and negative fluctuations in year 2, and smooth positive responses from year 4 through year 8 (Appendix VII). When the impulse is GROWTH (Appendix VII) shows the highest negative response of ROS within year 2, positive response from year 2 to 4, and subsequent negative responses from end of year 4 to year 6, with a subsequent positive response from the end of year 6 through year 8. When the impulse is LEV, Appendix X shows a positive response of ROS in the first 2 years and a subsequent minimal negative response followed by positive response from year to 4 through year 8 with period showing the highest positive response.

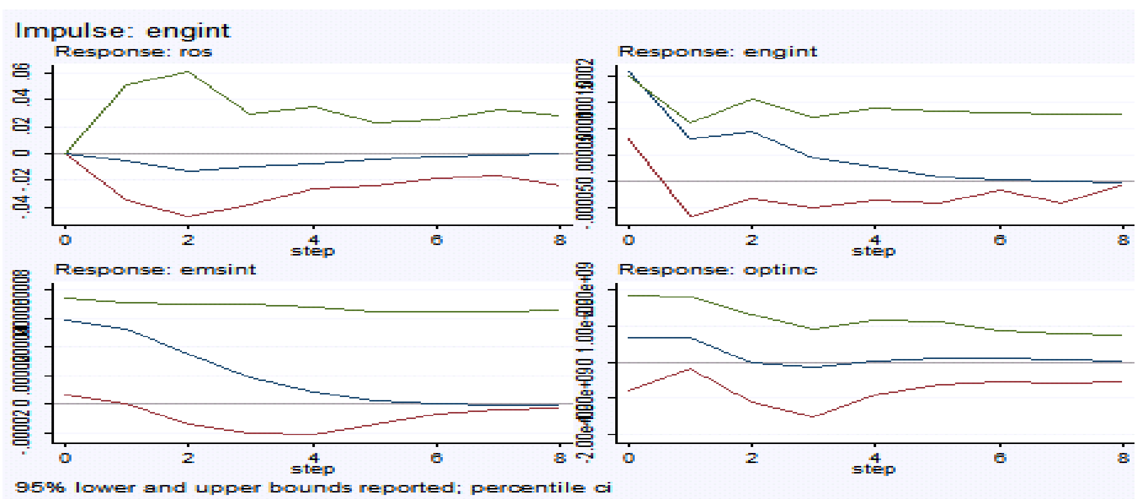

Figure 4.III: Response of ROS to Shocks in ENGINT

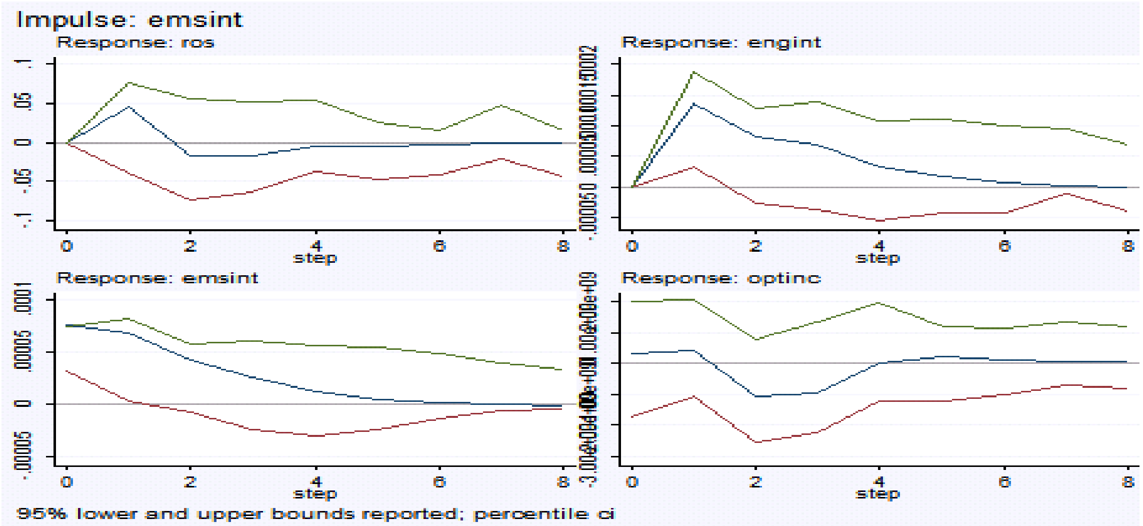

Figure 4.IV: Response of ROS to Shocks in EMSINT

4.3.2 Carbon Intensity effect on Market-Based Measures: Impulse Response Function Analysis

This section reports on how market-based performance indicators respond to shocks in carbon output intensity and carbon input intensity. They determined the relationship employing impulse response function analysis in short PVARs using statistical software STATA. Carbon intensity as stated in the preceding sections refer to a firm's physical carbon performance and describes the extent to which firms' business activities are based on carbon related energy usage, i.e. carbon input intensity, and emissions, i.e. carbon output intensity for a defined scope in a fiscal year (Hoffmann and Busch, 2008).

Hence, the study focused on establishing how market-based performance indicators, i.e. EQRTNS and MVE/S respond to shocks in carbon output intensity (EMSINT) and carbon input intensity (ENGINT). When the study estimated the response of EQRTNS to shocks in the sustainability measure carbon input intensity (ENGINT), Figure 4.V shows a smooth positive response of EQRTNS in year 1, and fluctuating negative response from year 2 through year 6, after which EQRTNS starts to revert to the equilibrium point. The results also show the highest negative effect of the shocks in year 2. When the impulse is from the sustainability measure carbon output intensity (EMSINT), Figure 4.VI shows an obvious positive response of EQRTNS in year 1, and subsequent negative response from year 2 through to year 7, after which EQRTNS starts to revert to the equilibrium point, with year 2 showing the highest negative response. When the impulse is from LNMVE, Appendix XV shows an obvious negative response of EQRTNS from year 2 through year 6, and smooth positive response from the end of year 6 to the eighth year. When LEV is the impulse, EQRTNS exhibits an obvious positive response from period up to period 5, and subsequent smooth positive response to year 8 (Appendix XIII). When the impulse is OPTINC, EQRTNS tends to show a smooth positive response in year 1, and an obvious negative fluctuating in year 2, with a subsequent positive response from year 3 through year 8 (Appendix XVI). When the impulse is GROWTH, EQRTNS exhibits a positive response up to year 3, obvious negative response in year 4, with some smooth tendencies from year 5 through year 8 (Appendix XVI)

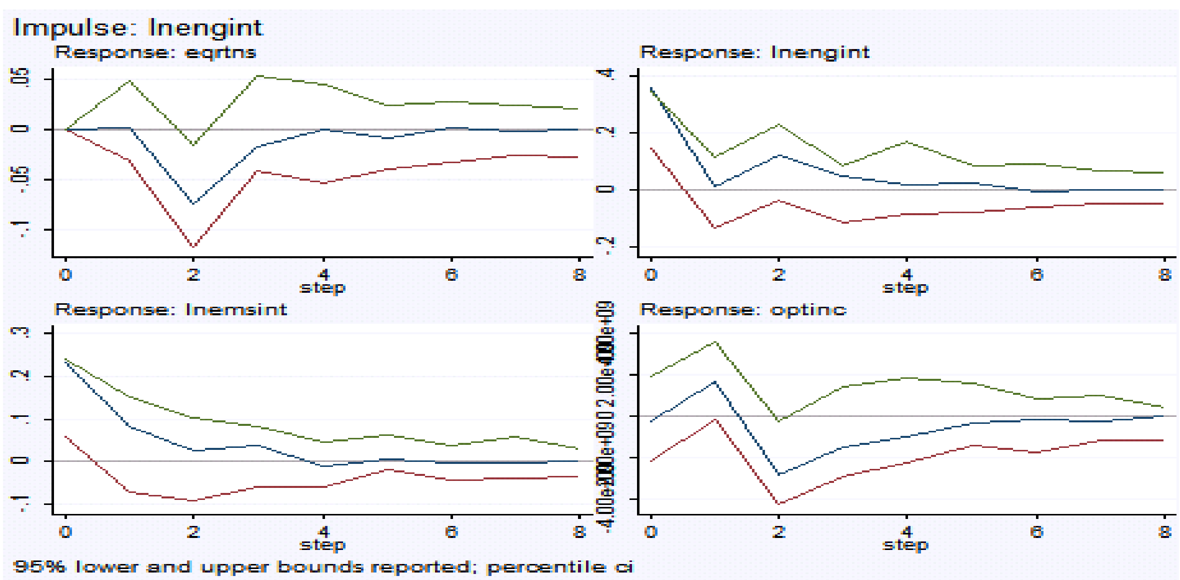

Figure 4.V: Response of EQRTNS to Shocks in LnENGINT

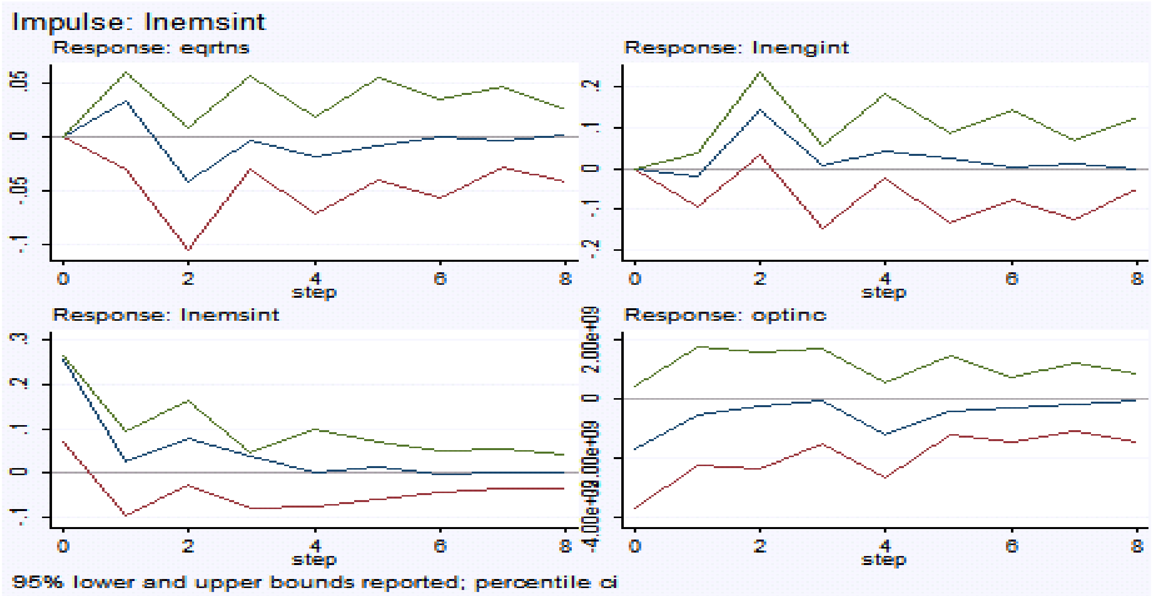

Figure 4.VI: Response of EQRTNS to Shocks in LnEMSINT

Figure 4.VII shows that when the shock is from the sustainability measure carbon input intensity (ENGINT), MVE/S is able to sustain the shocks from year 1 to year 4, after which a minimal positive and a negative impact are registered up to the eighth year. Figure 4.VIII similarly indicates that when the impulse is sustainability measure carbon output intensity (EMSINT), MVE/S is able to sustain shocks at each time responsive period. When the impulse is from ASSETS/S, there is a minimal response from MVE/S from year 1 through year 3, but subsequently shows obvious positive responses at each time responsive period from year 4 to year 8, with the highest positive response in year 8 (Appendix XX). When the impulse is LEV, a minimal effect of LEV is found on MVE/S from year 1 through to year 6, but subsequently shows obvious positive and negative responses from year 6 throug year 8 (Appendix XVIII). When the impulse is GROWTH, effects of shocks are minimal from year 1 to year 3, with subsequent obvious positive and negative effects from year 4 to year 8.

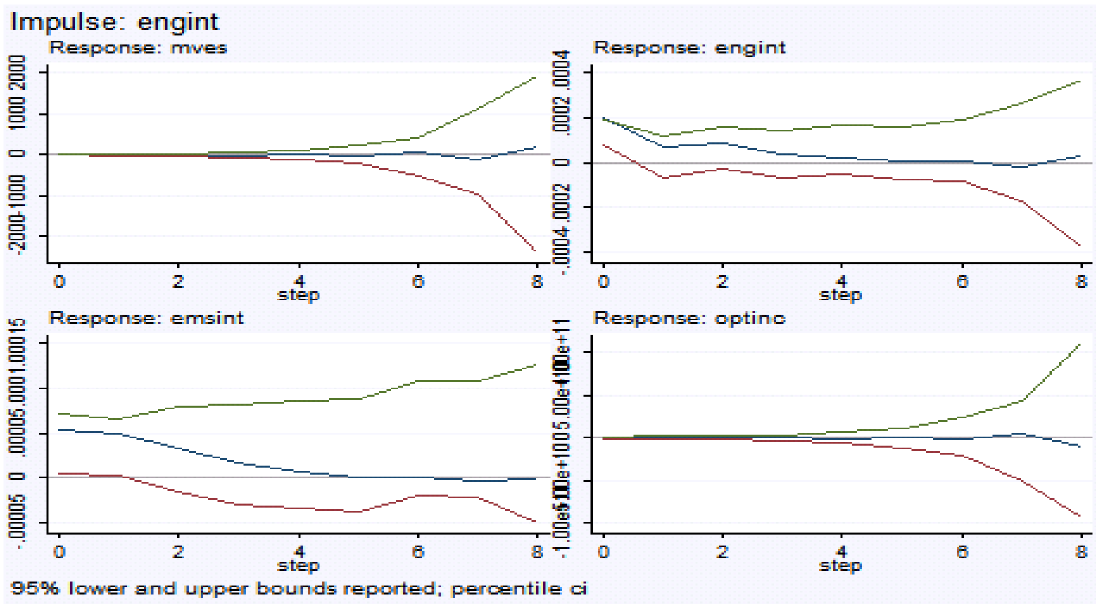

Figure 4.VII: Response of MVE/S to Shocks in ENGINT

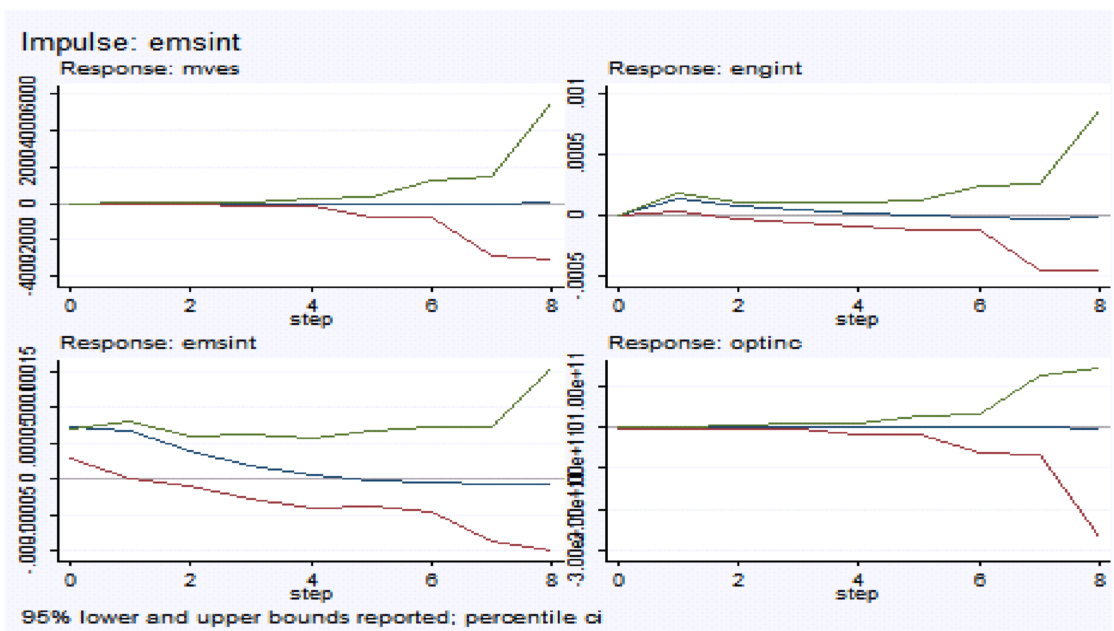

Figure 4.VIII: Response of MVE/S to Shocks in EMSINT

Discussion:

IRF analysis in SPVARs shows that on average ROA tends to respond negatively to shocks in carbon input intensity for the first 4 years of the shocks, after which it exhibits mean reversion tendencies. The response indicates that shocks in carbon input intensity is value destroying and does not enhance firms' competitiveness with respect to ROA. The study also found that shocks from carbon input intensity persist for 4 years before reversion to equilibrium starts. On the contrary, response of ROA to shocks in carbon output intensity indicates that on average shocks from sustainability measures carbon output intensity (EMSINT) are value driven and tend to enhance firms' competitiveness. With respect to the carbon input intensity effect on return on sales (ROS), the results show a negative effect of ROS to shocks in carbon output intensity which persist for more than 7 years; indicating a value destroying effect and non-competitiveness of firms of shocks in carbon input intensity. With regards to the response of EQRTNS to shocks in carbon input intensity, the results show that shocks in carbon input intensity enhances firms' competitiveness relative to EQRTNS only in year 1, and tend to respond negatively from year 2 through to year 6, before reverting to the equilibrium point. The results show that shocks in carbon input intensity persist for 5 years before EQRTNS begins to move towards stability, an indication of value destroying and poor returns to equity-holders. On the carbon output intensity effect on EQRTNS, the results show that on average EQRTNS tends to respond negatively to shocks in carbon output intensity and persist for 7 years then tends to regain stability. This result equally shows that shocks in carbon output intensity is value destroying and does not enhance corporate competitiveness. On carbon input intensity relations with MVE/S, the results reveal that MVE/S has the ability to sustain and maintain shocks from carbon input intensity for 4 years, and subsequently exhibited unobserved/ minimal intermittent positive and negative tendencies toward stability. With respect to carbon output intensity (EMSINT) relative to MVE/S, the results show that MVE/S exhibited the tendency to absolve the shocks from EMSINT.

In conclusion the results indicate that on average shocks in carbon output intensity (EMSINT) tend to pay financially in the first 6 years with respect to ROA, with the highest gain in year 2. With respect to ROS the gain is seen in the first 2 years, EQRTNS sees gain only in the first year, with MVE/S exhibiting stability tendencies till the last period. On the contrary, shocks in carbon input intensity (ENGINT) tend to cause a decrease in ROA in the first 4 years, with ROS showing decreasing tendencies throughout the periods. EQRTNS similarly showed a decreasing trend for the first 6 years, and MVE/S exhibiting stability in the 4 years.

4. 4 Carbon Intensity effect on Financial Performance Measures: Dynamic Panel Threshold estimation

Carbon intensity as referred to in the preceding sections refers to a firm's physical carbon performance and describes the extent to which firms' business activities are based on carbon related energy usage (carbon input intensity) and emissions (carbon output intensity) for a defined scope in a fiscal year (Hoffmann and Busch, 2008).

4.4.1 Carbon Intensity effect on Accounting-Based Measures: Dynamic Panel Threshold estimation

This section focuses on estimating carbon intensity (emissions intensity & energy usage intensity) threshold effect on accounting-based performance measured by ROA and ROS. Applying a dynamic threshold model using the statistical software R, the study allowed sequentially for zero, single, double, and triple thresholds.

Test statistics F_1, F_2 and F_3, critical values along with bootstrap p-values are shown in Table 4.IX. Based on the test statistics (F_1, F_2) and their critical values, the study accepts the null hypothesis (H_0) of no threshold for the single threshold F_1, and double threshold F_2. The test for the third threshold F_3 rejects the null hypothesis (H_0) of no threshold at 0.05 significant level with a bootstrap p-value of 0.023. The study concludes that there exists a triple threshold in the regression relationship. Hence, for the remainder of the analysis, the study works with the triple threshold model. Point estimates of the three thresholds together with their asymptotic 95% confidence intervals are reported in Table 4.X. The estimates are 0.0009, 0.0001 and 0.0001, which are very small values in the empirical distribution of the carbon input intensity (ENGINT) effect on return on assets (ROA). Thus, four classes of firms indicated by the point estimates are 'low energy usage firms', 'medium energy usage firms', 'high energy usage firms' and 'very high energy usage firms'. Asymptotic confidence intervals for the thresholds are very close, indicating little uncertainty about the nature of the division. Table 4.XI reports the regression slope coefficients, standard errors, het standard errors, and t-stats and for four regimes. The estimated model from the empirical findings is expressed as follows:

if $q_{it-1} \leq 0.00013$,

if $0.00013 < q_{it-1} \leq 0.00017$,

if $0.00017 < q_{it-1} \leq 0.00093$,

if $q_{it-1} > 0.00093$.

In the first regime (low energy usage firms) where the ENGINT ratio is less than 0.00013, the estimated coefficient ϕ_1 is 0.14421. This indicates that ROA increases by 0.14421 with 1% increase in the ENGINT ratio. In the second regime, i.e. medium energy usage firms) where the ENGINT ratio is between 0.00013 and 0.00017, the estimated coefficient ϕ_2 is 0.17430. This similarly show that ROA increases by 0.17430 with1% increase in the ENGINT ratio. In the third regime, i.e. high energy usage firms) where the ENGINT ratio is between 0.00017 and 0.00093, the coefficient ϕ_3 is 0.29772. This also shows that ROA increase by 0.29772 in with 1% increase in the ENGINT ratio. The last regime, i.e. very high energy usage) where the ENGINT ratio exceeds 0.00093, the estimated coefficients ϕ_4 is - 0.08868. This indicate that ROA decreases by -0.08868 with 1% increase in the ENGINT ratio. The results indicate that any time the ENGINT ratio improves beyond 0.00093 ROA tends to decline by - 0.08868.

Table 4.IX: ENGINT Threshold Effect On ROA

Test for Thresholds	
F_1	16.75533
P-value	0.20
Critical values	20.08167 24.52529 27.9868
F_2	16.97452

P-value	0.17
Critical values	22.98719 28.90956 42.13225
F_3	36.2881
P-value	0.023
Critical values	19.49541 22.95595 43.6704

[CVs at 10%, 5% and 1%]

Table 4.X: ENGINT- ROA Threshold Estimate

	Estimate	95% Confidence Interval
٢	0.0009	[0.0001, 0.0010]
٢	0.0001	[0.0001. 0.0001]
٢	0.0001	[0.0001, 0.0001]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.XI: Estimated Coefficients of ROA

Coeff	Value	Std error	White	tstat
ϕ_1	0.14421	0.08778	0.05994	2.40601
ϕ_2	0.17430	0.22442	0.21126	0.82505
ϕ_3	0.29772	0.07663	0.06966	4.25542
ϕ_4	-0.08868	0.12110	0.08944	-0.99156

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. Value, std error, white and tstat represent regime-dependent coefficients, standard errors, het standard errors and t-stat.

The study also estimated the number of thresholds in the carbon output intensity (EMSINT)-ROA relationship estimating equation (19), employing dynamic panel and allowing for (sequentially) zero, one, two, and three thresholds. Based on the test statistics (F_1, F_2) and their critical values the study accepts the null hypothesis (H_0) of no threshold for the single threshold F_1, and double threshold F_2. The test for the third threshold F_3 rejects the null hypothesis (H_0) of no threshold at 0.05 significant level with a bootstrap p-value of 0.03. This indicates the presence of triple threshold in the regression relationship (Table 4.XII). Hence, for the remainder of the analysis the study works with a triple threshold model. Point estimates together with their asymptotic 95% confidence intervals are reported in Table 4.XIII. The point estimates are 0.00015, 0.00016 and 0.00053. The classes of firms indicated by the point estimates are 'low emitting firms', 'medium emitting firms', 'high emitting firms' and 'very high emitting' firms. Asymptotic confidence intervals for the threshold are close indicating a little uncertainty about the nature of the division. Table 4.XIV reports the regression slope coefficients, standard errors, het standard errors, and t-stat and for four regimes. The estimated model from the empirical findings is expressed as follows:

if $q_{it-1} \leq 0.00015$

if $0.00015 < q_{it-1} \leq 0.00016$

if $0.00016 < q_{it-1} \leq 0.00053$

if $q_{it-1} > 0.00053$.

In the first regime (low emitting firms) where EMSINT ratio is less than 0.00015, the estimated coefficient $\phi 1$ is 0.19622, indicating that ROA increases by 0.19622 with 1% increase of in EMSINT ratio. In the second regime (i.e. medium emitting firms) where EMSINT ratio lies between 0.00015 and 0.00016, the estimated coefficient ϕ_2 is - 0.32231. This indicates that ROA decreases by - 0.32231 with1% increase in EMSINT ratio. In the third regime (i.e. high emitting firms) where EMSINT ratio is between 0.00016 and 0.00053, the coefficient ϕ_3 is 0.15745, indicating that ROA increases by 0.15745 with 1% increase in EMSINT ratio. In the last regime (i.e. very high emitting firms) where EMSINT ratio exceeds 0.00053, the estimated coefficients ϕ_4 is 0.51799. This indicates that ROA increases by 0.51799 with 1% increase in EMSINT ratio. The results show that ROA decreases when the EMSINT ratio is between 0.00015 and 0.00016.

