

Does it pay to be green? An empirical study of the South African mining industry

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Abstract

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In recent years, the growing importance of environmental and social issues has put pressure on companies to implement environmental and social systems. With the pressure on companies to improve environmental performance, environmental management accounting can provide a valuable tool that enables companies to respond to environmental challenges. The purpose of this study is to determine the relationship between environmental performance and economic performance in the South African mining industry and also to identify and evaluate the opportunities to improve both a company's environmental performance and economic performance.

In this study, scatter plot diagrams were used to determine the relationship between environmental performance and economic performance in the South African mining industry. Ten South African mining companies were selected for the study and their financial information as well as environmental information for the period 2005 to 2009 was used.

After the analysis of the scatter plot diagrams was done, it was found that it pays to be green for coal-mining companies, but not for gold- and platinum-mining companies. This study also identified that environmental management accounting is essential to identify and effectively manage environmental costs to improve environmental performance and that it is a very important tool to help companies to implement environmentally friendly programmes for ensuring a company's long-term strategic position. Despite all the risks and challenges facing the mining industry, opportunities to improve a company's environmental performance and economic performance, include emissions trading, development of new technologies, investing in projects in renewable energy and an increase in demand of mining products due to the effects of climate change.

The value of the study is that it is the first study to investigate the relationship between environmental performance and economic performance in the South African mining industry. This study is also unique as it takes into account how investors see the company in terms of environmental performance. This study uses economic performance measures from an internal and external point of view and not merely from an internal point of view like the previous studies. Companies in the mining industry as well as investors can use the findings presented in this study to realise the importance of preserving the environment as well as the importance of triple bottom line accounting.

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List of abbreviations

CH ₄	Methane
CO ₂	Carbon dioxide
DEAT	Department of Environmental Affairs and Tourism
EBIT	Earnings before interest and tax
EMA	Environmental management accounting
EPS	Earnings per share
EVA	Economic value added
EY	Earnings yield
GAAP	Generally Accepted Accounting Practice
GDP	Gross Domestic Product
GHG	Greenhouse gases
GRI	Global Reporting Initiative
JFI	Jaggi-Freedman Index
N ₂ O	Nitrous oxide
NBI	National Business Initiative
NOPAT	Net operating profit after tax
P/B	Price-book value
P/CF	Price-cash flow
P/E	Price-earnings ratio
RI	Residual income
ROA	Return on assets
ROE	Return on equity
ROS	Return on sales
SEFA	System of Integrated Environmental and Economic Accounting
UNFCCC	United Nations Framework Convention on Climate Change
UNSD	United Nations for Sustainable Development
US EPA	US Environmental Protection Agency
WACC	Weighted average cost of capital

Chapter One

Nature and scope of the study

1.1 Introduction

In recent years, the growing importance of environmental and social issues has put pressure on companies to implement environmental and social systems (Laurinkevičiūtė *et al.*, 2008:69). Due the pressures on companies to improve environmental performance, environmental management accounting can provide a valuable tool that enables companies to respond to environmental challenges. The Kyoto Protocol for Greenhouse Gas Emissions, the World Summit on Sustainable Development held in Johannesburg, South Africa, in 2002 and the United Nations Climate Change Conference held in Copenhagen, in December 2009 show the concern that stakeholders have about the negative impact industries have on the environment and humans (Ambe, 2007:54). Companies have started to show a lot of interest in the areas of corporate social responsibility as well as social and environmental management accounting. As a result of this interest, a growing number of companies are publishing triple bottom line and sustainability reports (Brown & Fraser, 2006:103). Many companies are reporting according to the Sustainable Reporting Guidelines (GRI, 2002) that show the growing importance of sustainability development. The Global Reporting Initiative (GRI) is voluntary guidelines that companies use to report on the environment. The aim of the GRI is to enhance the quality of environmental reporting (Ambe, 2007:54).

In the past, many managers and companies viewed environmental protection as additional costs and an expenditure that will lower profits (Telle, 2006:195). Porter and Van der Linde (1995:97-119) were two of the many authors who challenged this idea. They argued that better environmental performance will lead to higher profits. By reducing

pollution, future cost savings are made by improved efficiency, reducing compliance costs and minimising future liabilities. In their research, they found a positive relationship between environmental and economic performance that was based on quantitative empirical studies.

According to Bhat (1999:497-507), lower emissions mean lower costs. Waste discharge consists of labour, materials and equipment hours that the company has already paid for. No value is added through waste management; instead, costs are added through transportation, handling and disposal. If pollution is high, it means that the manufacturing processes are inefficient. If pollution is low, it will lower energy consumption, make the workplace safer, reduce production costs and enhance the quality of the product (Bhat, 1999:499). By lowering pollution, it creates a win-win situation for both the environment and the companies.

1.2 Previous studies

The relationship between environmental and economic performance has been investigated by several previous studies. Most of these studies used correlation coefficients to test the relationship between environmental performance and economic performance. Bragdon and Marlin (1972), Jaggi and Freedman (1992), Orlitzky *et al.* (2003) and Porter and Van der Linde (1995) have tested this relationship. In their studies, they found that there was a positive relationship between environmental performance and economic performance. Hart and Ahuja (1996) studied 127 US companies, and based on their research they concluded that it is profitable to be green. In the study, the authors used return on assets, return on sales and return on equity