Table 4.XII: EMSINT Threshold Effect On ROA

Test for Thresholds	
F_1	19.31735
P-value	0.22
Critical values	26.17635 30.89724 34.16181
F_2	10.76762
P-value	0.41
Critical values	24.51725 29.84084 37.34802
F_3	35.52142

P-value	0.03
Critical values	21.92242 29.38851 44.77624
[CVs at 10%, 5% and 1%]	

Table 4.XIII: EMSINT-ROA Threshold Estimate

	Estimate	95% Confidence Interval
٢	0.0005	[0.0004, 0.0005]
٢	0.0001	[0.0001, 0.0002]
٢	0.0001	[0.0001, 0.0001]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.XIV: Estimated Coefficients of ROA

Coeff	Value	Std error	White	tstat
ϕ_1	0.19622	0.08492	0.07707	2.54592
ϕ_2	-0.32231	0.15698	0.24278	-132755
ϕ_3	0.15745	0.08714	0.06052	2.60166
ϕ_4	0.51799	0.10768	0.07604	6.81168

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. value, std error, white and tstat represent regime-dependent coefficients, standard errors, het standard errors and t-stats.

To determine the number of thresholds in the carbon input intensity (ENGINT)-return on sales (ROS) relationship, equation (19) is estimated by a dynamic panel estimation allowing for (sequentially) zero, one, two, and three thresholds. Test statistics F_1, F_2 and F_3, critical values along with bootstrap p-values are shown in Table 4.XV. Null of no threshold (H_0) is rejected at 0.01 in the case of the single threshold F_1, double threshold F_2, and triple threshold F_3, with their bootstrap p-values showing significant p values of 0.00 in each case. The study concludes that there are three thresholds in the regression relationship. For the remainder of the analysis the study works with this triple threshold model. Point estimates of the three thresholds together with their asymptotic 95% confidence intervals are reported in Table 4.XVI. The estimates are 0.00017, 0.00093 and 0.00119 which are very small values in the empirical distribution of the ENGINT-ROS threshold variable. The four classes of firms indicated by the point estimates are ‘low energy usage firms’, ‘medium energy usage firms’, ‘high energy usage firms’ and ‘very high energy usage firms’. The closeness of asymptotic confidence intervals for the threshold indicates a little uncertainty about the nature of the division. Table 4.XVII reports the regression slope coefficients, standard errors, het standard errors, and t-stat and for four regimes. The estimated model from the empirical findings can be expressed as follows:

if $q_{it-1} \leq 0.00017$

if $0.00017 < q_{it-1} \leq 0.00093$

if $0.00093 < q_{it-1} \leq 0.00119$

if $q_{it-1} > 0.00119$.

In the first regime where ENGINT ratio is less than 0.00017, the estimated coefficient ϕ_1 is 0.1170. This indicates that ROS increases by 0.1170 with an increase of 1% in ENGINT ratio. In the second regime where ENGINT ratio lies between 0.00017 and 0.00093 the estimated coefficient ϕ_2 is 0.2413. This means that ROS increases by 0.2413 with an increase of 1% in ENGINT ratio. In the third regime where ENGINT ratio is between 0.00093 and 0.00119, the coefficient ϕ_3 is -3.0147. This indicates that ROS decreases by - 3.0147 with 1% increase in ENGINT ratio. In the last regime where ENGINT ratio exceeds 0.00119, the estimated coefficients ϕ_4 is - 0.3467. This similarly shows that ROS decreases by - 0.3467 with 1% increase in ENGINT ratio. The results suggest that the relationship between ENGINT and ROS (slope value) varies in accordance with different changes in ENGINT, and this shows that ENGINT exhibits a nonlinear relationship (inverted U-shape).

Table 4.XV: ENGINT Threshold Effect On ROS

Test for Thresholds	
F_1	104.2437
P-value	0.00
Critical values	23.18085 43.68785 65.43865
F_2	45.51412
P-value	0.00
Critical values	20.17043 23.37171 30.69071
F_3	286.9418
P-value	0.00

Critical values	33.63791 55.60378 106.6214

[CVs at 10%, 5% and 1%]

Table 4.XVI: ENGINT-ROS Threshold Estimate

	Estimate	95% Confidence Interval
٢	0.0009	[0.0009, 0.0010]
٢	0.0011	[0.0006, 0.0012]
٢	0.0001	[0.0001, 0.0001]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.XVII: Estimated Coefficients of ROS

Coeff	Value	Std error	White	tstat
ϕ_1	0.1170	0.1948	0.1231	0.9504
ϕ_2	0.2413	0.1964	0.2051	1.1764
ϕ_3	-3.0147	0.3767	0.2854	-10.5644
ϕ_4	-0.3467	0.4047	0.1594	-2.1756

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. value, std error, white and tstat represent regime-dependent coefficients, standard errors, het standard errors and t-stat.

The study similarly determined the number of thresholds in the carbon output intensity (EMSINT)-Return on sales (ROS) relationship estimating equation (19) by dynamic panel estimation allowing for (sequentially) zero, one, two, and three thresholds. Test statistics F_1, F_2 and F_3, critical values, along with bootstrap p-values are shown in Table 4.XVIII. Null of no threshold (H_0) is rejected at 0.01 in the case of the single threshold F_1, 0.05 in the case of double threshold F_2, and 0.01 in the case of triple threshold F_3, with bootstrap p-values of 0.00 for F_1, 0.035 for F_2 and 0.00 for F_3. The study concludes that there are three thresholds in the regression relationship. For the remainder of the analysis the study works with the triple threshold model. Point estimates of the three thresholds together with their asymptotic 95% confidence intervals are reported in Table 4.XIX. The estimates are 0.00026, 0.00044 and 0.00061, which are very small values in the empirical distribution of the EMSINT-ROS threshold variable. Four classes of firms indicated by the point estimates are 'low emitting firms', 'medium emitting firms', 'high emitting firms' and 'very high emitting firms'. The closeness of asymptotic confidence intervals for the threshold is very close indicating a little uncertainty about the nature of the divisions. Table 4.XX reports the regression slope coefficients, standard errors, het standard errors and t-stat. The estimated model from the empirical findings is expressed as below:

if $q_{it-1} \leq 0.00026$

if $0.0002 < q_{it-1} \leq 0.00044$

if $0.00044 < q_{it-1} \leq 0.00061$

if $q_{it-1} > 0.00061$.

In the first regime where EMSINT ratio is less than 0.00026 the estimated coefficient ϕ_1 is 0.1944643, indicating that ROS increases by 0.1944643 with an increase of 1% in EMSINT ratio. In the second regime where EMSINT ratio is between 0.00026 and 0.00044, the estimated coefficient ϕ_2 is -1.3523797. This shows that ROS decreases by -1.3523797 with an increase of 1% in EMSINT ratio. In the third regime where EMSINT ratio is between 0.00044 and 0.00061, the coefficient ϕ_3 is 1.0841738. This tends to show that ROS increases by 1.0841738 with 1% increase in EMSINT ratio. In the last regime where EMSINT ratio exceeds 0.00061, the estimated coefficients ϕ_4 is 0.0002893. This indicates that ROS increases by 0.0002893 with 1% increase in EMSINT ratio. The results seem to indicate that EMSINT negatively affect ROS when the EMSINT ratio lies between 0.00026 - 0.00044.

Table 4.XVIII: EMSINT Threshold Effect On ROS

Test for Thresholds			
F_1		119.3488	
P-value		0.00	
Critical values	38.17907	47.77101	73.24798
F_2		31.97693	
P-value		0.035	
Critical values	24.9378	28.02969	47.28648
F_3		200.1955	
P-value		0.00	
Critical values	33.61706	47.32239	77.18123

[CVs at 10%, 5% and 1%]

Table 4.XIX EMSINT-ROS Threshold Estimate

	Estimate	95% Confidence Interval
٢	0.0005	[0.0005, 0.0005]
٢	0.0006	[0.0006, 0.0021]
٢	0.0002	[0.0001, 0.0002]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.XX: Estimated Coefficients of ROS

Coeff	Value	Std error	White	tstat
ϕ_1	0.1944643	0.1552055	0.1213879	1.6020072
ϕ_2	-1.3523797	0.3796068	0.2801250	-4.8277716
ϕ_3	1.0841738	0.3559689	0.2678195	4.0481507
ϕ_4	0.0002893	0.6081785	0.2675641	0.0010812

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. Value, std error, white and t stat represent regime-dependent coefficients, standard errors, het standard errors and t-stat.

4.4.2 Carbon Intensity Threshold effect on Market-Based Measures: Dynamic Panel estimations

The study determined the number of thresholds in the carbon input intensity (ENGINT) - Equity returns (EQRTNS) relationship, estimating equation (19), and allowing for (sequentially) zero, single, double, and triple thresholds. The test statistics F_1, F_2 and F_3, critical values, along with bootstrap p-values are shown in Table 4.3.XXI. Based on the test statistics (F_1, F_2) and their critical values the study accepts the null hypothesis (H_0) of no threshold for the single threshold F_1, and double threshold F_2. The test for third threshold F_3 rejects the null hypothesis (H_0) of no threshold at 0.01 significant level with a bootstrap p-value of 0.003. The study concludes that there exists triple threshold in the regression relationship. For the remainder of the analysis the study works with the triple threshold model. Point estimates of the three thresholds together with their asymptotic 95% confidence intervals are reported in Table 4.XXII. The estimates are -10.34246, -9.672444 and -6.555347, which are very small values in the empirical distribution of the ENGINT-EQRTNS threshold variable. The classes of firms indicated by the point estimates are ‘low energy usage firms’, ‘medium energy usage firms’, ‘high energy usage firms' and 'very high energy usage firms'. The closeness of asymptotic confidence intervals for the threshold are very close indicating little uncertainty about the nature of the divisions. Regression slope coefficients, standard errors, het standard errors and t-stat for four regimes are reported in Table 4.XXII. The estimated model from the empirical findings is expressed as follows:

if $q_{it-1} \leq -10.34246$

if $-10.34246 < q_{it-1} \leq --9.672444$

if $--9.672444 < q_{it-1} \leq -6.555347$

if $q_{it-1} > -6.555347$

In the first regime (low energy usage firms) where ENGINT ratio is less than -10.34246, the estimated coefficient ϕ1 is 0.04136. This indicates that EQRTNS increases by 0.14421 with 1% increase in ENGINT ratio. In the second regime (medium energy usage firms) where ENGINT ratio lies between -10.34246 and -9.672444 the estimated coefficient ϕ2 is 0.08056. This shows that EQRTNS increases by 0.08056 with 1% increase in ENGINT ratio. In the third regime (high energy usage firms) where ENGINT ratio is between - 9.672444 and -6.555347 and the coefficient ϕ3 is 0.14173 indicates that EQRTNS increase by 0.14173 with 1% increase in ENGINT ratio. In the last regime (very high energy usage firms) where ENGINT ratio exceeds - 6.555347, the estimated coefficients ϕ4 is 0.16847 and shows that EQRTNS increases by 0.16847 with 1% increase in ENGINT ratio. The results generally indicate that increase in ENGINT ratio generally increases EQRTNS.

Table 4.XXI: ENGINT Threshold Effect On EQRTNS

Test for Thresholds	
F_1	9.39125
P-value	0.49
Critical values	15.145 17.79878 21.07797
F_2	14.21751
P-value	0.16
Critical values	15.54133 16.93608 23.53217

F_3	23.86557
P-value	0.003
Critical values	12.47649 14.83339 18.10099

[CVs at 10%, 5% and 1%]

Table 4.XXII: ENGINT-EQRTNS Threshold Estimate

	Estimate	95% Confidence Interval
٢	-9.5011	[-9.7630, -5.1195]
٢	-6.555347	[-9.0956, - 6.5373]
٢	-10.34246	[-10.4143, - 6.7987]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.XXIII: Estimated Coefficients of EQRTNS

Coeff	Value	Std error	White	tstat
ϕ_1	0.04136	0.05654	0.02412	1.71483
ϕ_2	0.08056	0.04948	0.02630	3.06249
ϕ_3	0.14173	0.05775	0.03151	4.49782
ϕ_4	0.16847	0.07131	0.03388	4.97300

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. value, std error, white and t stat represent regime-dependent coefficients, standard errors, het standard errors and t-stat.

The study estimated the number of thresholds in the carbon output intensity (EMSINT)-Equity returns (EQRTNS) relationship applying equation (19) and allowing for (sequentially) zero, single, double, and triple thresholds. The test statistics F_1, F_2 and F_3, critical values, along with their bootstrap p-values are shown in Table 4.XXIV. Based on the test statistics (F_1, F_2) and their critical values the study accepts the null hypothesis (H_0) of no threshold for the single threshold F_1, and double threshold F_2. Test for third threshold F_3 rejects the null hypothesis (H_0) of no threshold at 0.01 significant levels with a bootstrap p-value of 0.00. The study concludes that there exists triple threshold in the regression relationship. And for the remainder of the analysis the study works with the triple threshold model. Point estimates of the triple thresholds together with their asymptotic 95% confidence intervals are also reported in Table 4.XXV. The estimates are -10.0995, -8.052812 and -10.0995 which are very small values in the empirical distribution of the EMSINT-EQRTNS threshold variable. The classes of firms indicated by point estimates are ‘low emitting firms’, ‘medium emitting firms’, ‘high emitting firms’ and 'very high emitting firms'. The closeness of asymptotic confidence intervals for the thresholds are very close indicating little uncertainty about the nature of the division. Regression slope coefficients, standard errors, het standard errors and t-stat for four regimes are reported in Table 4.XXVI. Estimated model from the empirical findings is expressed as follows:

if $q_{it-1} \leq -10.0995$

If $-10.0995 < q_{it-1} \leq -8.0528$

if $-8.0528 < q_{it-1} \leq -10.0995$

if $q_{it-1} > -10.0995$.

In the first regime (low emitting firms) where EMSINT ratio is less than -10.0995, the estimated coefficient ϕ_1 is - 0.16415, indicating that EQRTNS decreases by - 0.16415 with 1% increase in EMSINT ratio. In the second regime (medium emitting firms) where EMSINT ratio is between -10.0995 and - 8.052812 the estimated coefficient ϕ_2 is -0.13837, indicating that EQRTNS decreases by -0.13837 with 1% increase in EMSINT ratio. In the third regime (high emitting firms) where EMSINT is between -8.052812 and -10.0995 and coefficient ϕ_3 is -0.16484. This similarly shows that EQRTNS decreases by -0.16484 with 1% increase in EMSINT ratio. In the last regime (very high emitting firms) where EMSINT ratio exceeds -10.0995 and estimated coefficient ϕ_4 is - 0.35923. This equally shows that EQRTNS decreases by - 0.35923 with 1% increase in EMSINT ratio. The results generally indicate that improvement in EMSINT is inimical EQRTNS growth.

Table 4.3.XXIV: EMSINT Threshold Effect On EQRTNS

Test for Thresholds	
F_1	7.181246
P-value	0.74
Critical values	15.60819 18.62255 21.69831
F_2	8.942155
P-value	0.51
Critical values	13.98637 16.7379 20.41019
F_3	30.33787
P-value	0.00

Critical values	12.00513 13.27987 17.9077

[CVs at 10%, 5% and 1%]

Table 4.XXV: EMSINT-EQRTNS Threshold Estimate

	Estimate	95% Confidence Interval
٢	-10.0995	[-11.2147, -6.1184]
٢	-8.0528	[-11.2147, -7.3666]
٢	-10.0995	[-10.6471, 10.0995]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures for 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.XXVI: Estimated Coefficients of EQRTNS

Coeff	Value	Std error	White	tstat
ϕ_1	-0.16415	0.07467	0.05620	-2.92049
ϕ_2	-0.13837	0.08764	0.06800	-2.03484
ϕ_3	-0.16484	0.10162	0.07764	-2.12321
ϕ_4	-0.35923	0.14963	0.10898	-3.29611

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. value, std error, white and tstat represent regime-dependent coefficients, standard errors, het standard errors and t-stat.

The study determined the number of thresholds in the carbon input intensity (ENGINT)-Market value of equity deflated by sales (MVE/S) relationship estimating equation (19) and allowing for (sequentially) zero, single, double, and triple thresholds. The test statistics F_1, F_2 and F_3, critical values along with bootstrap p-values are shown in Table 4.XXVII. Null of no threshold (H_0) is rejected at 0.01 in the single threshold F_1, double threshold F_2, and triple threshold F_3, with their bootstrap p-values showing highly significant values of p> 0.01, p> 0.00, and p>0.00 respectively. The study concludes that there are three thresholds in the regression relationship. For the remainder of the analysis the study works with the triple threshold model. Point estimates of the three thresholds together with their asymptotic 95% confidence intervals are also reported in Table 4.XXVIII. The estimates are 0.00068, 0.00093 and 0.00110, which are very small values in the empirical distribution of the ENGINT- MVE/S threshold variable. The classes of firms indicate by point estimates are ‘low energy usage firms’, ‘medium energy usage firms’, ‘high energy usage firms’ and ‘very high energy usage firms’. The closeness of asymptotic confidence intervals for the threshold is very close indicating little uncertainty about the nature of the division. Table 4.XXIX reports the regression slope coefficients, standard errors, het standard errors and t-stat and for four regimes. The estimated model from the empirical findings is expressed as follows:

if $q_{it-1} \leq 0.00068$

if $0.00068 < q_{it-1} \leq 0.00093$

if $0.00093 < q_{it-1} \leq 0.00110$

if $q_{it-1} > 0.00110$

In the first regime (low energy usage firms) where ENGINT ratio is less than 0.00068, the estimated coefficient ϕ_1 is -58.098, indicating that MVE/S decreases by -58.098 with 1% increase in ENGINT ratio. In the second regime (medium energy usage firms) where ENGINT ratio is between 0.00068 and 0.00093 the estimated coefficient ϕ_2 is -1493.025. This indicates that MVE/S decreases by -1493.025 with 1% increase in ENGINT ratio. In the third regime (high energy usage firms) where ENGINT ratio is between 0.00093 and 0.00110, the coefficient ϕ_3 is 1165.510. This however shows that MVE/S increases by 1165.510 with 1% increase in ENGINT ratio. In the last regime (very high energy usage firms) where ENGINT exceeds 0.00110 the estimated coefficients ϕ_4 is 136.104. This again shows that MVE/S increases by 136.104 with 1% increase in ENGINT ratio. The results suggest that the relationship between ENGINT and MVE/S (slope value) varies in accordance with different changes in ENGINT. This shows that ENGINT exhibits a linear relationship (inverse U-shape).

Table 4.XXVII: ENGINT Threshold Effect On MVE/S

Test for Thresholds	
F_1	220.0344
P-value	0.01
Critical values	30.13489 48.46399 164.3896
F_2	269.3122
P-value	0.00
Critical values	25.12891 33.27547 45.46908

F_3	315.7607
P-value	0.00
Critical values	19.46946 23.50075 34.30394

[CVs at 10%, 5% and 1%]

Table 4.XXVIII: ENGINT-MVE/S Threshold Estimate

	Estimate	95% Confidence Interval
٢	0.0009	[0.0009, 0.0010]
٢	0.0006	[0.0006, 0.0006]
٢	0.0011	[0.0001, 0.0017]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures for 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.3.XXIX: Estimated coefficients of MVE/S

Coeff	Value	Std error	White	tstat
ϕ_1	-58.098	56.150	44.265	-1.313
ϕ_2	-1493.025	388.485	10.491	-1.809
ϕ_3	1165.510	449.053	351.348	3.317
ϕ_4	136.104	164.413	82.185	1.656

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. value, std error, white and tstat represent regime-dependent coefficients, standard errors, het standard errors and t-stat.

The study also determined the number of thresholds in the carbon output intensity (EMSINT)-market value of equity deflated by sales (MVE/S) relationship by estimating equation (19) allowing for (sequentially) zero, single, double, and triple thresholds. Test statistics F_1, F_2 and F_3, critical values along with bootstrap p-values are shown in Table 4.XXX. Null of no threshold (H_0) is rejected at 0.01 in each of the cases, i.e. single threshold F_1, double threshold F_2, and triple threshold F_3, with bootstrap p-values showing highly significant values of p> 0.01, p> 0.00 and p> 0.00 in each case. The study concludes that there are three thresholds in the regression relationship. For the remainder of the analysis the study works with the triple threshold model. Point estimates of the three thresholds together with their asymptotic 95% confidence intervals are reported in Table 4.XXXI. The estimates are 0.00053, 0.00055 and 0.00061, which are very small values in the empirical distribution of the EMSINT- MVE/S threshold variable. The classes of firms indicated by point estimates are ‘low emitting firms’, ‘medium emitting firms’, ‘high emitting firms’ and ‘very high emitting firms’. The closeness of asymptotic confidence intervals for the threshold is very close indicating little uncertainty about the nature of the division. Table 4.XXXII reports the regression slope coefficients, standard errors, het standard errors and t-stat and for four regimes. The estimated model from the empirical findings can be expressed as follows:

if $q_{it-1} \leq 0.00053$

if $0.00053 < q_{it-1} \leq 0.00055$

if $0.00055 < q_{it-1} \leq 0.00061$

if $q_{it-1} > 0.00061$.

In the first regime (low emitting firms) where EMSINT ratio is less than 0.00053, the estimated coefficient ϕ_1 is –126.2427, indicating that MVE/S decreases by –126.2427 with 1% increase in EMSINT ratio. In the second regime (medium emitting firms) where EMSINT ratio is between 0.00053 and 0.00055, the estimated coefficient ϕ_2 is 476.1397. The result indicates that MVE/S increases by 476.1397 with 1% increase in EMSINT ratio. In the third regime (high emitting firms) where EMSINT ratio is between 0.00055 and 0.00061, the coefficient ϕ_3 is -3515.8567. This indicates that MVE/S decreases by -3515.8567 with 1% increase in EMSINT ratio. In the last regime (very emitting firms) where EMSINT ratio exceeds 0.00061, the estimated coefficients ϕ_4 is -121.7860. This also shows that MVE/S decreases by -121.7860 with 1% increase in EMSINT ratio.

Table 4.XXX: EMSINT Threshold Effect On MVE/S

Tests for Thresholds	
F_1	261.0626
P-value	0.01
Critical values	48.13166 111.6253 204.607
F_2	210.1656
P-value	0.00
Critical values	31.67894 40.76298 58.78185
F_3	1534.627
P-value	0.00
Critical values	117.333 185.4831 533.403

[CVs at 10%, 5% and 1%]

Table 4.XXXI: EMSINT-MVE/S Threshold Estimate

	Estimate	95% Confidence Interval
٢	0.0005	[0.0005, 0.0005]
٢	0.0006	[0.0006, 0.0006]
٢	0.0005	[0.0005, 0.0005]

Note: *F*- statistics, p-values, threshold estimates and critical values are from repeating bootstrap procedures for 600 times (100, 200 and 300) for each of the three bootstrap tests.

Table 4.XXXII: Estimated Coefficients of MVE/S

Coeff	Value	Std error	White	tstat
ϕ_1	-126.2427	51.6465	48.4104	-2.6078
ϕ_2	476.1397	343.8062	198.8222	2.3948
ϕ_3	-3515.8567	177.9356	84.9313	-41.3965
ϕ_4	-121.7860	196.2598	84.9824	-1.4331

Notes: ϕ_1 ϕ_2 ϕ_3 ϕ_4 are the coefficient estimates that are smaller and larger than the threshold value ٢. value, std error, white and tstat represent regime-dependent coefficients, standard errors, het standard errors and t-stat.

Discussion:

The results indicate that accounting-based performance measures (ROA & ROS) of JSE's SRI INDEX manufacturing and mining firms decrease when ENGINT ratio exceed 0.00093, with ROA declining by - 0.08868 and ROS by – 3.0147. The results however show that when the ENGINT ratio is between 0.00017 and 0.00093 the Index's firms maximise return on the accounting-based performance measures, with ROA showing an increase of 0.29772 and ROS of 0.2413. The results suggest that the ENGINT-ROS relationship (slope value) varies in accordance with different changes in ENGINT, with ENGINT showing a non-linear relationship (inverted U-shape). It is also found that the market-based measure (MVE/S) goes through a tremendous increase when the ENGINT ratio exceeds 0.00093, especially when the EMSINT ratio is in the range of 0.00093 and 0.00110. It was also found that the relationship between ENGINT and MVE/S (slope value) varies in accordance with different changes in ENGINT. This shows that ENGINT exhibits a linear relationship with MVE/S (inverse U-shape). It was further found that EQRTNS is at its highest when ENGINT ratio exceeds –

6.555347. ROA also exhibits the highest performance when the EMSINT ratio exceeds 0.00053, with ROA increasing by 0.51799. ROS is also at its highest increase of 1.0841738 when EMSINT ratio is between 0.00044 and 0.00061. It is also found that the MVE/S shows improvement at the point when the EMSINT ratio is between 0.00053 and 0.00055. The researcher found that a decline in EQRTNS of INDEX's firms is minimised when EMSINT ratio is between –10.0995 and –8.052812

CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

The thesis empirically examined the carbon emissions reduction effect on financial performance of JSE's SRI firms, the only country in Africa with a Socially Responsible Investment Index. The study subjected four dissimilar but complementary elements, effects, threshold effect, impulse response and causality into investigation. The study employed statistical and econometric techniques to examine the effects, threshold effects, impulse response and causality between carbon intensity and financial performance of JSE's SRI firms.

This final chapter concludes the study by presenting the summary of the findings from the study, presenting a proposed model that best represents Carbon intensity and financial standards of JSE's SRI firms, recommendations, limitations of the study and a conclusion.

5.2 Summary of Findings

This section of the chapter summarises the findings of the research in relation to individual specific research objectives:

Objective 1: To examine the carbon intensity effect on accounting and market-based performance of JSE's SRI firms.

Pooled data results confirm results of most previous studies indicating significant effect of carbon input/ output intensity on accounting-based performance (ROA & ROS). When this study accounts for firms' unobserved omitted variable bias as with some recent studies (e.g. Mutezo, 2014; Telle, 2008; King and Lenox, 2001), Fixed effects results indicate that sustainability performance, measured by that carbon output intensity and carbon input intensity does not significantly affect any of the financial performance indicators of this study, measured ROA, ROS, EQRTNS & MVE/S. When the study employed Arellano-Bond dynamic panel data estimations the results showed a significant and negative effect of carbon input intensity (ENGINT) on EQRTNS at level 0.002. Furthermore, OLS results on pooled data indicate that improvement in carbon intensity input (ENGINT) is value destroying and does not enhance firms' competitiveness with respect to ROA and ROS. On the contrary, pooled data results show that improvement in carbon output intensity (EMSINT) is value driven and enhances corporate competitiveness with respect to ROA and ROS. Arellano-Bond DPD estimations results also show that improvement in carbon input intensity (ENGINT) is value destroying with respect to EQRTNS. The study also found consistencies in the direction of association between carbon input intensity (ENGINT)-ROA, ROS and EQRTNS relations, and between carbon output intensity (EMSINT)-ROA, ROS relations with respect to OLS and Arellano-Bond estimations. Using panel Granger causality approach the author found that the lags of ENGINT do not improve a forecast of financial performance, and the opposite is also true. It was found however that a unidirectional relationship between EMSINT and EQRTNS at 1% significant level exists. Impliedly, the lags of EMSINT do improve a forecast of financial performance (EQRTNS). The author also found a bidirectional relationship between EMSINT and MVE/S at 1% significant levels. It can thus be concluded that prior improvement in EMSINT leads to subsequent improvement in EQRTNS. It is also true to say that as prior improvement in EMSINT subsequently improves MVE/S. Prior performance in MVE/S subsequently improves EMSINT of the SRI Index's firms. Cross sectional dependence test rejected the null of no cross-sectional dependence across the members of panel.

Objective 2: To estimate how accounting and market-based performance of JSE's SRI firms responds to shocks in carbon input/ output intensity.

Using impulse response function analysis in short panel vector auto regressions (SPVARs), results from chapter 4 show that ROA responds negatively to shocks in carbon input intensity (ENGINT) and persists for the first 4 years and afterwards reverts to the equilibrium. On carbon output intensity on (EMSINT)-ROA relations, the results show that ROA responds positively to shocks in carbon output intensity and persists for 7 years before attaining equilibrium. On carbon input intensity on (ENGINT)-ROS relations, the results show that the ROS response is negative to shocks in ENGINT and persists for 8 years. On carbon output intensity (EMSINT)-ROS relations the study found that on average shocks in carbon output intensity (EMSINT) enhances firms' competitiveness for the first 2 years, and thereafter showed value destroying tendencies through to the sixth year before attaining equilibrium. Furthermore, the study found that shocks in carbon input intensity (ENGINT) is value destroying with respect to EQRTNS and persists for 6 years after which EQRTNS starts to move towards equilibrium. On carbon output intensity (EMSINT)-EQRTNS the results show that on average the EQRTNS responds negatively to shocks in EMSINT and persists for 7 years before gaining stability. On ENGINT-MVE/S relations the results show that MVE/S sustains shocks from ENGINT for almost 4 years, after which unobserved and minimal intermittent positive and negative tendencies are exhibited through to year 8. On EMSINT-MVE/S relations the study observe that shocks in carbon output intensity (EMSINT) are sustained by MVE/S through-out the period. The study concludes that on average shocks in carbon output intensity tend to enhance firms' competitiveness. While shocks in carbon input intensity shows value destroying tendencies. Again, the study found MVE/S to sustain shocks from carbon output / input intensity. Furthermore, the results from OLS, Arellano-Bond estimation, and Impulse response analysis all show that reduction in carbon output intensity (EMSINT) enhances corporate competitiveness and is value driven, while reduction in carbon input intensity show value destroying effects.

Objective 3: To determine the carbon intensity threshold effect on accounting and market-based performance of JSE's SRI firms.

Utilising threshold estimations and applying bootstrap tests for the presence of thresholds, results from chapter 4.3 indicate the presence of a carbon output/ input intensity threshold effect on financial performance of JSE's SRI firms. The results indicate that ROA decreases by - 0.08868, while ROS decreases by – 3.0147 when ENGINT ratio exceed 0.00093. The results also show that when the ENGINT ratio is between 0.00017 and 0.00093, ROA and ROS increases by 0.29772 and 0.2413 respectively. The author also found that the ENGINT-ROS relationship (slope value) varies in accordance with different changes in ENGINT, with ENGINT showing a non-linear relationship (inverted U-shape). The study also found that MVE/S goes through a tremendous increase when the carbon input intensity (ENGINT) ratio exceeds 0.00093, especially when the ENGINT ratio is in the range of 0.00093 and 0.00110. It was also found that the ENGINT-MVE/S relations (slope value) vary in accordance with different changes in ENGINT, with ENGINT showing a linear relationship (inverse U-shape). It was further found that ROA is at its highest when the EMSINT ratio exceeds 0.00053 with ROA increasing by 0.51799. ROS seemed to be at its highest increase of 1.0841738 when EMSINT ratio is between 0.00044 and 0.00061. MVE/S also shows an improvement at the point where EMSINT ratio is between 0.00053 and 0.00055.

KING III (2009) enjoins companies to disclose environment data (e.g. emissions and energy usage) in order to allow interested parties to have full knowledge regarding how companies are interacting with the environment. Findings from this study was aided by the fact that companies adhered to stakeholder requirements and disclose such environmental data to help parties to make informed decisions. Findings from this study support stakeholder theory as the results showed the extent to which companies manage energy related resources to create a balance between sustainability engagements and financial gains. The findings also support institutional theory as the results seemed to show why companies institute integrated/ multifaceted programmes and activities in the attempt to enhancing their interaction with the environment and meeting stakeholder demands.

5.3 Contribution of the study

This thesis has made three contributions to literature on carbon emissions reduction and financial performance in South Africa, namely to research and to the academia and practice. Therefore, the contribution is highlighted in the following sections:

5.3.1 Contribution to Research

First, owing to the low power associated with OLS and Fixed effects estimations, the study applied Arellano-Bond (1991) DPD estimation in addition to OLS and Fixed effect estimations to examine the carbon emissions reduction effect on financial performance of JSE's SRI firms. To the best of the researcher's knowledge this is the first study in sustainability accounting research in South Africa to have applied all the three estimations simultaneously to gain a comprehensive understanding of how carbon emissions reduction affects corporate financial performance.

Secondly, this is the first sustainability accounting research in South Africa to address the issue of how firms' economic performance measures respond to shocks in carbon output intensity (EMSINT) and carbon input intensity (ENGINT) using Impulse response function analysis in short panel vector auto regressions (SPVARs).

Furthermore, to the best of the researcher's knowledge this is the first study on sustainability accounting research in South Africa to address the issue of a carbon output intensity (EMSINT)/ carbon input intensity (ENGINT) threshold effect on corporate economic performance employing Bootstrap Panel dynamic threshold models.

Finally, review of extant literature showed that this is the first study in sustainability accounting research in South Africa to examine the carbon intensity effect on financial performance using a combination of carbon output intensity (EMSINT) and carbon input intensity (ENGINT), and four accounting control variables, which are: OPTINC, GROWTH, LEV and/or ASSET/ LNMVE. Therefore, the improved model employed in this research, which future researchers may replicate in other countries, is re-produced in the Table 5.I.

Table 5.I: Variables for OLS, Fixed Effects and Arellano-BOND Estimations

Dependent	Independent variables
Return on Assets (y)	EMISNT($x_{1)}$,ENGINT($x_{2)}$,OPTINC(x_3),LEV(x_4),LNASSET(x_5), GROWTH(x_6)
Return on Sales (y)	EMISNT(x_1),ENGINT(x_2),OPTINC(x_3),LEV(x_4),ASSETS/S(x_5), GROWTH(x_6)
Equity returns (y)	EMISNT(x_1), ENGINT(x_2), OPTINC(x_3), LEV(x_4), LNMVE(x_5), GROWTH(x_6)
Market value of equity /Sales	EMISNT(x_1), ENGINT(x_2), OPTINC(x_3), LEV(x_4), ASSETS/S(x_5), GROWTH(x_6)

Owing to the low power of OLS and Fixed Effects estimations, some recent studies in sustainability accounting research have resorted to more robust statistical techniques including; 2 Stage Least Squares and Partial Least Squares/ Structural Equation Models (SEMs). This study however applied different statistical tools including: Arellano-Bond DPD estimations, Impulse Response Function analysis in short panel vector auto regressions (SPVARs), and Bootstrap dynamic panel threshold models. Application of these estimators in this current study makes this study unique and distinct from previous studies in sustainability accounting research (see Table 5.II).

Table 5.II: Some Advanced Statistical Models used in related previous studies

Authors/ Study	2/ 3 Stage Least Squares	Partial Least Squares/ SEMs
Erhemjamts et al., (2013)	✓	X
Sambasivan et al., (2012);	X	✓
Boltcher & Muller, (2014)	✓	X
Klingenberg et al., (2013)	✓	X
Russo & Pogutz, (2009)	✓	X
Lee and Park, (2009)	✓	X
Salama, (2005)	✓	X
Mullin et al., (2014)	✓	X
Alzboun et al., (2016)	x	✓
Sen et al., (2015)	X	✓
Agan, et al., (2014)	✓	X

Table 5.III: Some Advanced Statistical Models used in this research but not in previous related studies

Authors/ Study	Arellano-Bond DPD Model	Impulse Response Function in SPVARs	Bootstrap Dynamic Panel Threshold Model
This study by Worae., (2016)	✓	✓	✓
Previous studies:			
Erhemjamts et al., (2013)	X	X	X
Sambasivan et al., (2012)	X	X	X
Boltcher and Muller, (2014)	X	X	X
Klingenberg et al., (2013)	X	X	X
Russo and Pogutz, (2009)	X	X	X
Lee and Park, (2009)	X	X	X
Salama, (2005)	X	X	X
Mullin et al., (2014)	X	X	X
Sen et al., (2015)	X	X	X

Alzboun et al.,(2016)	X	X	X
Agan, et al., (2014)	X	X	X

Chart (figure 5.I) of impulse and threshold offers a further agenda for research. So far, no previous research has examined which of the two points may trigger better financial gains. Therefore it becomes pertinent for further research to examine the following relationships:

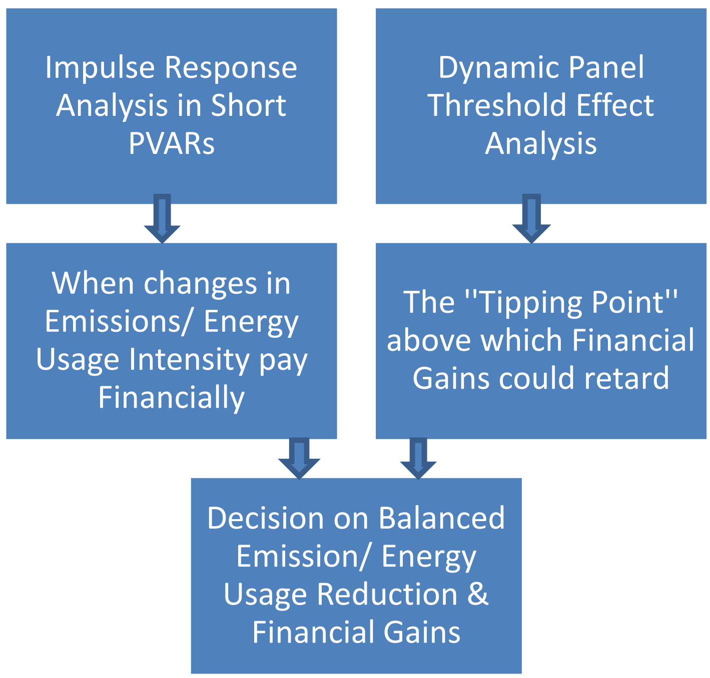

Figure 5.I: Suggested Framework for further analysis of Carbon Emissions & Financial Performance

i. The relationship between residuals from the threshold model and impulse response function on financial performance

$$y = \beta_0 + \beta_1 X_{it} + \beta_1 X_{it} + \varepsilon_{it},$$

Where:

y= the level of financial gains

X_{it} = residuals from threshold estimation

X_{it} = residuals from impulse response analysis

ε_{it} = error term following a normal distribution with mean zero and variance 1

ii. The relationship between residuals from the threshold model and impulse response function on managerial decisions

$y = \beta_0 + \beta_1 x_{it} + \beta_2 x_{it} + \varepsilon_{it}$

Where:

y = level of managerial decisions on carbon output/ input reduction

X_{it} = residuals from threshold estimation

X_{it} = residuals from impulse response analysis

ε_{it} = error term following normal distribution with mean zero and variance 1.

5.3.2 Contribution to Practice and Policy

Practice

Conventional managerial performance evaluation is based on financial and non-financial measures which exclude environmental Greenhouse Gas variables. But from the results of this study, it becomes evident that managerial performance evaluation needs transformation to include environmental ratios such as, emissions intensity, energy intensity to the traditionally adopted internal managerial performance measures against divisional investment and/or earnings.

Policy

As climate change policies trigger unprecedented emergence in internal corporate carbon policies, companies are increasingly developing ambitious carbon reduction agendas in all activities. Yet, one of the setbacks amongst others is how to determine which of the corporate activities that have significant influence on corporate carbon levels (Kjaer, Høst-Madsen, Schmidt, and McAloone, 2015). This research has demonstrated the use of impulse response and threshold analysis in determining economic implications of carbon reduction. This research has contributed to internal corporate carbon policy through the application of impulse response and threshold effects to determine what level of carbon reduction might be economically feasible and/or worthwhile to maintain a permissible level of carbon at a tolerable economic level for a firm's economic capacity. This threshold-impulse response assessment should be able to direct management as to when, and at what level they should swing into action regarding carbon abatement management. The assessment could also inform policy on carbon reduction investment commitments, and signal management as to where to stop or continue with carbon improvement activities and investments. This it is believe could enhance internal policy on carbon reduction in a more sustainable competitive manner.

5.4 Recommendation

Drawing from the findings of this research the following recommendations are made for future research:

Research

Given the controversies surrounding the carbon emissions reduction effect on corporate financial performance, much work remains to be done to understand the dynamics and fundamentals of the carbon emissions reduction effect on firms' economic performance. While the carbon emissions reduction effect on firms' economic performance and causal relations between variables seem to show confirmation of some previous empirical findings, the author also examined carbon emissions reduction threshold effect on firms' financial performance, and how corporate financial performance responds to shocks in carbon intensity. The researcher therefore recommends further research in this area to consider:

i. The issue of non-linearity and structural breaks in Impulse Response Function estimations to provide a better understanding of how financial performance measures (ROA, ROS, EQRTNS and MVE/S) respond to shocks in carbon output intensity and energy usage intensity.

ii. Slope homogeneity to provide insight into whether a significant sustainability and economic relationship in a firm is not replicated in other firms.

iii. How non-mean reverting variables through corporate policy could be reverted to the equilibrium point.

Future research that incorporates these recommendations into their investigations could provide better answers to the interrelations between carbon emissions performance and firms' economic performance which it's believed may tilt the carbon performance-financial performance conundrum.

Practice

i. Conventional managerial performance evaluation should be made to include carbon emissions/energy consumption variables such as energy intensity and emissions intensity to re-focus managers' attention toward energy conservation and emissions reduction.

ii. It will be necessary and required of management to put in place a policy intervention that could drag in variables that are non-mean reverting to stability.

iii. To achieve a balance in energy conservation, carbon output reduction and wealth maximisation require companies to develop integrated policies that ensure co-ordination between sustainability engagements and financial gains.

Academia

This study has fostered the relevance for renewed approach to environmental Accounting education in South Africa to go beyond the traditional focus on environmental/sustainability disclosures. The researcher found no previous study where current academic work (teaching and learning) has focused on the connectivity between carbon reduction achievement and managerial decision strategies to boast future carbon reduction. The researcher therefore recommends an integration of post carbon managerial decisions appraisals into current post-graduate teaching and learning curriculum in South African universities that have integrated sustainability accounting in their post-graduate studies to equip graduates with skills required for managing carbon foot print and not compromising financial gains for the good of society.

5.5 Limitation of the Study

The study is limited to14 manufacturing and mining companies listed on JSE's SRI Index for the periods 2008-2014. The cross-section and time series dimensions might not be sufficiently representative to allow for generalisation. Limited cross section and the time dimension are primarily attributed to difficulties encountered in accessing carbon related data, even from the Carbon Disclosure Project, an organisation known for repository of global sustainability data. Hence, future studies could include more companies and as well extend the time series dimension. Furthermore, the choice of sustainability and financial performance indicators together with statistical estimators could be subjective as it relied on the researcher's value judgement and assumptions.

5.6 Conclusion

This research examined carbon emissions reduction and financial performance of JSE's SRI firms. The researcher hand-collect sustainability data from the Carbon Disclosure Project database. While the accounting-based financial performance data were collected from online-databases of selected companies, the market-based performance data were collected from Tick-data-market, a French-based company.

Using OLS on pooled data a significant effect of carbon intensity on ROA and ROS was found. When accounting for firms' unobserved omitted variable bias as with some recent studies (Mutezo, 2014; Telle, 2008; King and Lenox, 2001), the FE (within) results exhibit an insignificant effect on ROA, ROS, EQRTNS and MVE/S. Furthermore, the OLS results indicate that an improvement in ENGINT is value destroying and does not enhance firms' competitiveness with respect to ROA and ROS. The study found that improvement in EMSINT enhances corporate competitiveness and value driven with respect to ROA and ROS.

Arellano-Bond dynamic panel data estimation shows that improvement in carbon input intensity (ENGINT) is value destroying with respect to EQRTNS. The study further found consistency in the direction of association between ENGINT-ROA, ROS and EQRTNS, and between EMSINT-ROA and ROS from OLS and Arellano-Bond dynamic panel data estimation.

Using Impulse response function analysis in short panel vector auto regressions (SPVARs), ROA is found to respond negatively to shocks in ENGINT and to persist for the first 4 years, before attaining equilibrium. This indicates the mean reversion tendency of the variable after the fourth year. On EMSINT-ROA relations were found to have persistent and positive responses of the variable to shocks in EMSINT for 7 years before attaining equilibrium. ENGINT-ROS relations indicate persistent and negative responses of ROS to shocks in ENGINT for the 8 years. EMSINT-ROS relations show an initial 2 year positive response to shocks in EMSINT, and subsequently persistent negative responses till the sixth year, before gaining stability. ENGINT-EQRTNS relations also show persistent and negative responses of EQRTNS for 6 years before attaining equilibrium. EMSINT-EQRTNS similarly show persistent and negative responses of EQRTNS to shocks in EMSINT for 7 years before stability is gained. On ENGINT-MVE/S relations the study found a sustained equilibrium from MVE/S to shocks in ENGINT for 4 years and thereafter showing unobserved/minimal intermittent positive and negative tendencies till the eighth year. EMSINT-MVE/S relations similarly show a sustained stability from MVE/S to shocks in EMSINT through-out the period. The author concludes that on average, shocks in carbon intensity tend to enhance corporate competitiveness with respect to ROA. MVE/S on the other hand tends to maintain equilibrium with the shocks in carbon intensity.

Employing dynamic panel threshold models, the results confirm the presence of carbon intensity threshold effect on financial performance of JSE's SRI firms. The researcher also found that ROA decreases by - 0.08868, and ROS by – 3.0147 when ENGINT ratio exceed 0.00093. While ROA and ROS increase by 0.29772, and 0.2413, if ENGINT ratio is in the range of 0.00017 and 0.00093. Furthermore, ENGINT-ROS relationship exhibited a non-linear relationship (inverted U-shape). It was also found that MVE/S enjoys a tremendous increase when ENGINT ratio exceeds 0.00093, but increases more if the ENGINT ratio lies between 0.00093 and 0.00110. The study again found a linear relationship (inverse U-shape) between ENGINT and MVE/S.

With EMSINT-ROA relationship, the study found that ROA is at its highest when the EMSINT ratio exceeds 0.00053, with ROA increasing by 0.51799. ROS on the other hand is at its highest with 1.0841738, if EMSINT ratio is between 0.00044 and 0.00061, with MVE/S showing an improvement at the point where EMSINT ratio is in the range of 0.00053 and 0.00055.

Panel Granger causality results showed that lags of ENGINT do not improve a forecast of financial performance. There is however a unidirectional relationship between EMSINT and EQRTNS at 1% significant level. Finally, the researcher found a bidirectional relationship between EMSINT and MVE/S at 1% significant levels. The results also showed cross-sectional dependence across the members of panel.

Findings of the study support stakeholder theory as the results showed the extent to which companies manage energy related resources to create a balance between sustainability engagements and financial gains. The findings also support institutional theory as the results seemed to show why companies institute integrated/ multifaceted programmes and activities in the attempt to enhancing their interaction with the environment and meeting stakeholder demands.

Given the findings of this study in the light of empirical literature, the author concludes that this research makes a contribution to knowledge on how carbon emissions reduction affects financial performance of JSE's SRI firms. Firstly, owing to the low power associated with OLS and Fixed effects (within) estimations, this thesis adopted a more robust technique proposed by Arellano-Bond (1991) to examine carbon intensity effect on financial performance of JSE's SRI firms. Secondly, this thesis is probably the first in empirical environmental accounting research to address the issue of carbon intensity shocks on corporate financial performance applying an Impulse response function analysis in short panel vector (SPVARs). Thirdly, to the best of the researcher's knowledge, this is the first study in empirical environmental accounting research to address the carbon emissions reduction threshold effect on firms' financial performance. Finally, the application of statistical and econometric concepts and techniques to a traditional accounting problem is a noteworthy contribution that could attract other researchers to undertake multidisciplinary research.

This research bridged the existing gap in knowledge about carbon emissions reduction and financial performance of JSE's SRI firms as no previous studies in South Africa have investigated this relationship applying Arellano-Bond estimations, impulse response function analysis in short PVARs, and dynamic panel threshold models. The study extends previous international research on carbon emissions reduction and economic performance in countries such as: Australia, Britain, USA, China, Japan, Egypt, Czech Republic and Brazil (e.g.

Chapple et al., 2009; Salama, 2005; Johnston et al., 2008; Qiet et al., 2014; Iwata & Okala, 2011; Horvathove, 2012; Wahba, 2008; Crisostomo et al., 2011) by considering the variables and models investigated in the previous studies in relation to JSE's SRI companies.

This study differs from previous related international and South African studies on carbon emissions reduction and financial performance as this study extended further to:

i. Account for unobserved omitted variable bias and possible orthogonality conditions, owing to the low power associated with OLS and Fixed Effects estimations that are mostly applied in previous studies in South Africa.

ii. Determine persistence and mean reversion tendencies of JSE's SRI firms' ROA, ROS, EQRTNS and MVE/S to shocks in carbon output/ input intensity.

iii. Investigate the carbon output/ input intensity reduction threshold effect on ROA, ROS, EQRTNS and MVE/S of JSE's SRI firms.

iv. Employ variables (see Table 5.1 in chapter 5) that have not been studied in any single study in South Africa to the best of the researcher's knowledge.

v. Suggest a framework/ model for analysis of carbon emissions-financial performance relationship and managerial decisions (see figure 5.I).

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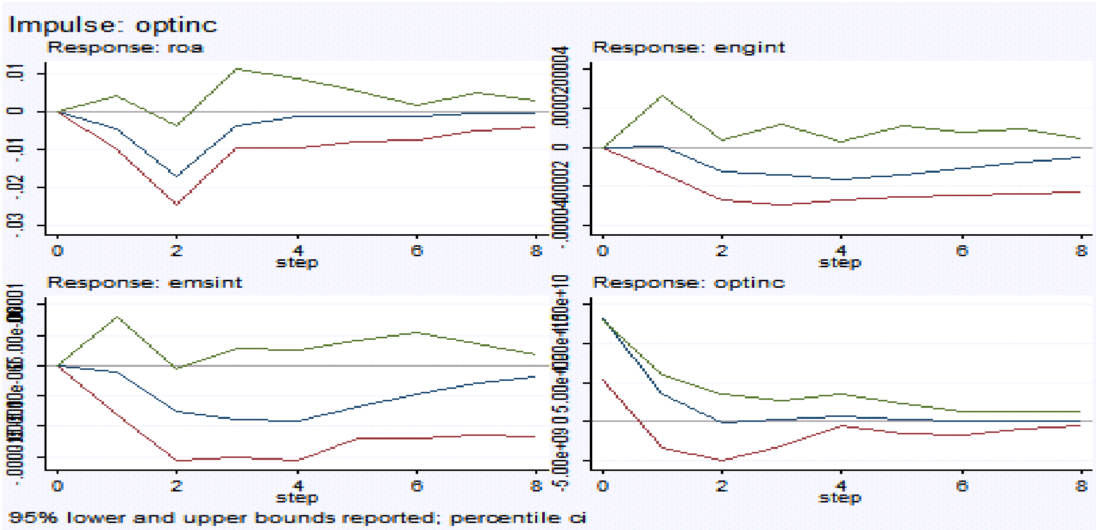
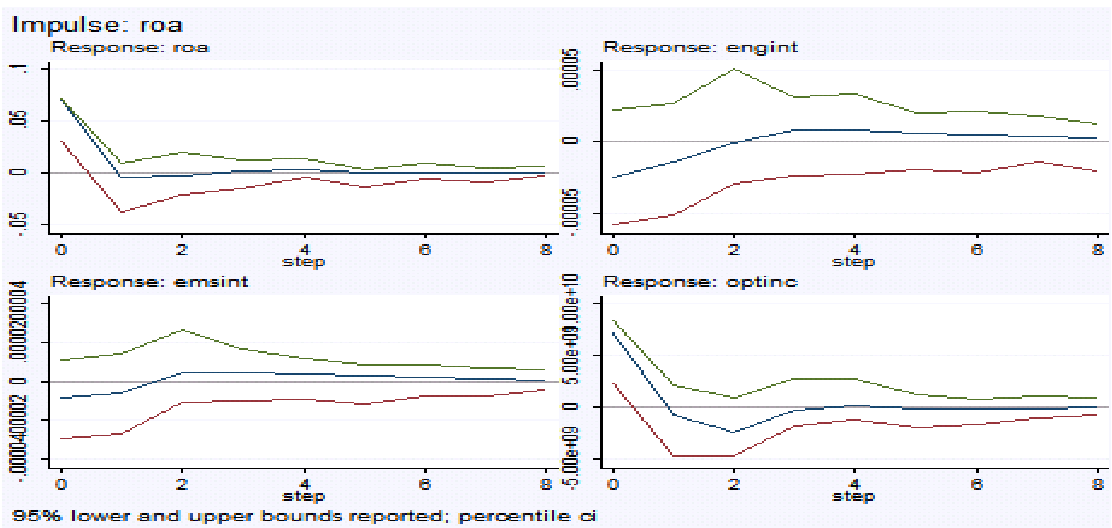
APPENDICES:



APPENDIX I: Response of ROA to Shocks in OPTINC



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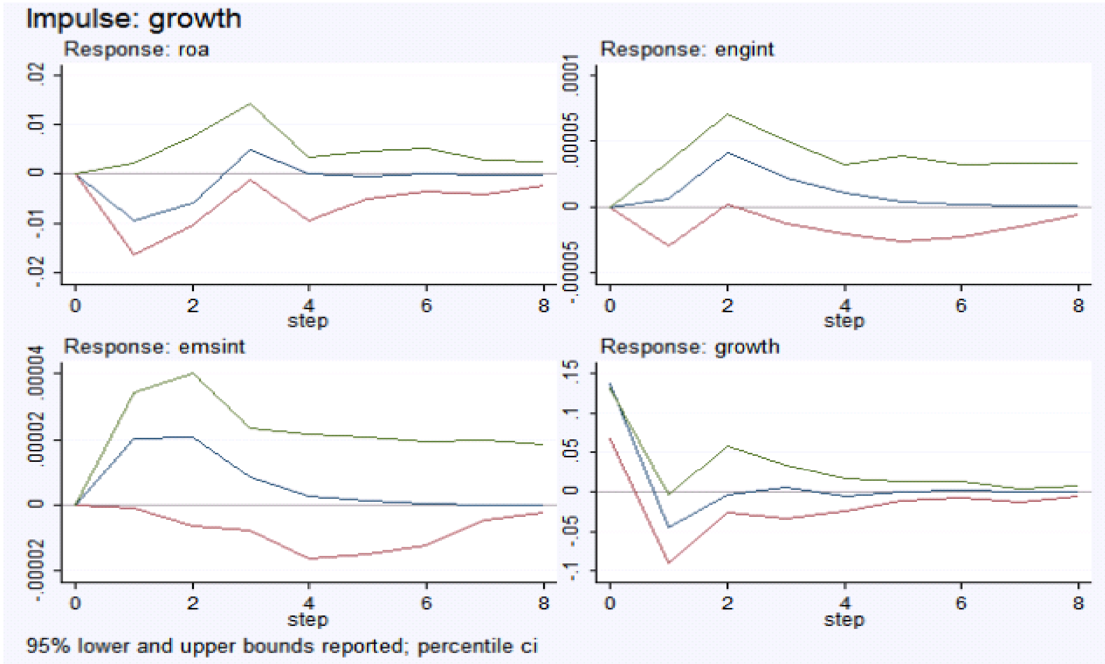
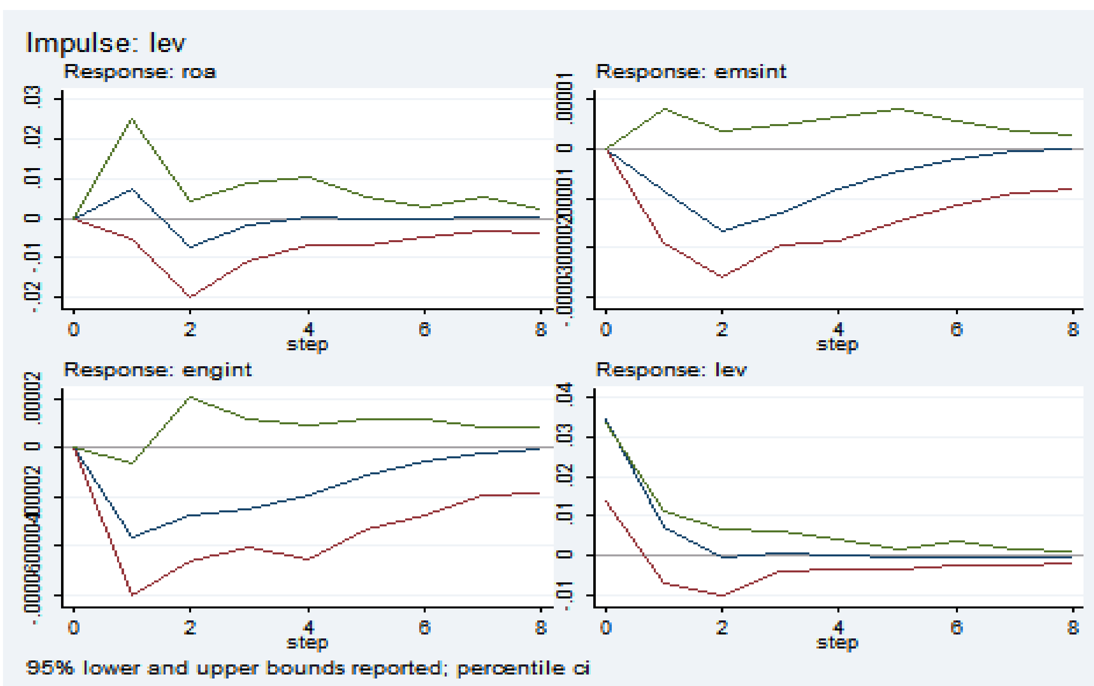


APPENDIX III: Response of ROA to Shocks in GROWTH



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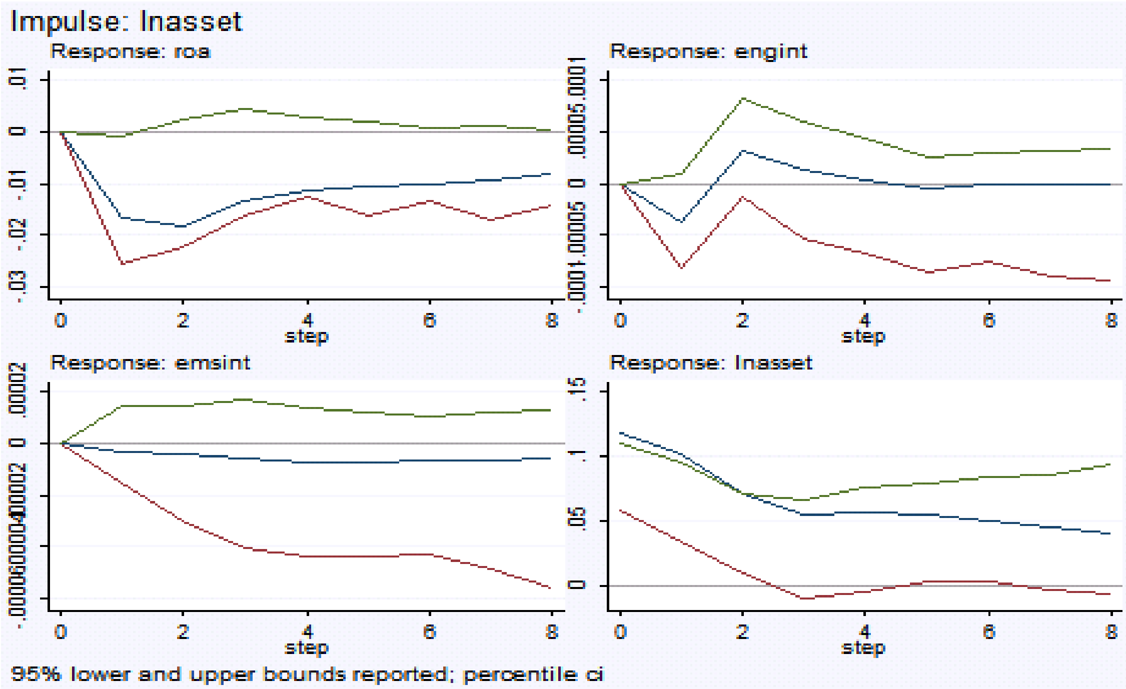
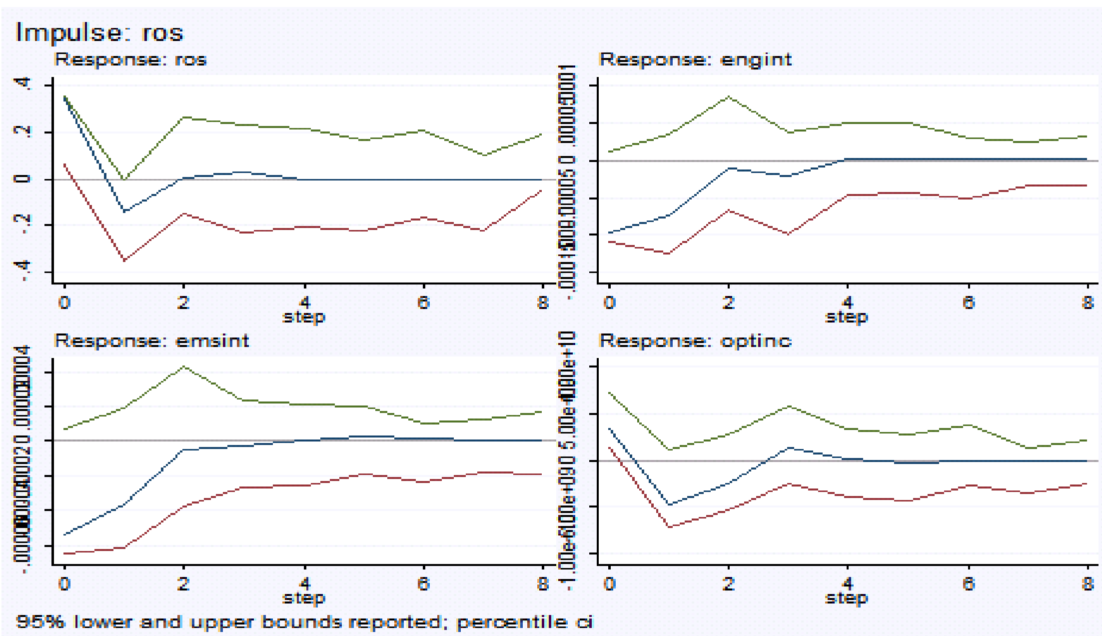
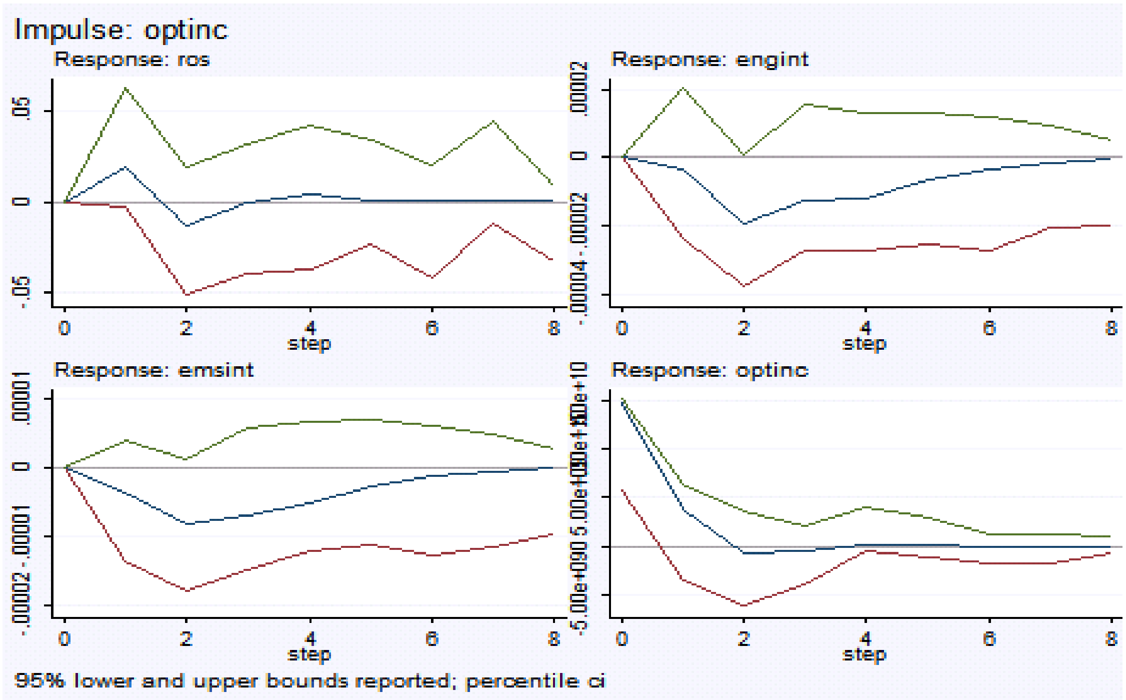


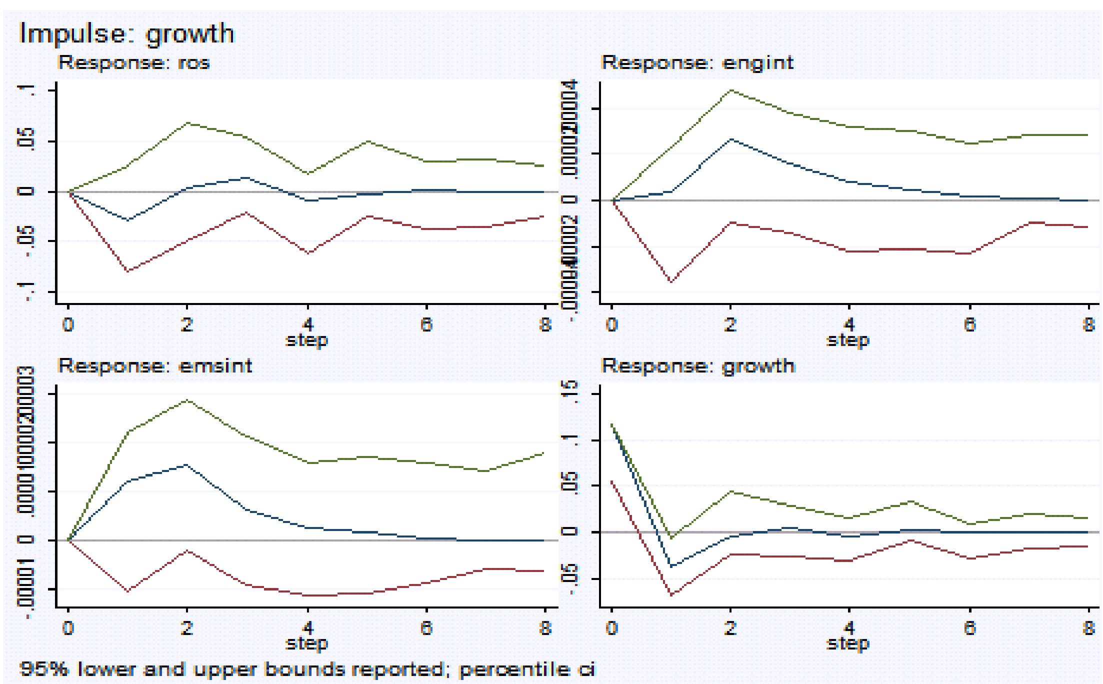
APPENDIX V: Response of ROA to Shocks in LnASSET



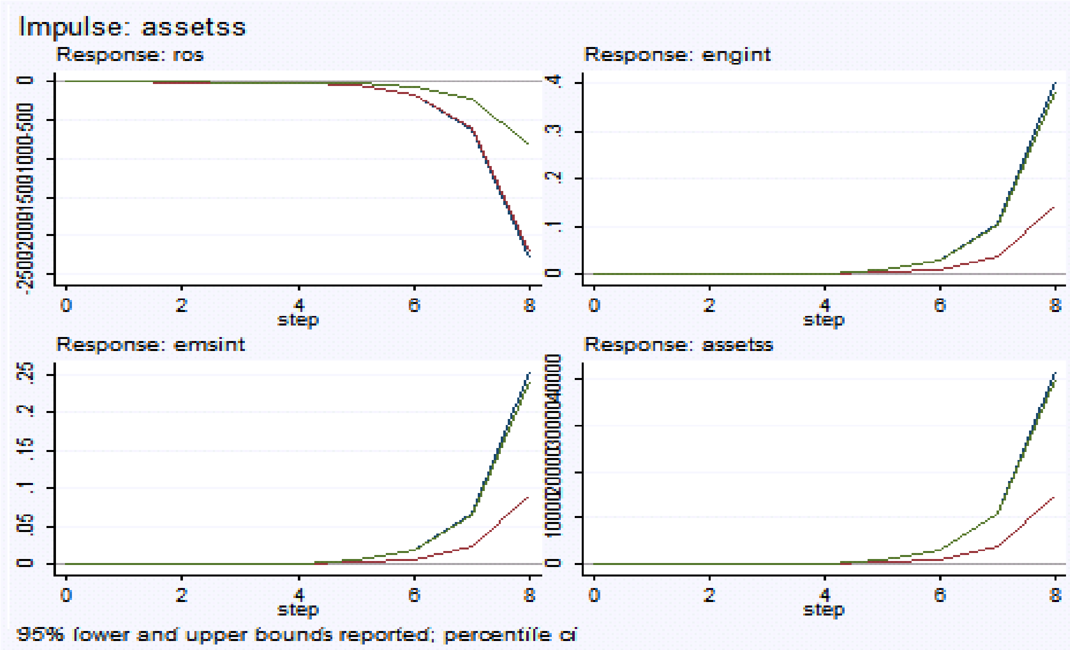
APPENDIX VI: Response of ROS To Shocks In ROS



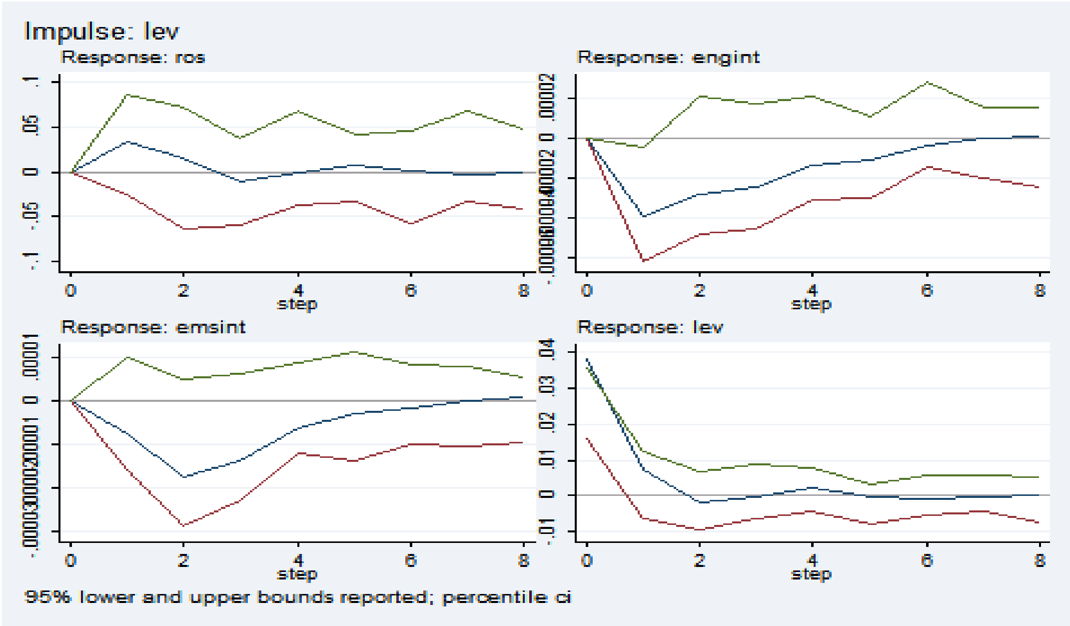
APPENDIX.VII :Response of ROS to Shocks in OPINC



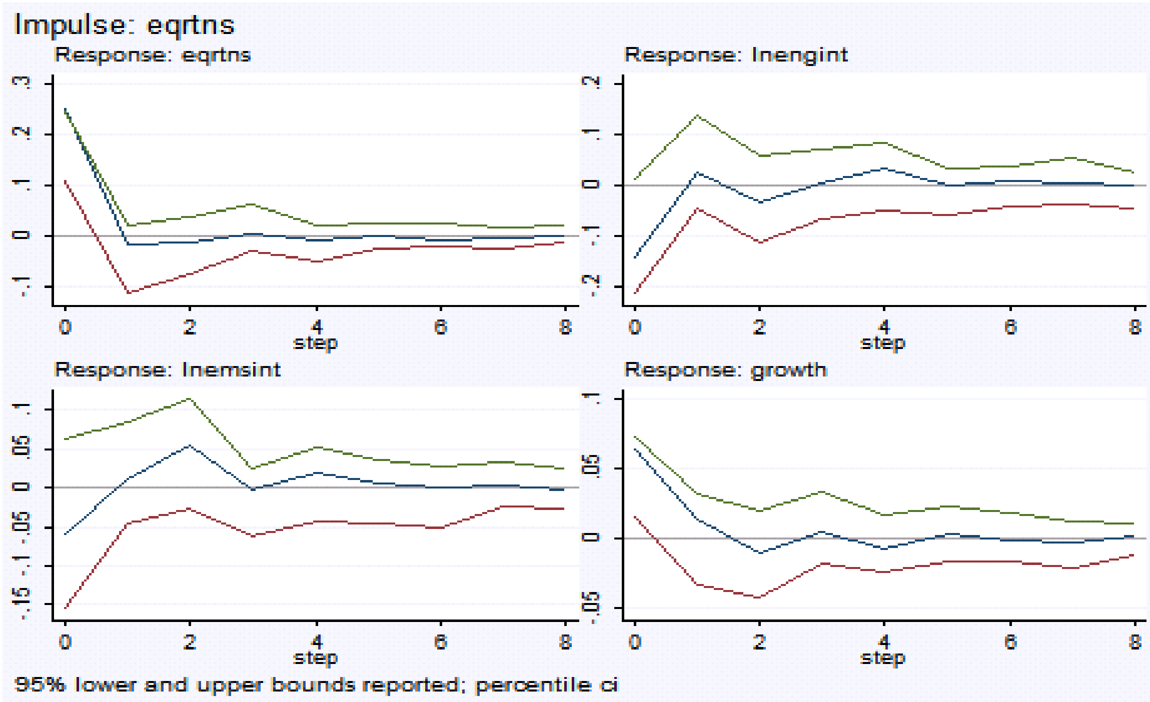
APPENDIX. VIII: Response of ROS to Shocks in GROWTH



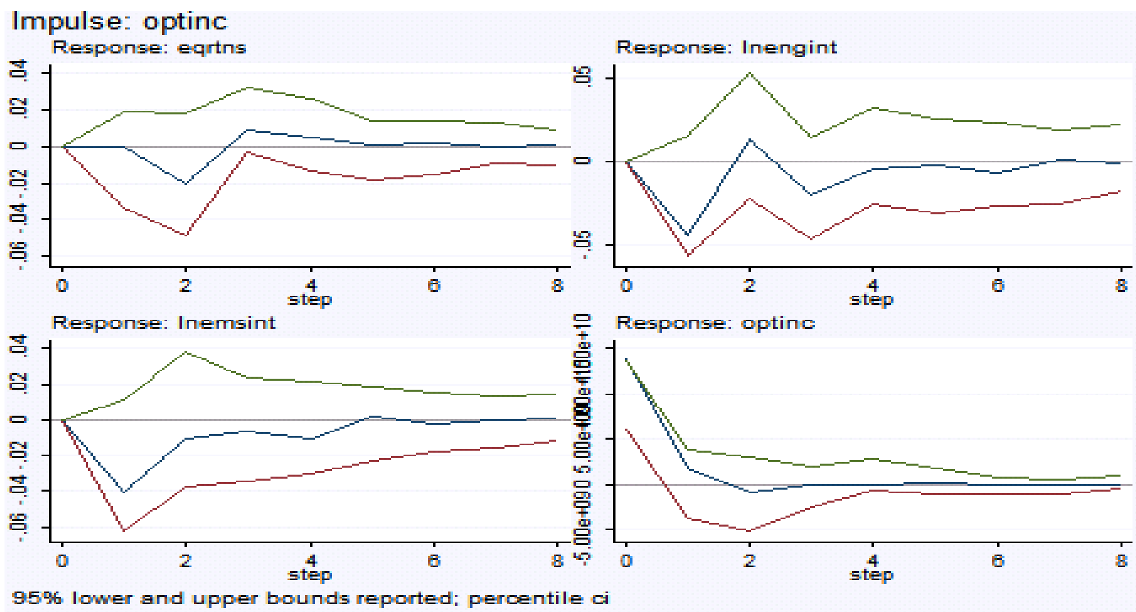
APPENDIX IX:Response of ROS to Shocks in ASSETS/S



APPENDIX X: Response of ROS to Shocks in LEV



APPENDIX XI: Response of EQRTNS to Shocks in EQRTNS



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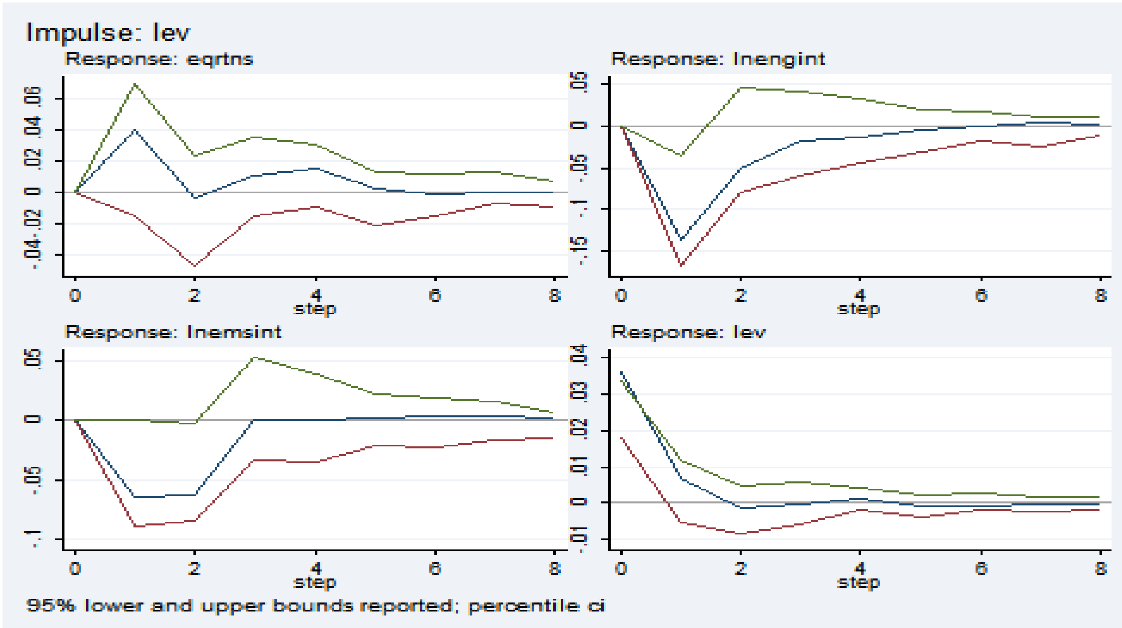
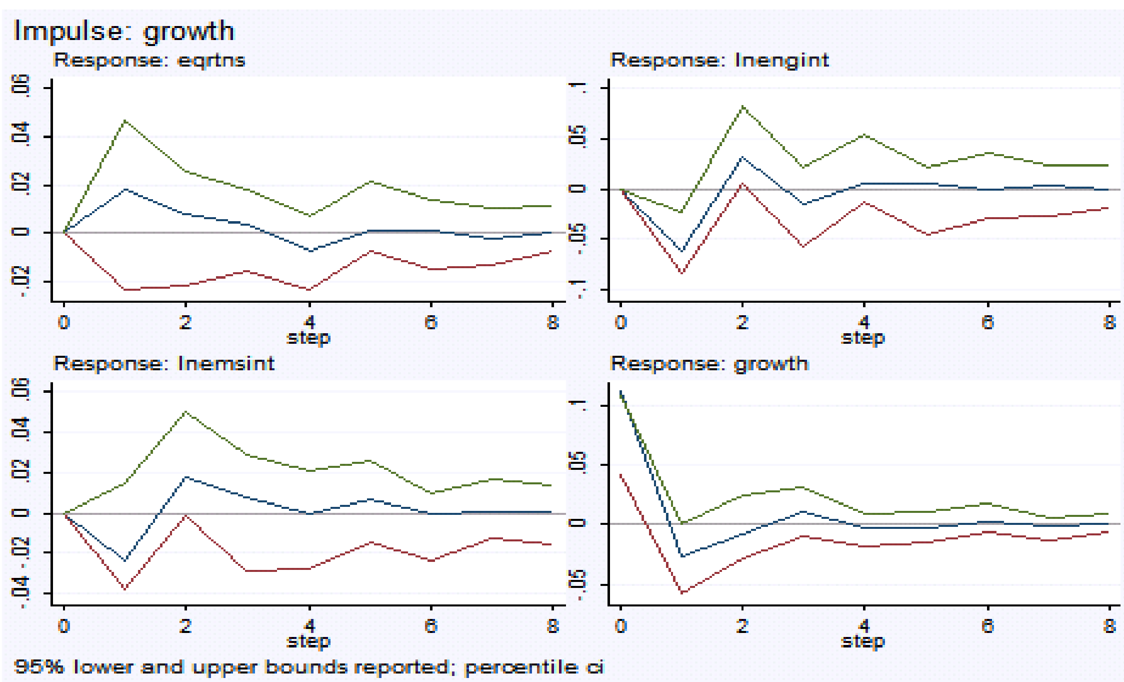
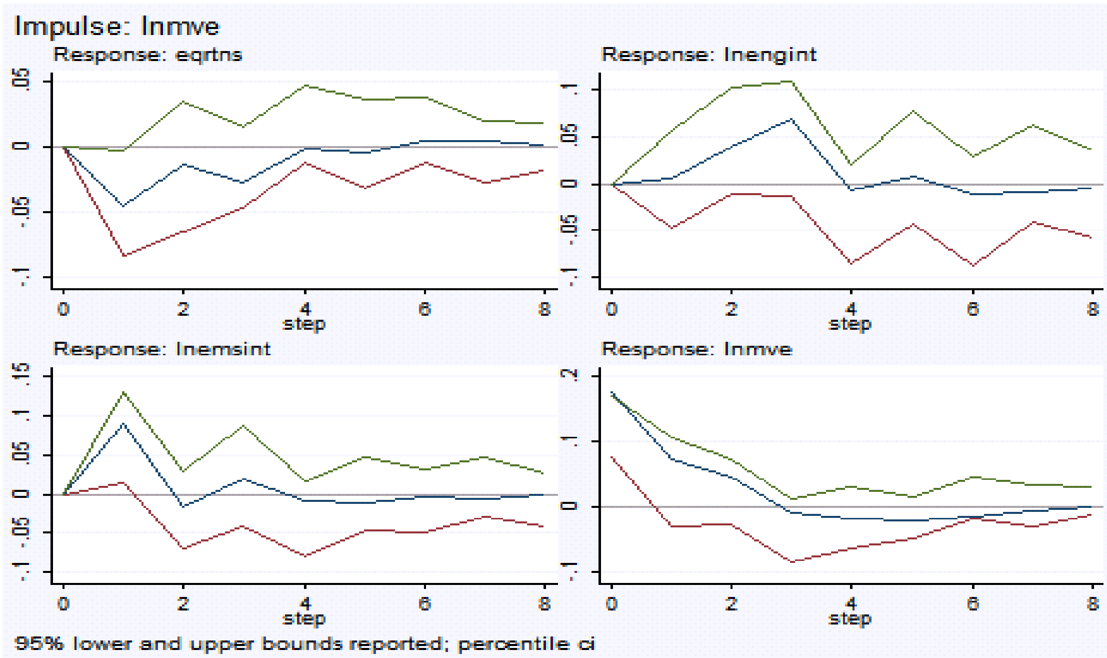


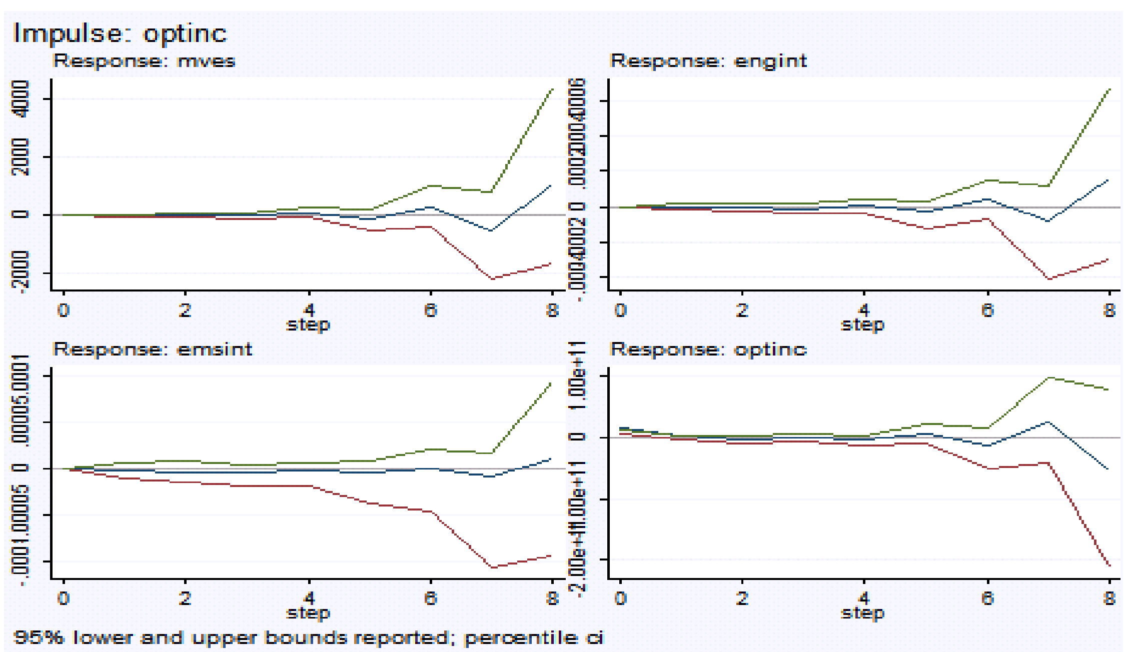
APPENDIX. XIII: Response of EQRTNS to Shocks in LEV



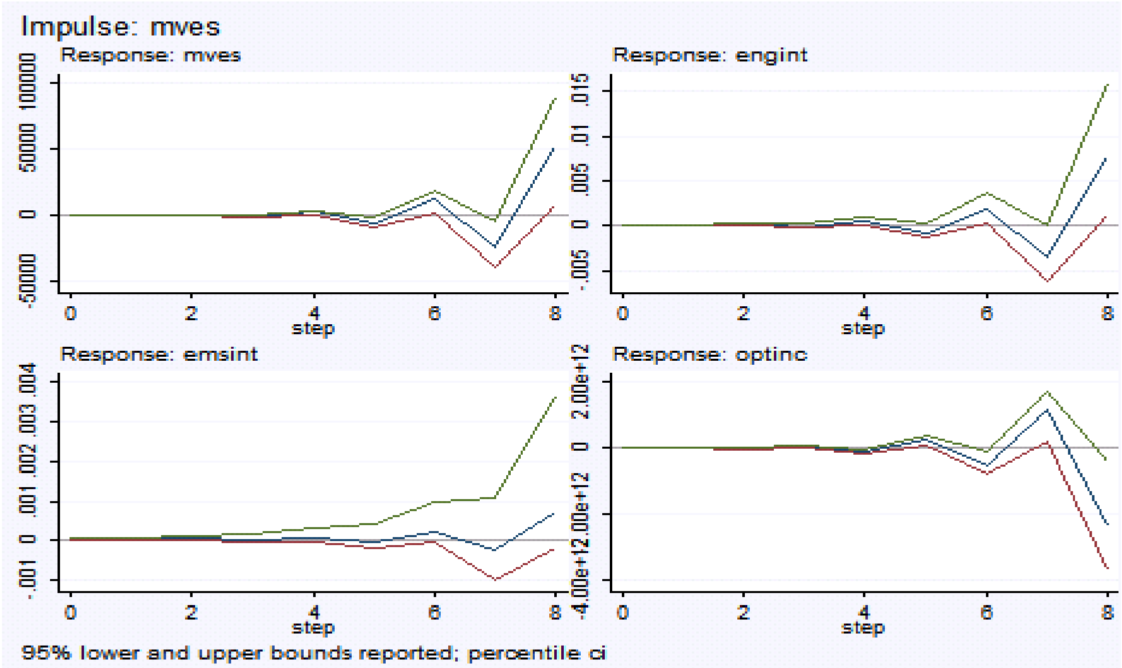
APPENDIX.XIV: Response of EQRTNS to Shocks in GROWTH



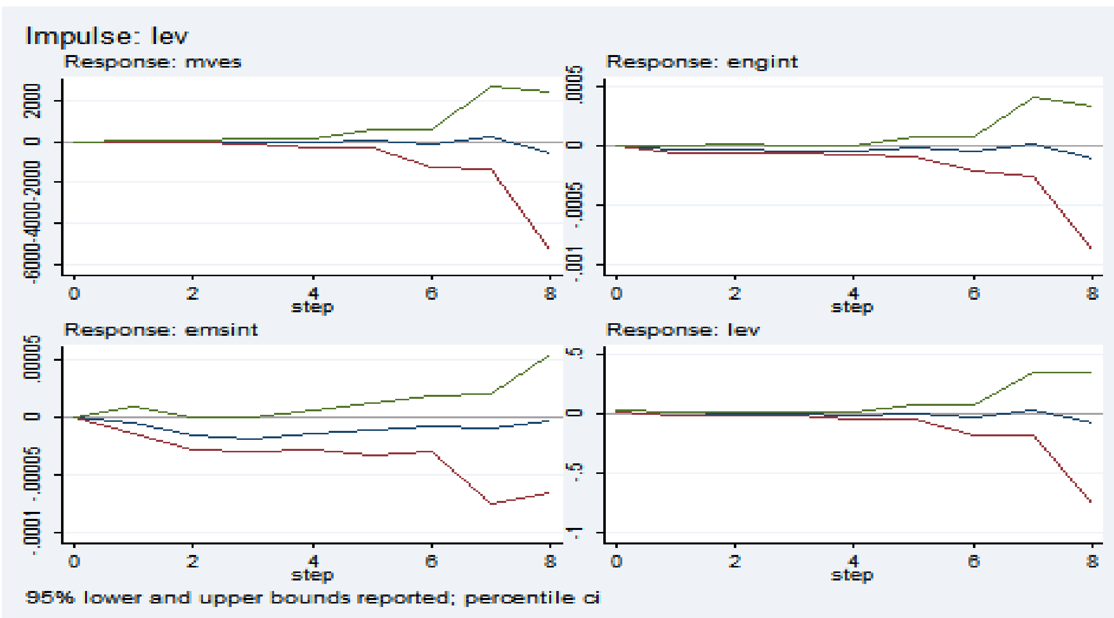
APPENDIX.XV: Response of EQRTNS To Shocks In LnMVE



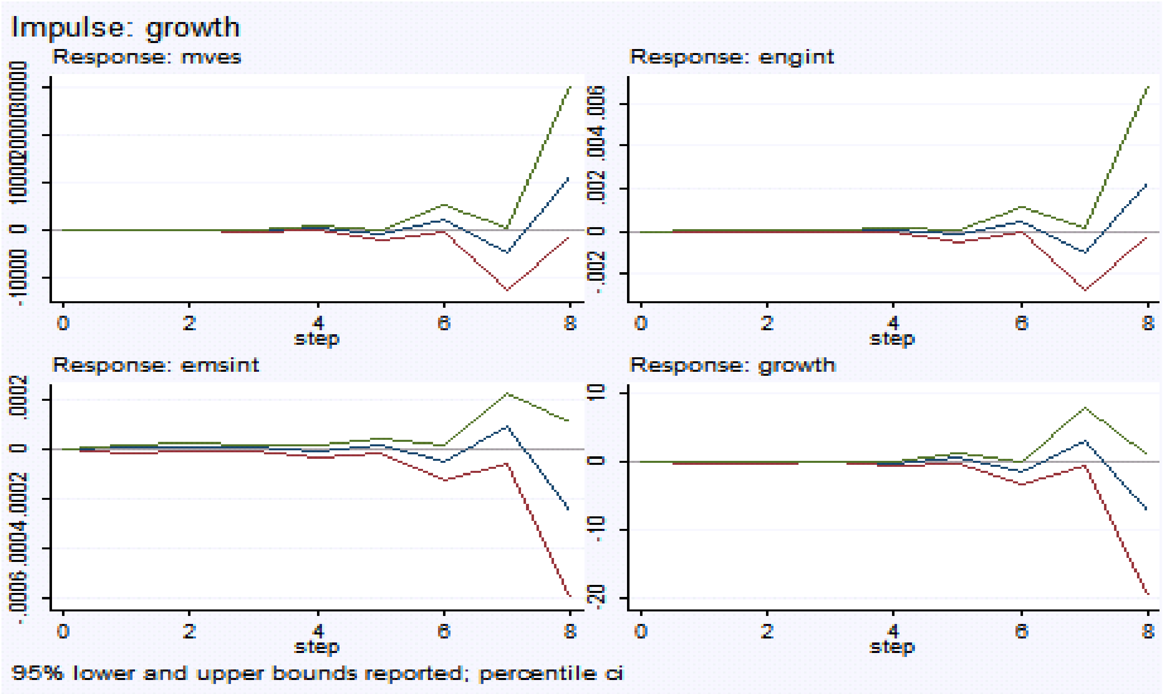
APPENDIX.XVI: Response of MVE/S To Shocks In OPTINC



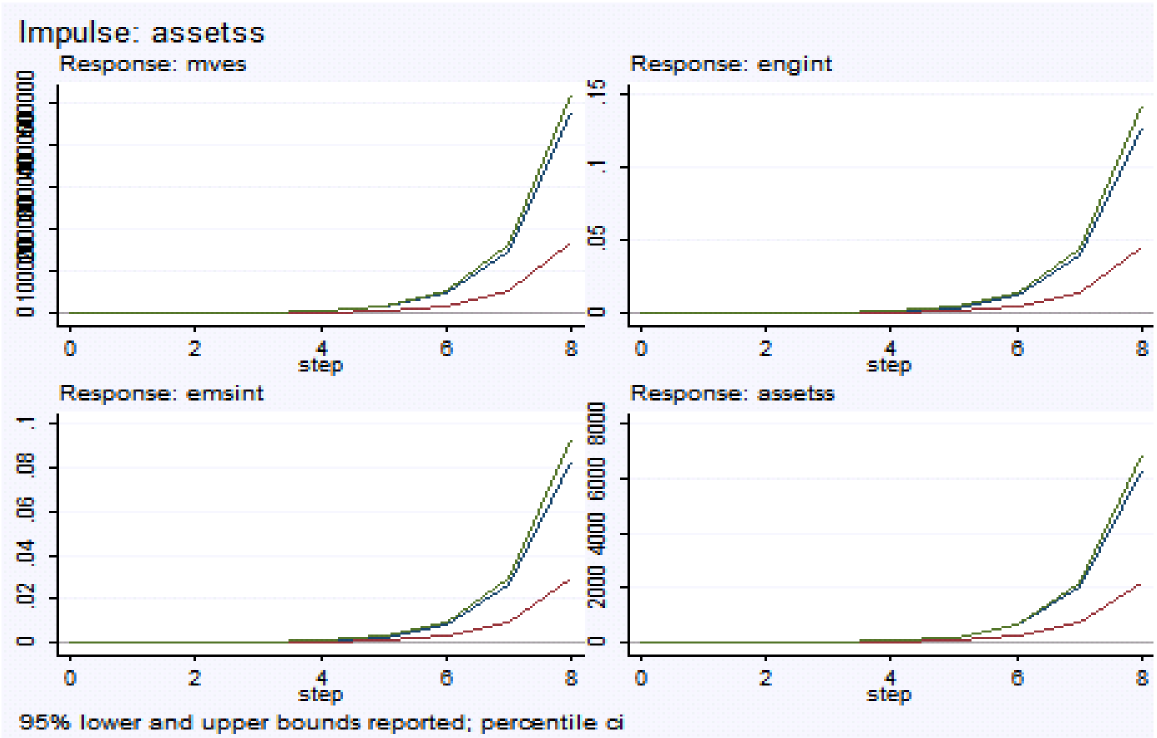
APPENDIX.XVII: Response of MVE/S to Shocks in MVE/S



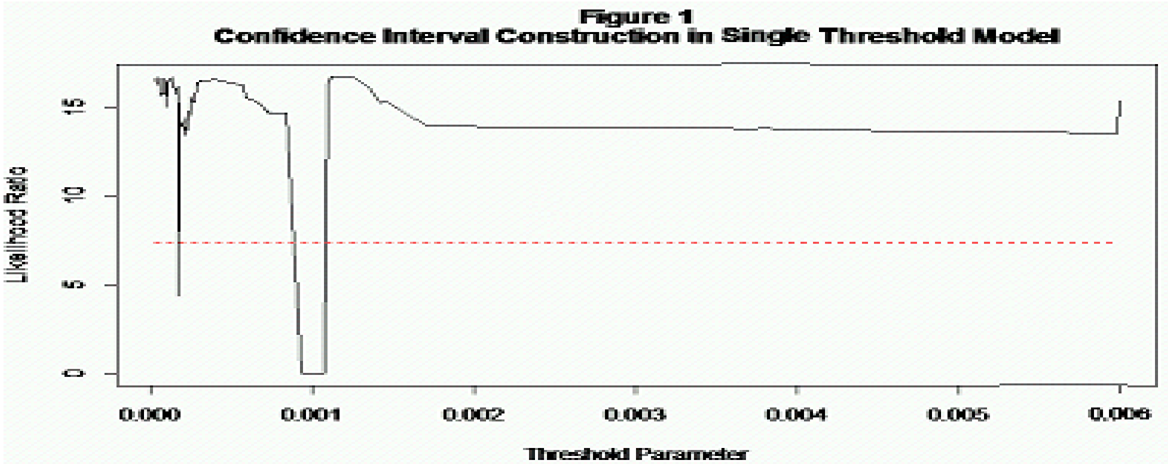
APPENDIX.XVIII: Response of MVE/S to Shocks in LEV



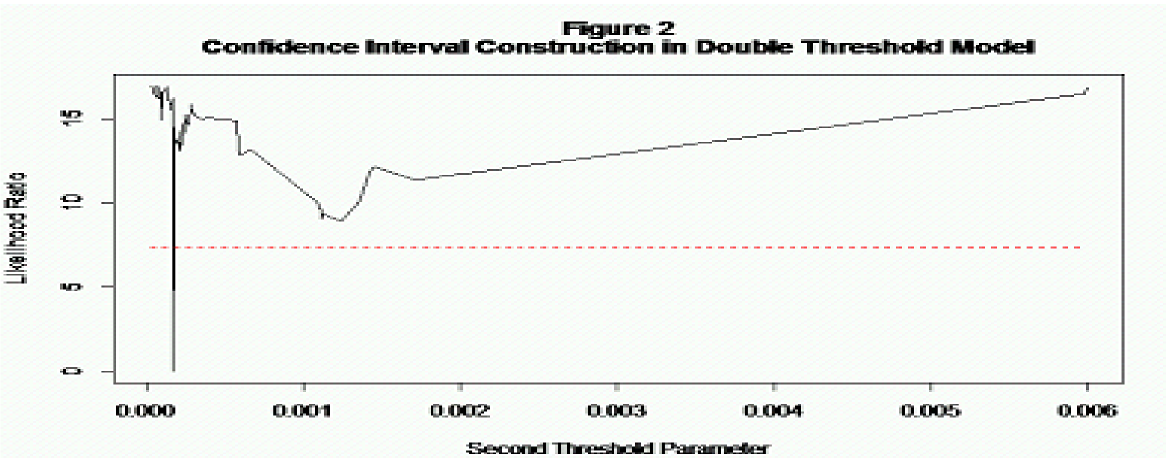
APPENDIX.XIX: Response of MVE/S To Shocks In GROWTH



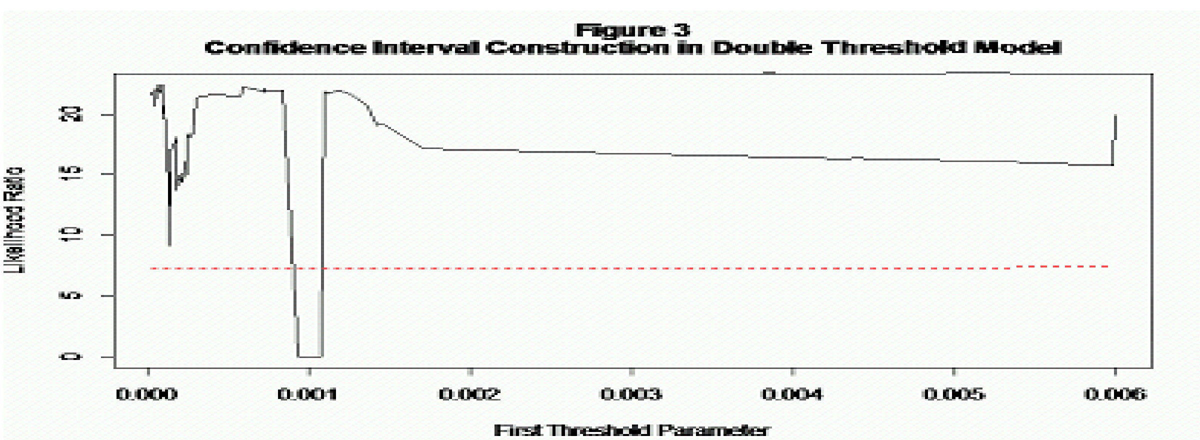
APPENDIX.XX: Response of MVE/S To Shocks In ASSETSS



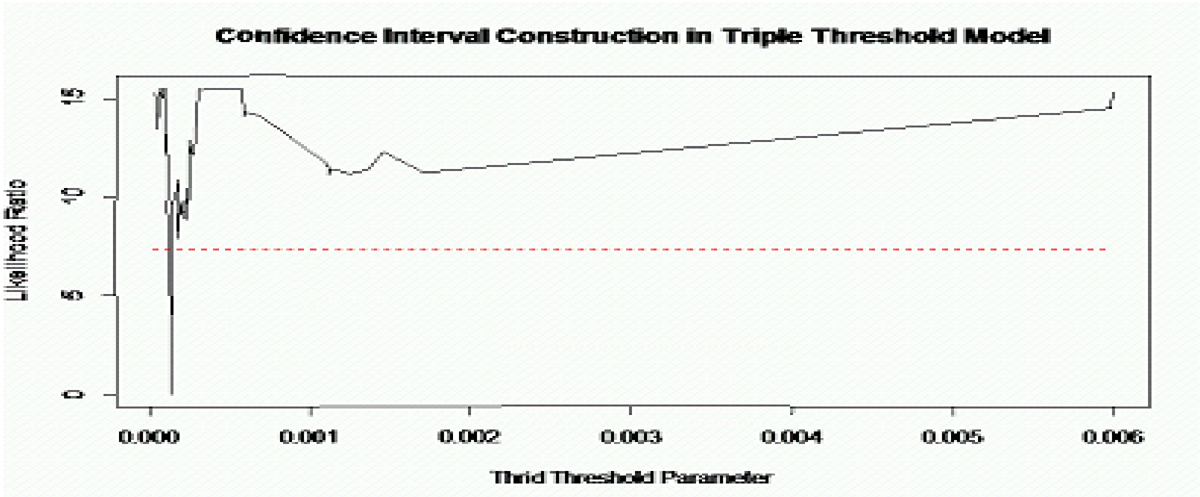
APPENDIX XXI: Threshold Parameter (ENGINT-ROA)



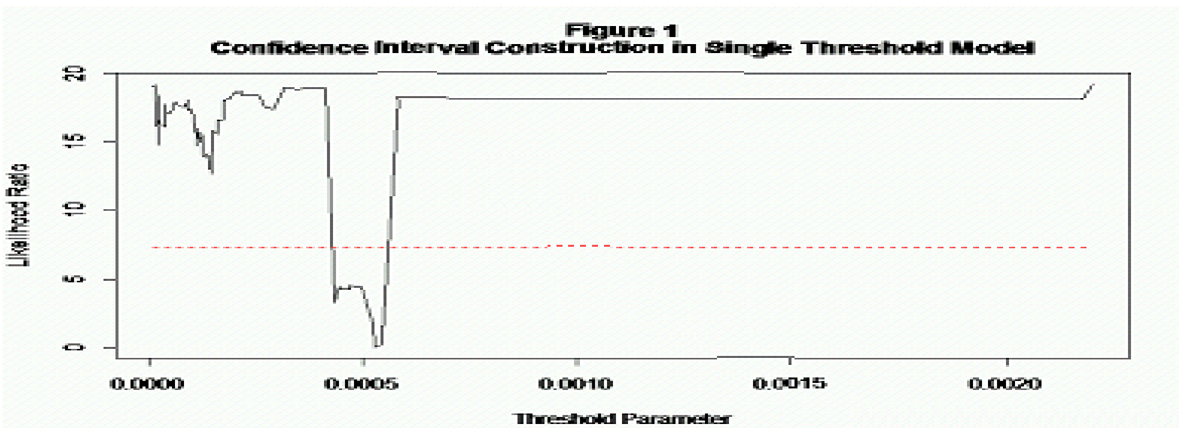
APPENDIX XXII: Second Threshold Parameter (ENGINT-ROA)



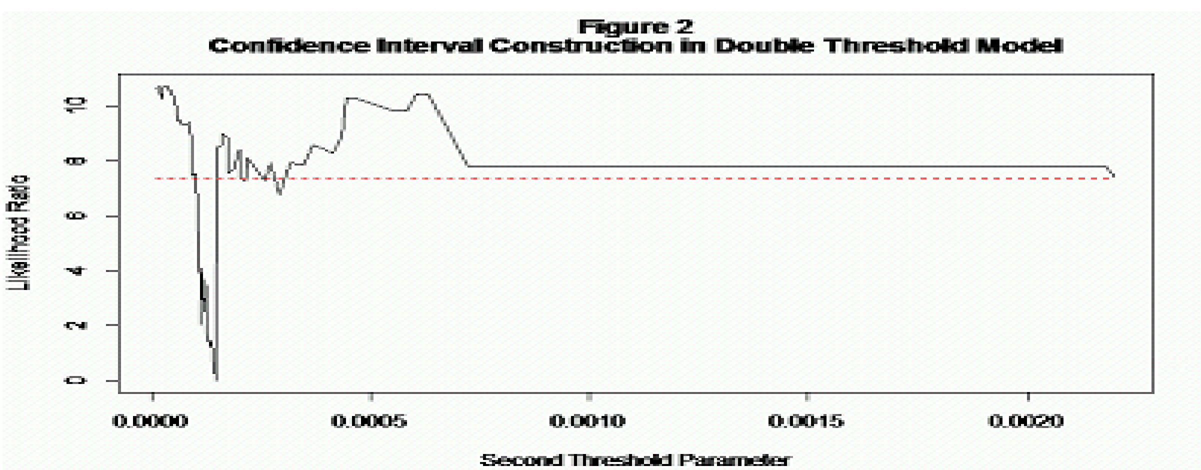
APPENDIX XXIII: First Threshold Parameter (ENGINT-ROA)



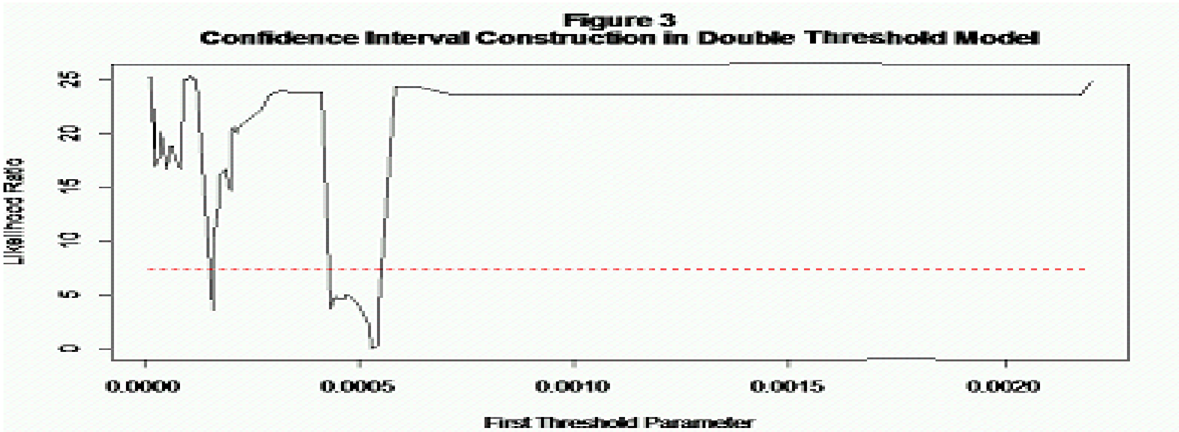
APPENDIX.XXIV: Thrid Threshold Parameter (ENGINT-ROA)



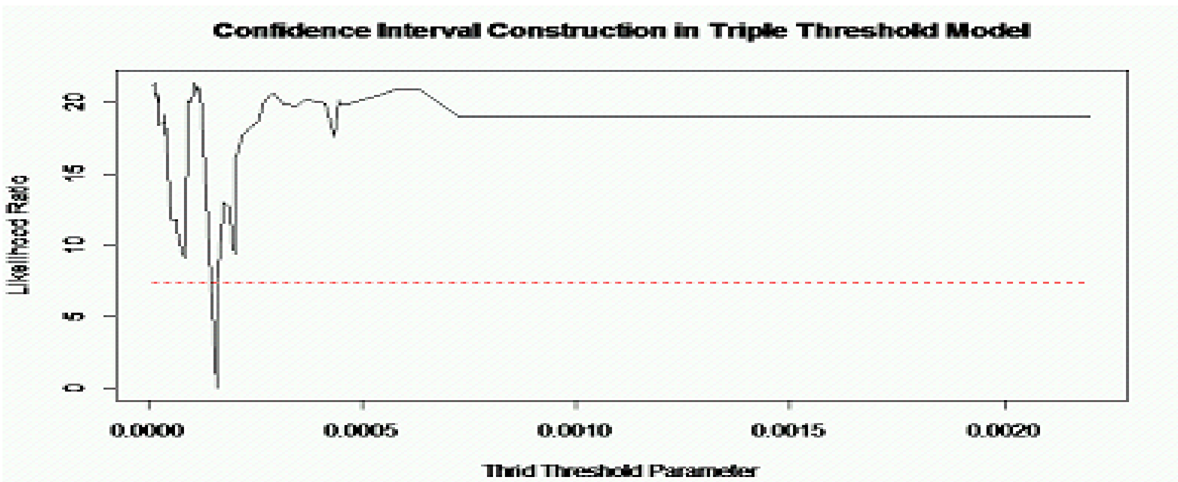
APPENDIX.XXV. Threshold Parameter (EMSINT-ROA)



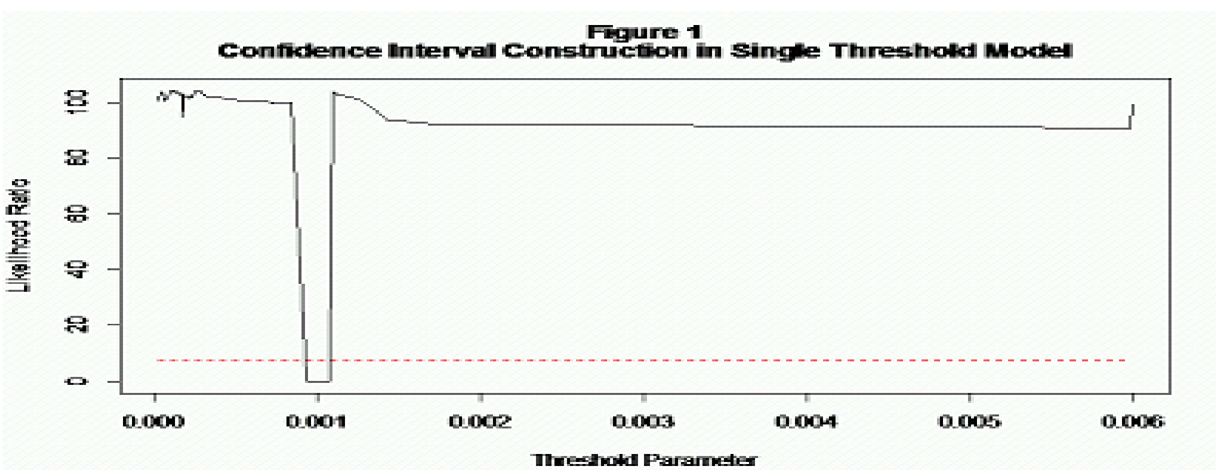
APPENDIX.XXVI. Second Threshold Parameter (EMSINT-ROA)



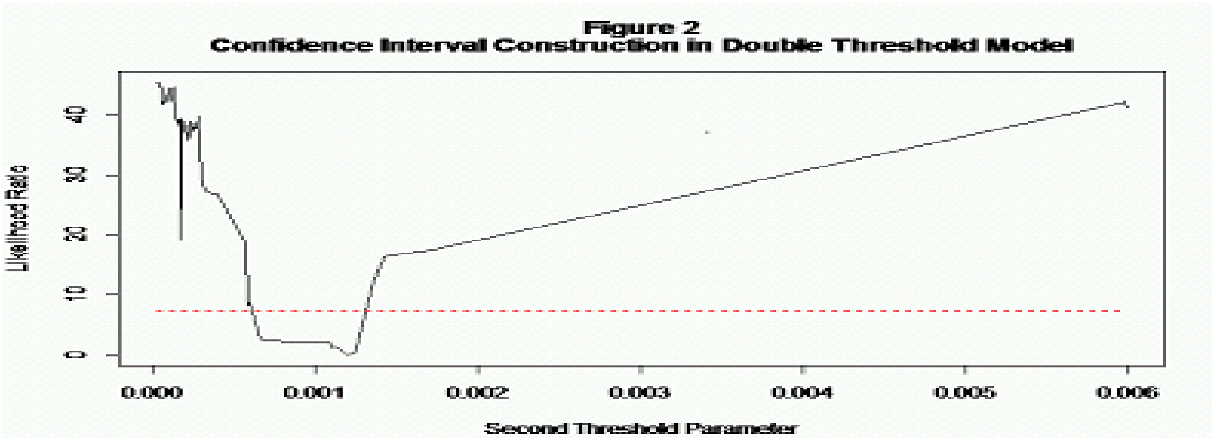
APPENDIX.XXVII: First Threshold Parameter (EMSINT-ROA)



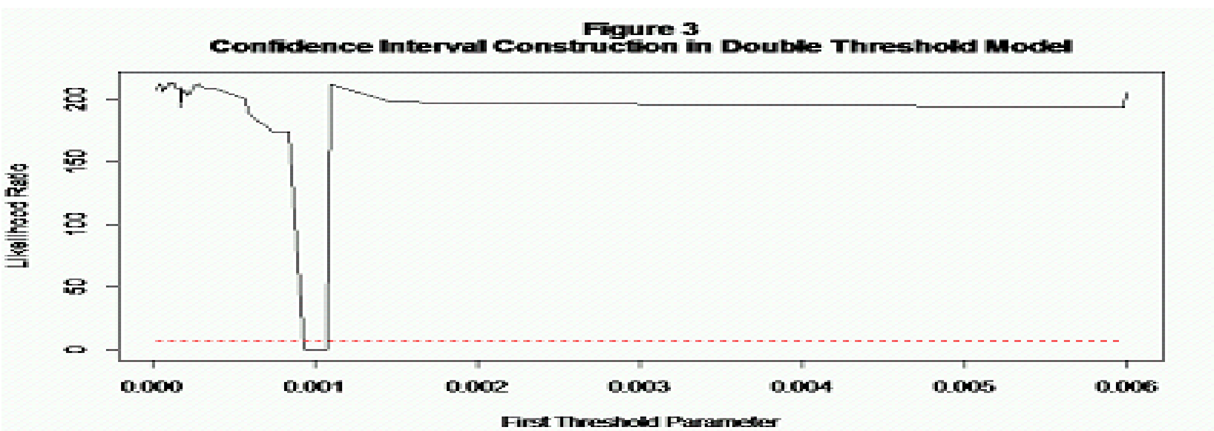
APPENDIX.XXVIII. Thrid Threshold Parameter (EMSINT-ROA)



APPENDIX.XXIX. Threshold Parameter (ENGINT-ROS)

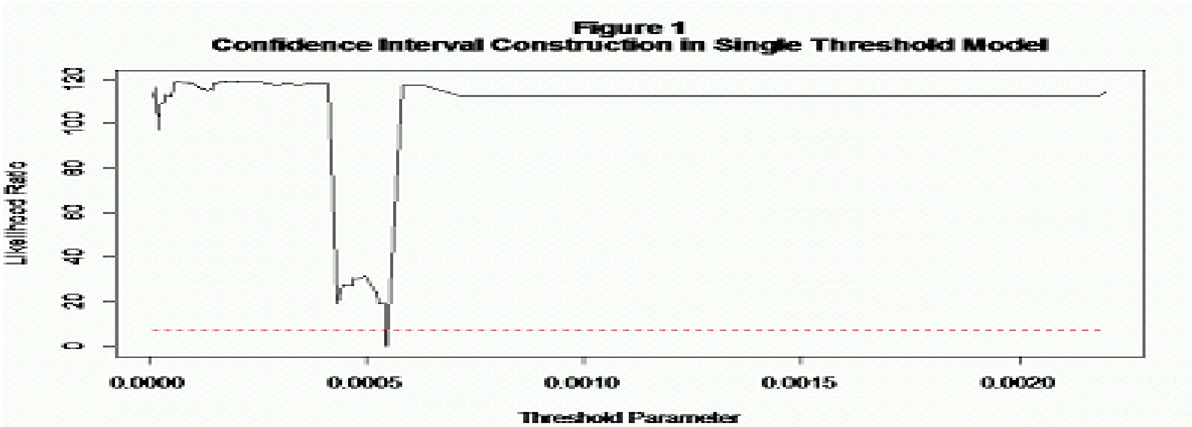


APPENDIX.XXX. Second Threshold Parameter (ENGINT-ROS)

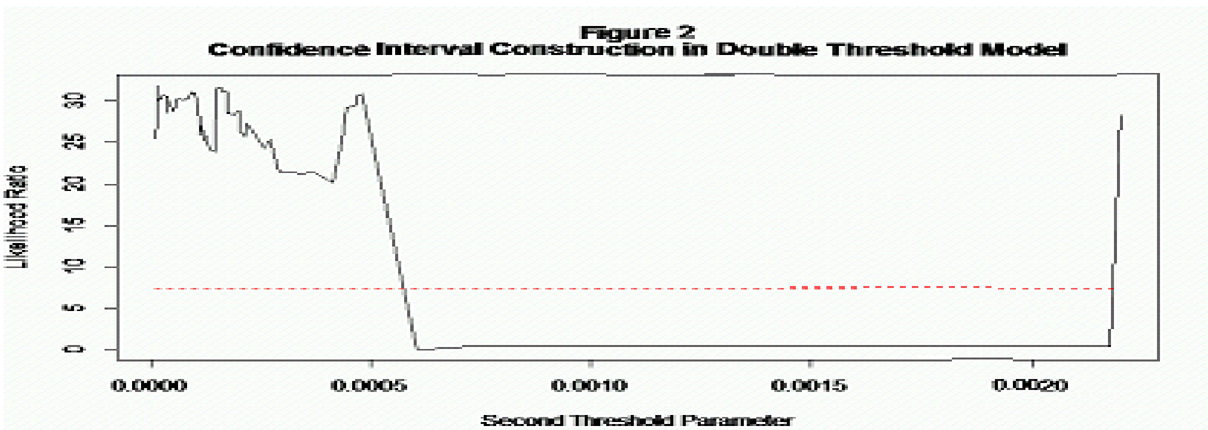


APPENDIX.XXXI. First Threshold Parameter (ENGINT-ROS)

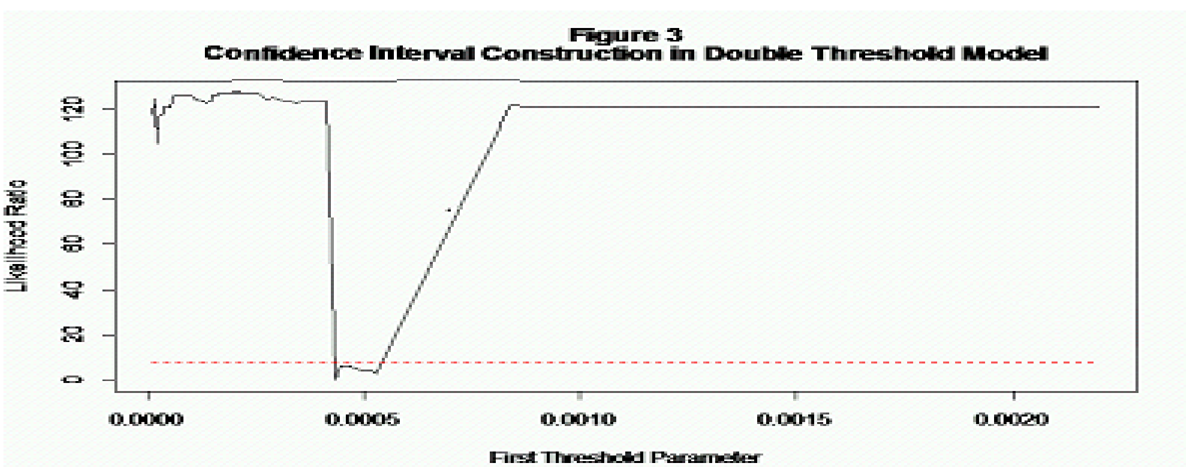
APPENDIX.XXXII: Thrid Threshold Parameter (ENGINT-ROS)



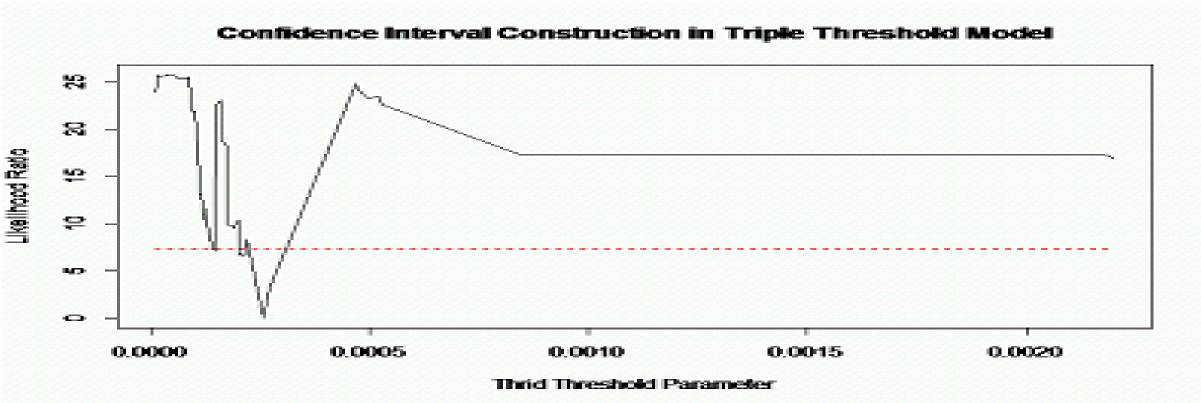
APPENDIX.XXXIII: Threshold Parameter (EMSINT-ROS)



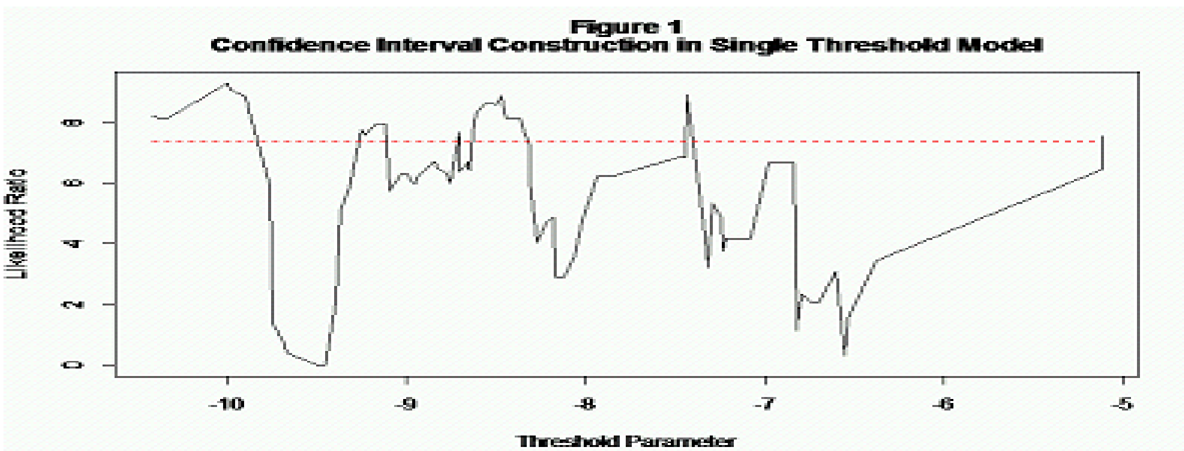
APPENDIX.XXXIV: Second Threshold Parameter (EMSINT-ROS)



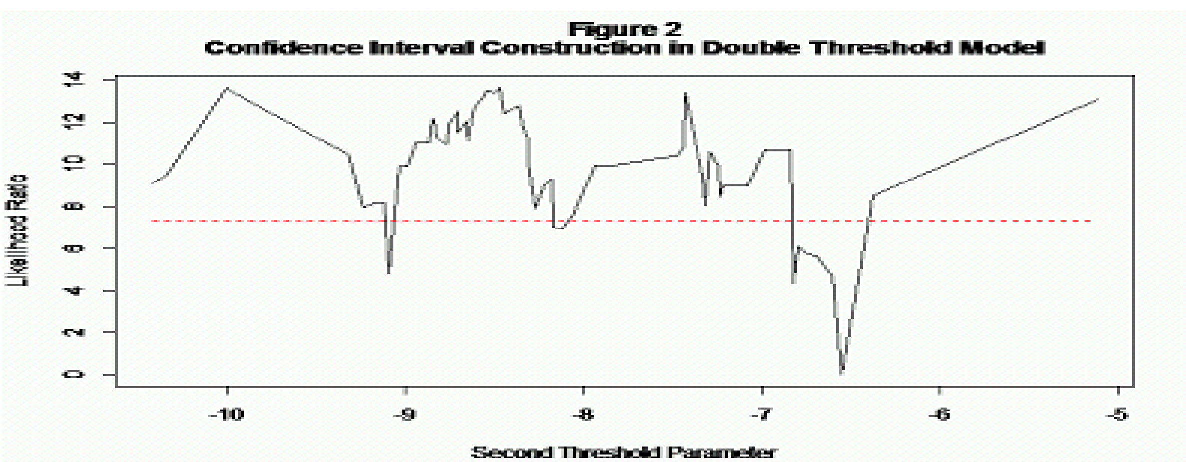
APPENDIX.XXXV. First Threshold Parameter (EMSINT-ROS)



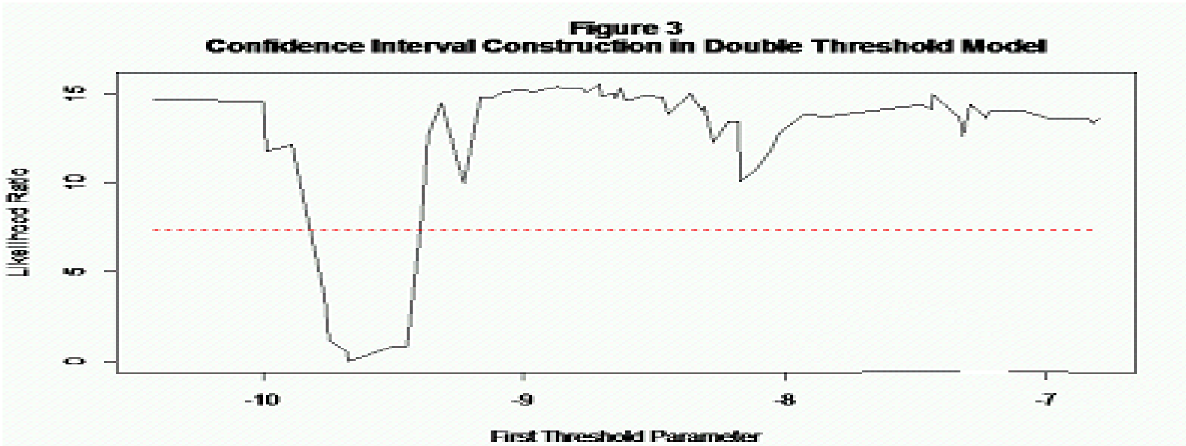
APPENDIX.XXXVI: Thrid Threshold Parameter (EMSINT-ROS)



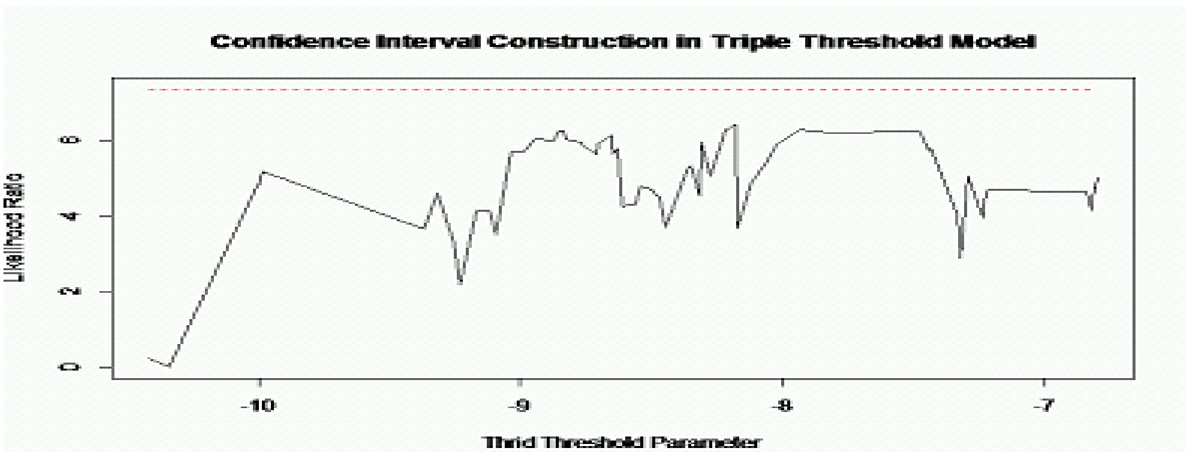
APPENDIX.XXXVII: Threshold Parameter (ENGINT-EQRTNS)



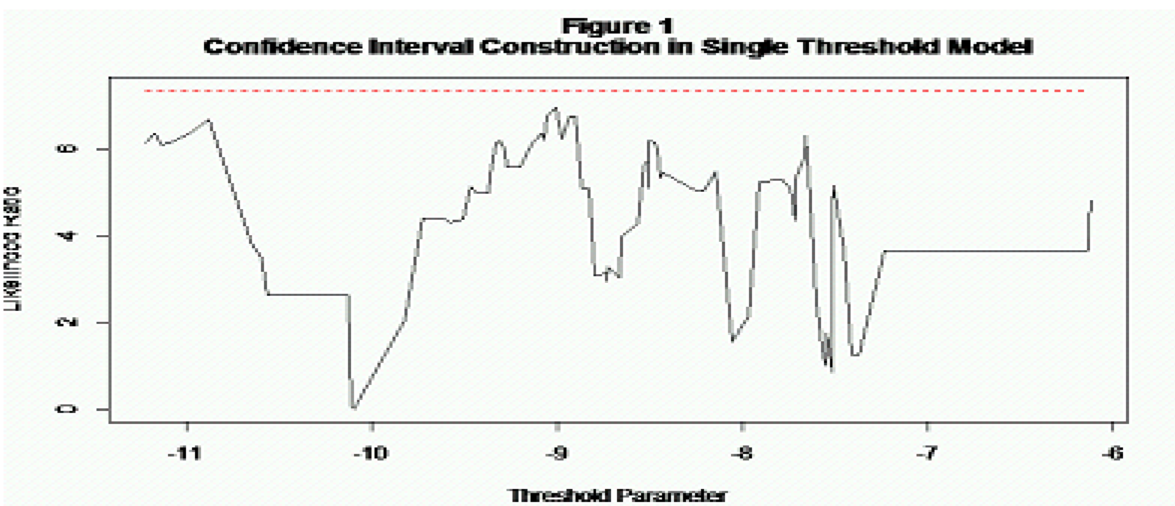
APPENDIX.XXXVIII: Second Threshold Parameter (ENGINT-EQRTNS)



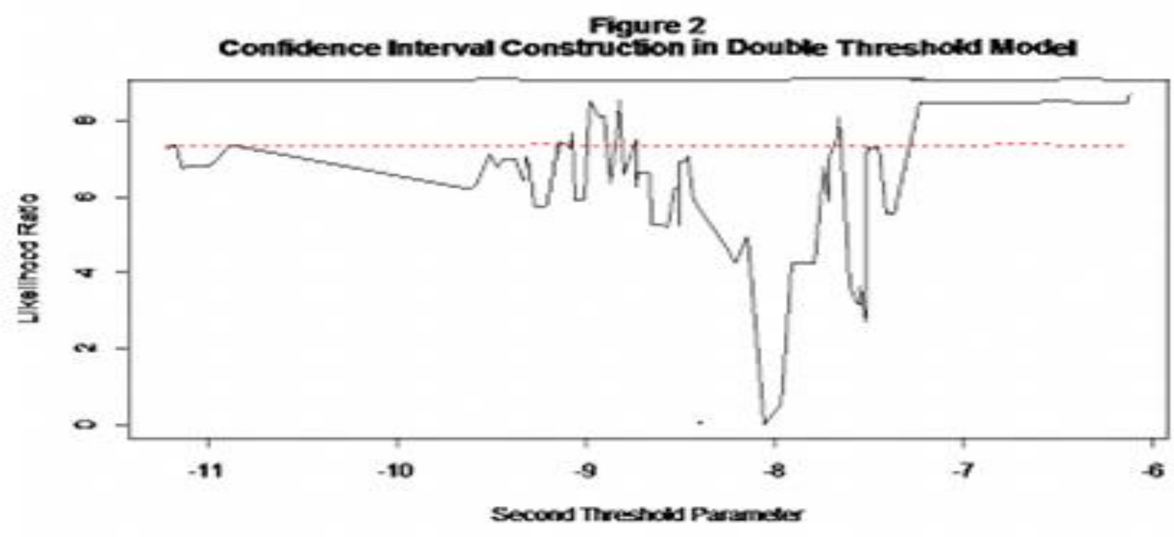
APPENDIX.XXXIV: First Threshold Parameter (ENGINT-EQRTNS)



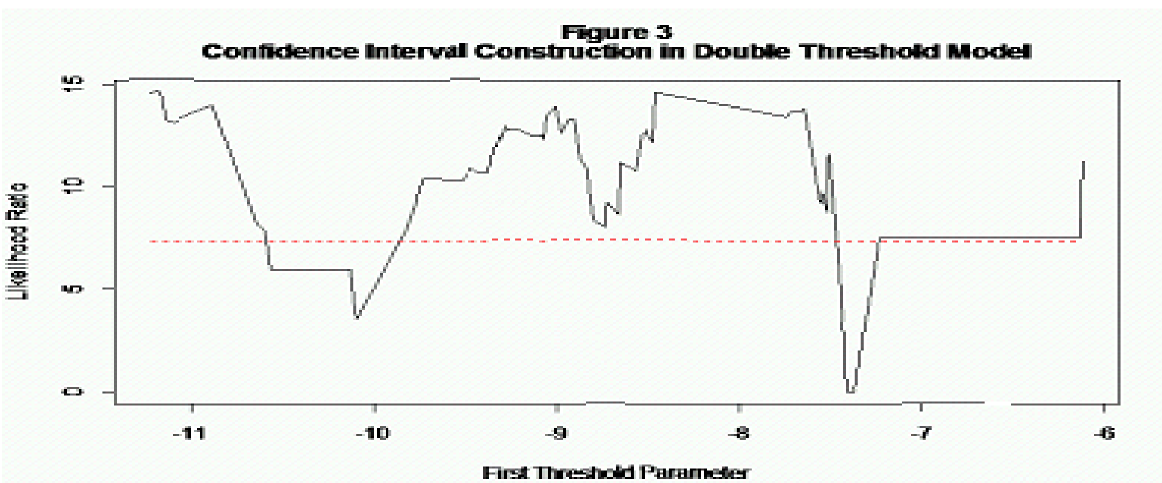
APPENDIX.XXXX: Thrid Threshold Parameter (ENGINT-EQRTNS)



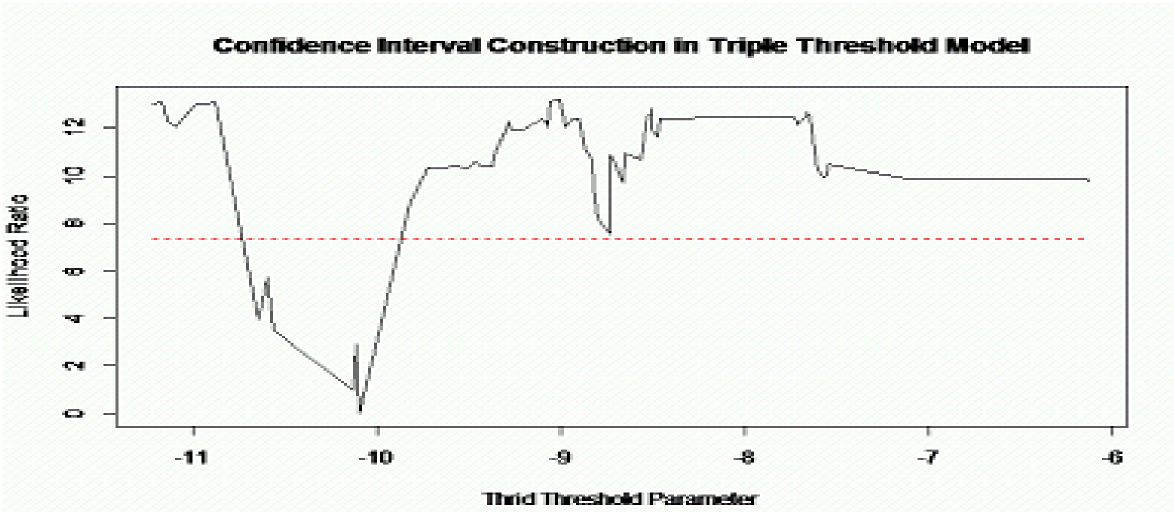
APPENDIX.XXXXI: Threshold Parameter (EMSINT-EQRTNS)



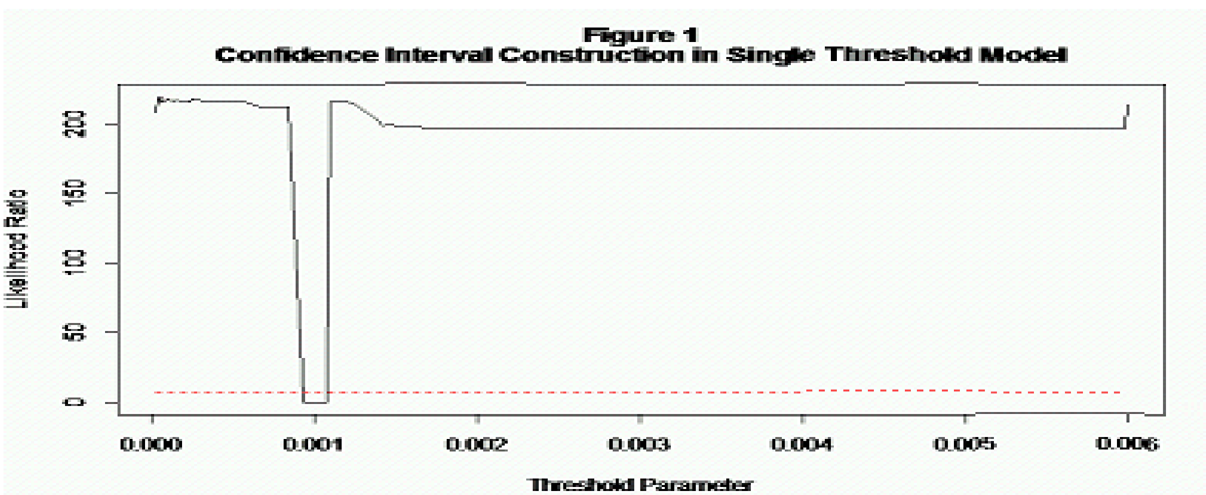
APPENDIX.XXXXII: Second Threshold Parameter (EMSINT-EQRTNS)



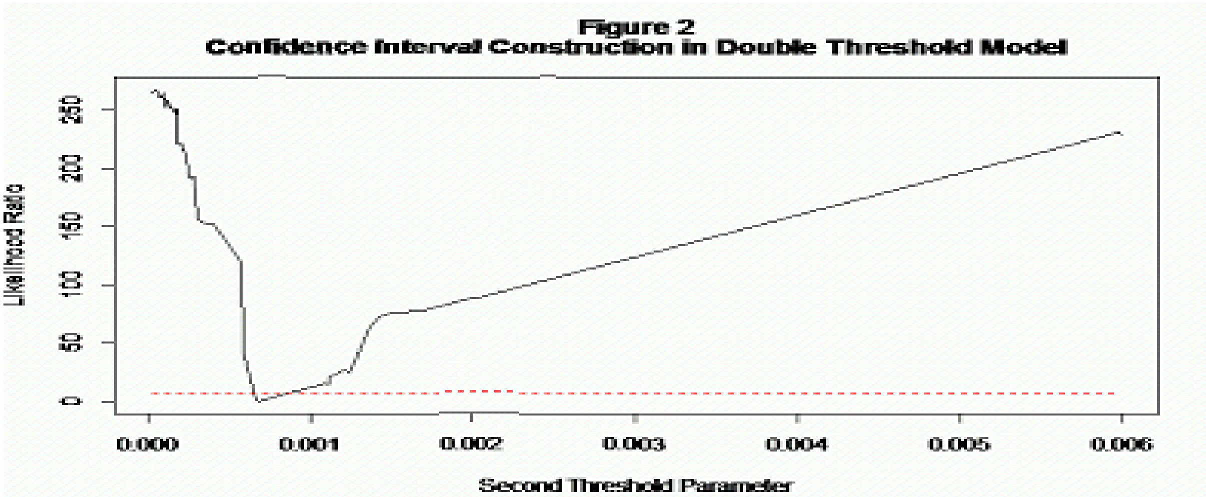
APPENDIX.XXXXIII: First Threshold Parameter (EMSINT-EQRTNS)



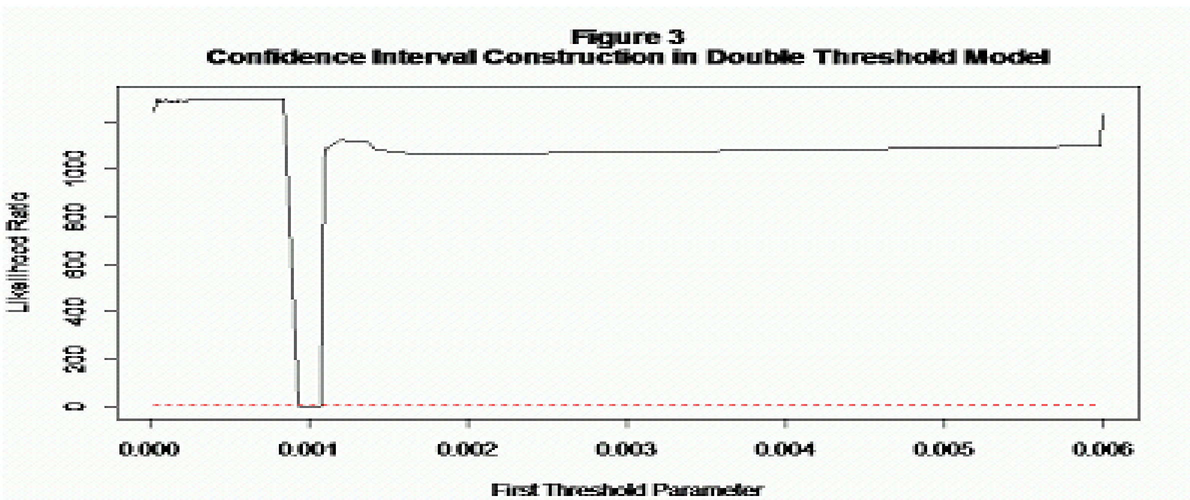
APPENDIX.XXXXIV: Thrid Threshold Parameter (EMSINT-EQRTNS)



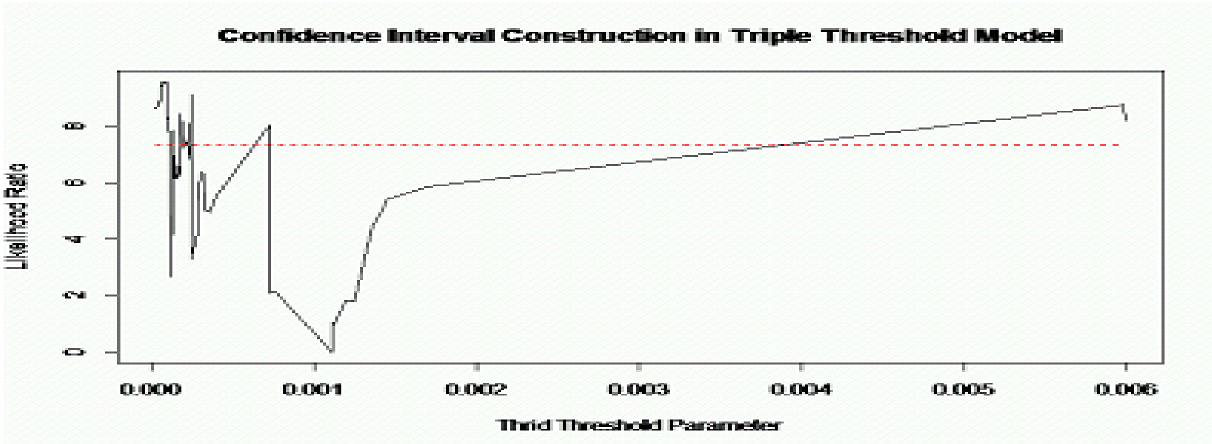
APPENDIX.XXXXV: Threshold Parameter (ENGINT-MVE/S)



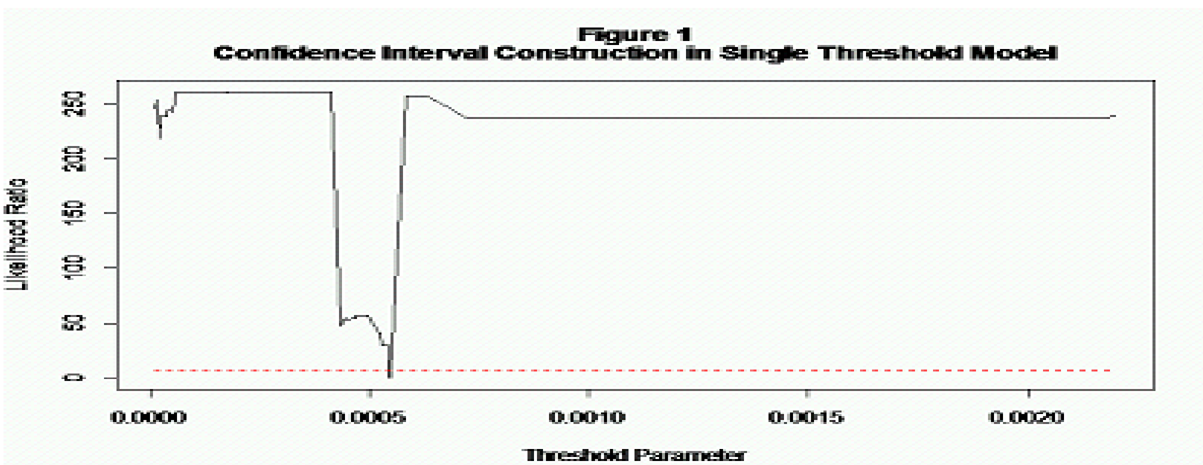
APPENDIX.XXXXVI: Second Threshold Parameter (ENGINT-MVE/S)



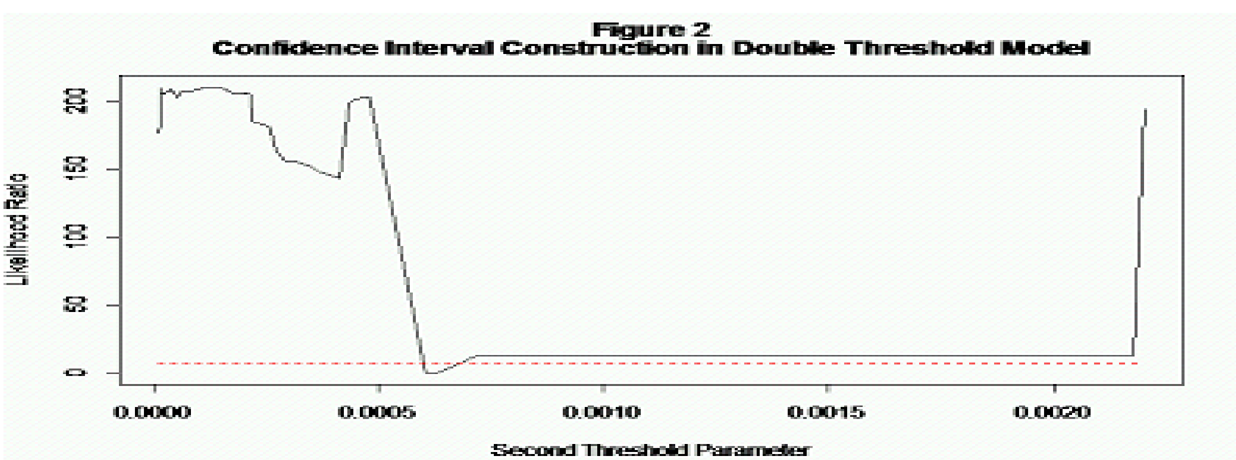
APPENDIX.XXXXVII: First Threshold Parameter (ENGINT-MVE/S)



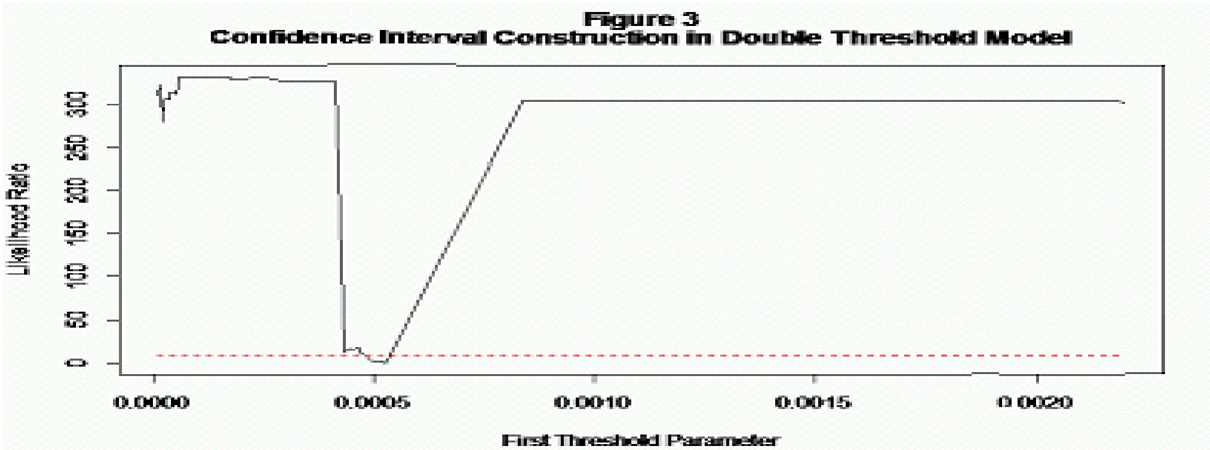
APPENDIX.XXXXVIII: Thrid Threshold Parameter (ENGINT-MVE/S)



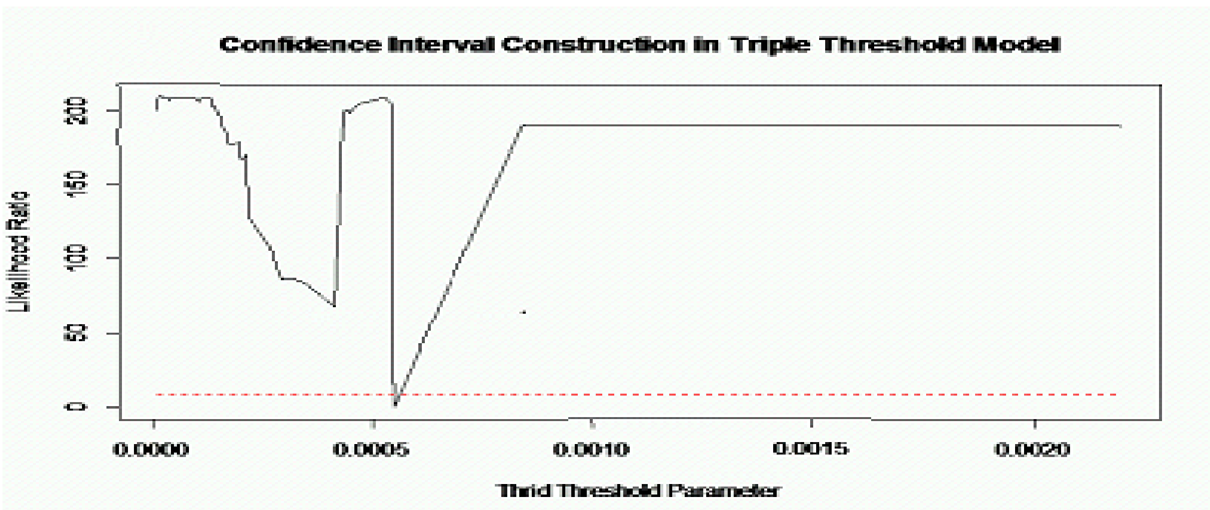
APPENDIX.XXXXIX: Threshold Parameter (EMSINT-MVE/S)



APPENDIX.XXXXX: Second Threshold Parameter (EMSINT-MVE/S)



APPENDIX.XXXXXI: First Threshold Parameter (EMSINT-MVE/S)



APPENDIX.XXXXXII: Thrid Threshold Parameter (EMSINT-MVE/S)

APPENDIX.XXXXXIII: Panel Unit Root test (Fisher type based on ADF)

i: Variables stationary at level 1(0)

xtunitroot fisher optinc, dfuller lags(0)

		Statistic	p-value
Inverse chi-squared(28)	P	131.4302	0.0000
Inverse normal	Z	-4.0634	0.0000
Inverse logit t(74)	L*	-8.0269	0.0000
Modified inv. chi-squared	Pm	13.8214	0.0000

xtunitroot fisher growth, dfuller lags(0)

		Statistic	p-value
Inverse chi-squared(28)	P	152.0905	0.0000
Inverse normal	Z	-6.9689	0.0000
Inverse logit t(74)	L*	-10.6423	0.0000
Modified inv. chi-squared	Pm	16.5823	0.0000

. xtunitroot fisher roa, dfuller lags(0)

		Statistic	p-value
Inverse chi-squared(28)	P	204.0476	0.0000
Inverse normal	Z	-7.6205	0.0000
Inverse logit t(74)	L*	-14.3324	0.0000
Modified inv. chi-squared	Pm	23.5254	0.0000

. xtunitroot fisher eqrtns, dfuller lags(0)

		Statistic	p-value
Inverse chi-squared(28)	P	160.4547	0.0000
Inverse normal	Z	-7.7170	0.0000
Inverse logit t(74)	L*	-11.4316	0.0000
Modified inv. chi-squared	Pm	17.7000	0.0000

xtunitroot fisher ros, dfuller lags(0)

		Statistic	p-value
Inverse chi-squared(28)	P	143.2358	0.0000
Inverse normal	Z	-5.4678	0.0000
Inverse logit t(74)	L*	-9.4595	0.0000
Modified inv. chi-squared	Pm	15.3990	0.0000

ii. Variables stationary at first difference 1(1)

```
xtunitroot fisher d.engint, dfuller lags(0)
```

		Statistic	p-value
Inverse chi-squared(28)	P	208.6179	0.0000
Inverse normal	Z	-9.2439	0.0000
Inverse logit t(74)	L*	-15.0694	0.0000
Modified inv. chi-squared	Pm	24.1361	0.0000

```
xtunitroot fisher d.lnmve, dfuller lags(0)
```

		Statistic	p-value
Inverse chi-squared(28)	P	95.7353	0.0000
Inverse normal	Z	-3.8823	0.0001
Inverse logit t(74)	L*	-5.4336	0.0000
Modified inv. chi-squared	Pm	9.0515	0.0000

```
xtunitroot fisher D.lev, dfuller lags(0)
```

		Statistic	p-value
Inverse chi-squared(28)	P	137.8497	0.0000
Inverse normal	Z	-7.3005	0.0000
Inverse logit t(74)	L*	-9.8610	0.0000
Modified inv. chi-squared	Pm	14.6793	0.0000

```
xtunitroot fisher d.lnemsint, dfuller lags(0)
14 missing values generated)
```

		Statistic	p-value
Inverse chi-squared(28)	P	230.5920	0.0000
Inverse normal	Z	-9.0581	0.0000
Inverse logit t(74)	L*	-16.4400	0.0000
Modified inv. chi-squared	Pm	27.0725	0.0000

```
. xtunitroot fisher d.mves, dfuller lags(0)
(14 missing values generated)
```

		Statistic	p-value
Inverse chi-squared(28)	P	210.5941	0.0000
Inverse normal	Z	-9.8606	0.0000
Inverse logit t(74)	L*	-15.3567	0.0000
Modified inv. chi-squared	Pm	24.4002	0.0000

```
xtunitroot fisher D.lev, dfuller lags(0)
------------------------------------------------------------------
                              Statistic      p-value
------------------------------------------------------------------
 Inverse chi-squared(28)   P      137.8497       0.0000
 Inverse normal            Z       -7.3005       0.0000
 Inverse logit t(74)       L*      -9.8610       0.0000
 Modified inv. chi-squared Pm      14.6793       0.0000
------------------------------------------------------------------
```

```
xtunitroot fisher d.lnengint, dfuller lags(0)

------------------------------------------------------------------
                              Statistic      p-value
------------------------------------------------------------------
 Inverse chi-squared(28)   P      192.9469       0.0000
 Inverse normal            Z       -8.3466       0.0000
 Inverse logit t(74)       L*     -13.6291       0.0000
 Modified inv. chi-squared Pm      22.0420       0.0000
------------------------------------------------------------------
```

```
xtunitroot fisher d.emsint, dfuller lags(0)

------------------------------------------------------------------
                              Statistic      p-value
------------------------------------------------------------------
 Inverse chi-squared(28)   P      255.4076       0.0000
 Inverse normal            Z      -10.4072       0.0000
 Inverse logit t(74)       L*     -18.5394       0.0000
 Modified inv. chi-squared Pm      30.3886       0.0000
------------------------------------------------------------------
```

```
 xtunitroot fisher d.lnasset, dfuller lags(0)
14 missing values generated)

------------------------------------------------------------------
                              Statistic      p-value
------------------------------------------------------------------
Inverse chi-squared(28)   P       78.4253       0.0000
Inverse normal            Z       -3.9174       0.0000
Inverse logit t(74)       L*      -5.0272       0.0000
Modified inv. chi-squared Pm       6.7384       0.0000
------------------------------------------------------------------
```

```
 xtunitroot fisher d.assetss, dfuller lags(0)
14 missing values generated)

------------------------------------------------------------------
                              Statistic      p-value
------------------------------------------------------------------
Inverse chi-squared(28)   P      192.4283       0.0000
Inverse normal            Z       -8.0728       0.0000
Inverse logit t(74)       L*     -13.4194       0.0000
Modified inv. chi-squared Pm      21.9727       0.0000
------------------------------------------------------------------
```

APPENDIX.XXXXXIV: Pre-Marginal Means Results

i. Pooled data results

roa	Coef.	Std. Err.	t	P>|t|
engint	-99.29005	23.77889	-4.18	0.000
emsint	271.7946	64.26889	4.23	0.000
optinc	1.47e-12	2.57e-13	5.72	0.000
lev	.0179631	.0099442	1.81	0.074
lnasset	-.0251179	.0105189	-2.39	0.019
growth	.08401	.0418901	2.01	0.048
indtype	-.0693115	.0200721	-3.45	0.001
_cons	.6984036	.2625455	2.66	0.009

ros	Coef.	Std. Err.	t	P>|t|
emsint	319.7502	108.0448	2.96	0.004
engint	-117.4154	42.03316	-2.79	0.006
optinc	1.69e-12	3.43e-13	4.94	0.000
lev	.0072928	.0177167	0.41	0.682
assetss	-.0708429	.0055455	-12.77	0.000
growth	.1486667	.0831777	1.79	0.077
indtype	.02945	.0362372	0.81	0.419
_cons	.1692462	.0318671	5.31	0.000

mves	Coef.	Std. Err.	t	P>|t|
emsint	-110661.2	71351.15	-1.55	0.124
engint	45677.64	27758.05	1.65	0.103
optinc	-2.67e-10	2.27e-10	-1.18	0.242
lev	38.58119	11.69986	3.30	0.001
assetss	81.63605	3.662153	22.29	0.000
growth	.5824161	54.92925	0.01	0.992
indtype	-46.04445	23.93046	-1.92	0.058
_cons	-23.20784	21.04453	-1.10	0.273

ii. Fixed Effects results

roa	Coef.	Std. Err.	t	P>|t|
emsint	-27.22604	104.7175	-0.26	0.796
engint	3.123326	50.09331	0.06	0.950
optinc	2.14e-12	5.87e-13	3.64	0.000
lev	-.0075606	.018907	-0.40	0.690
lnasset	-.1370636	.044023	-3.11	0.003
growth	.0588799	.0421164	1.40	0.166
_cons	3.455249	1.09896	3.14	0.002

ros	Coef.	Std. Err.	t	P>|t|
emsint	36.80856	163.1316	0.23	0.822
engint	8.548865	80.78467	0.11	0.916
optinc	3.87e-12	9.34e-13	4.14	0.000
lev	-.0127653	.030805	-0.41	0.680
assetss	-.0768812	.0052184	-14.73	0.000
growth	.085176	.0750257	1.14	0.260
_cons	.1656539	.0504991	3.28	0.002

mves	Coef.	Std. Err.	t	P>|t|
emsint	69737.48	61064.43	1.14	0.257
engint	-3956.102	30239.82	-0.13	0.896
optinc	4.07e-10	3.50e-10	1.16	0.249
lev	-5.396747	11.53112	-0.47	0.641
assetss	72.35023	1.953393	37.04	0.000
growth	3.944543	28.08408	0.14	0.889
_cons	-81.54657	18.90313	-4.31	0.000

iii. Arellano-BOND results

roa	Coef.	Std. Err.	z	P>|z|
roa				
L1.	.0997365	.1041241	0.96	0.338
engint	-52.0729	51.19447	-1.02	0.309
emsint	105.1963	108.2904	0.97	0.331
optinc	1.93e-12	5.68e-13	3.40	0.001
lev	-.0223927	.0331136	-0.68	0.499
lnasset	-.1297556	.0462428	-2.81	0.005
growth	.165641	.049678	3.33	0.001
_cons	3.248358	1.163458	2.79	0.005

ros	Coef.	Std. Err.	z	P>|z|
ros				
L1.	-.0903579	.1163408	-0.78	0.437
engint	-51.7848	97.01542	-0.53	0.593
emsint	142.1457	202.3952	0.70	0.482
optinc	3.53e-12	1.06e-12	3.33	0.001
lev	-.0844806	.0606055	-1.39	0.163
assetss	-.0803304	.0061042	-13.16	0.000
growth	.1220486	.1104241	1.11	0.269
_cons	.1885727	.0618247	3.05	0.002

mves	Coef.	Std. Err.	z	P>|z|
mves				
L1.	.1901619	.1385654	1.37	0.170
engint	-5723.786	30585.32	-0.19	0.852
emsint	105582.9	67690.8	1.56	0.119
optinc	4.12e-10	3.35e-10	1.23	0.218
lev	1.023961	19.5571	0.05	0.958
assetss	70.30085	1.567846	44.84	0.000
growth	-12.14791	33.34401	-0.36	0.716
_cons	-104.8454	18.30717	-5.73	0.000

APPENDIX.XXXXXV: Impulse Response Statistics

	Coef.	Std. Err.	t	P>|t|
roa				
l1_roa	-.0177077	.149234	-0.12	0.906
l1_engint	-87.89288	71.49181	-1.23	0.225
l1_emsint	81.84818	137.9213	0.59	0.556
l1_growth	-.0685381	.0744021	-0.92	0.362
l2_roa	-.0183081	.1267257	-0.14	0.886
l2_engint	-51.37788	53.65439	-0.96	0.343
l2_emsint	178.7738	141.1535	1.27	0.211
l2_growth	-.0736132	.045696	-1.61	0.114
engint				
l1_roa	-.0000397	.0004762	-0.08	0.934
l1_engint	-.0888176	.2281446	-0.39	0.699
l1_emsint	1.752753	.4401344	3.98	0.000
l1_growth	.0000451	.0002374	0.19	0.850
l2_roa	.0001389	.0004044	0.34	0.733
l2_engint	.147669	.1712218	0.86	0.393
l2_emsint	-.3601432	.450449	-0.80	0.428
l2_growth	.0000581	.0001458	0.40	0.692
emsint				
l1_roa	-.0000727	.0002266	-0.32	0.750
l1_engint	.0276394	.1085359	0.25	0.800
l1_emsint	.8661911	.2093864	4.14	0.000
l1_growth	.0001484	.000113	1.31	0.195
l2_roa	.0002112	.0001924	1.10	0.278
l2_engint	.0249265	.0814559	0.31	0.761
l2_emsint	-.2796642	.2142934	-1.31	0.198
l2_growth	.0000644	.0000694	0.93	0.358
growth				
l1_roa	-.3917462	.3484875	-1.12	0.267
l1_engint	-107.9244	166.9459	-0.65	0.521
l1_emsint	174.3057	322.0704	0.54	0.591
l1_growth	-.3212112	.173742	-1.85	0.071
l2_roa	-.0330554	.2959267	-0.11	0.912
l2_engint	53.45025	125.2924	0.43	0.672
l2_emsint	-184.4444	329.6181	-0.56	0.578
l2_growth	-.1722466	.106708	-1.61	0.113

	Coef.	Std. Err.	t	P>|t|
ros				
l1_ros	-.2646706	.3817305	-0.69	0.491
l1_engint	-261.4672	346.0288	-0.76	0.454
l1_emsint	614.058	663.1621	0.93	0.359
l1_growth	-.2510571	.3279939	-0.77	0.448
l2_ros	-.2002781	.336113	-0.60	0.554
l2_engint	-107.3879	259.8237	-0.41	0.681
l2_emsint	-86.1367	680.1894	-0.13	0.900
l2_growth	-.168912	.2224257	-0.76	0.451
engint				
l1_ros	.0000214	.0002525	0.08	0.933
l1_engint	-.0901138	.2288633	-0.39	0.696
l1_emsint	1.766359	.4386152	4.03	0.000
l1_growth	.0000278	.0002169	0.13	0.899
l2_ros	.000086	.0002223	0.39	0.701
l2_engint	.1443612	.1718473	0.84	0.405
l2_emsint	-.3594168	.449877	-0.80	0.428
l2_growth	.0000588	.0001471	0.40	0.691
emsint				
l1_ros	4.82e-06	.0001213	0.04	0.968
l1_engint	.032873	.1099685	0.30	0.766
l1_emsint	.8851042	.210754	4.20	0.000
l1_growth	.0001031	.0001042	0.99	0.328
l2_ros	.0000581	.0001068	0.54	0.589
l2_engint	.0249101	.0825724	0.30	0.764
l2_emsint	-.3002082	.2161653	-1.39	0.171
l2_growth	.0000711	.0000707	1.01	0.320
growth				
l1_ros	-.1916437	.1851441	-1.04	0.306
l1_engint	-118.7998	167.8283	-0.71	0.482
l1_emsint	170.1814	321.6419	0.53	0.599
l1_growth	-.3174297	.1590811	-2.00	0.052
l2_ros	.0414557	.163019	0.25	0.800
l2_engint	47.43814	126.0178	0.38	0.708
l2_emsint	-145.0006	329.9004	-0.44	0.662
l2_growth	-.1915503	.1078792	-1.78	0.082

	Coef.	Std. Err.	t	P>|t|
eqrtns				
l1_eqrtns	-.0825604	.132602	-0.62	0.536
l1_lnengint	-.0178581	.1482191	-0.12	0.905
l1_lnemsint	.136085	.1560498	0.87	0.388
l1_growth	.1669227	.2581691	0.65	0.521
l2_eqrtns	-.2124227	.12967	-1.64	0.108
l2_lnengint	-.1174306	.0886287	-1.32	0.191
l2_lnemsint	-.1884005	.1420238	-1.33	0.191
l2_growth	.1435088	.159648	0.90	0.373
lnengint				
l1_eqrtns	.2089718	.2003221	1.04	0.302
l1_lnengint	-.0042591	.2239149	-0.02	0.985
l1_lnemsint	-.1679524	.2357448	-0.71	0.480
l1_growth	-.5616444	.3900167	-1.44	0.156
l2_eqrtns	.0643267	.1958928	0.33	0.744
l2_lnengint	.0177593	.1338915	0.13	0.895
l2_lnemsint	.6328898	.2145557	2.95	0.005
l2_growth	.0764945	.2411805	0.32	0.752

lnemsint				
l1_eqrtns	.1966113	.185428	1.06	0.294
l1_lnengint	.1388009	.2072667	0.67	0.506
l1_lnemsint	.0546584	.218217	0.25	0.803
l1_growth	-.2133076	.3610187	-0.59	0.557
l2_eqrtns	.1947027	.181328	1.07	0.288
l2_lnengint	-.1216857	.1239366	-0.98	0.331
l2_lnemsint	.3156387	.1986033	1.59	0.119
l2_growth	.1648384	.2232486	0.74	0.464
growth				
l1_eqrtns	.1564387	.0827045	1.89	0.065
l1_lnengint	.0108659	.0924449	0.12	0.907
l1_lnemsint	.1346226	.097329	1.38	0.173
l1_growth	-.2362318	.1610213	-1.47	0.149
l2_eqrtns	-.021593	.0808758	-0.27	0.791
l2_lnengint	.0144169	.0552781	0.26	0.795
l2_lnemsint	-.129711	.0885809	-1.46	0.150
l2_growth	-.1113306	.0995732	-1.12	0.269

	Coef.	Std. Err.	t	P>|t|
mves				
l1_mves	-1.251373	.8626528	-1.45	0.153
l1_engint	44411.81	254591.1	0.17	0.862
l1_emsint	-255146.9	499668.4	-0.51	0.612
l1_growth	-265.216	242.8012	-1.09	0.280
l2_mves	3.071101	.8392931	3.66	0.001
l2_engint	11655.06	190789.1	0.06	0.952
l2_emsint	-58383.65	500013.6	-0.12	0.908
l2_growth	138.9598	163.8418	0.85	0.401
engint				
l1_mves	-1.81e-07	7.67e-07	-0.24	0.814
l1_engint	-.0892453	.2264899	-0.39	0.695
l1_emsint	1.767403	.4445162	3.98	0.000
l1_growth	-.0000526	.000216	-0.24	0.809
l2_mves	6.47e-07	7.47e-07	0.87	0.390
l2_engint	.1450655	.1697303	0.85	0.397
l2_emsint	-.4413385	.4448233	-0.99	0.326
l2_growth	.0000922	.0001458	0.63	0.530

emsint				
l1_mves	1.29e-07	3.71e-07	0.35	0.731
l1_engint	.0430598	.1095564	0.39	0.696
l1_emsint	.8630954	.2150188	4.01	0.000
l1_growth	.0000894	.0001045	0.86	0.396
l2_mves	7.13e-08	3.61e-07	0.20	0.844
l2_engint	.0284606	.0821009	0.35	0.730
l2_emsint	-.3250907	.2151673	-1.51	0.137
l2_growth	.0000853	.0000705	1.21	0.233
growth				
l1_mves	.0010623	.0005519	1.92	0.060
l1_engint	-66.82811	162.8802	-0.41	0.683
l1_emsint	42.06265	319.6738	0.13	0.896
l1_growth	-.2451068	.1553374	-1.58	0.121
l2_mves	-.000853	.000537	-1.59	0.119
l2_engint	60.59492	122.0615	0.50	0.622
l2_emsint	-99.87682	319.8947	-0.31	0.756
l2_growth	-.1749719	.1048214	-1.67	0.102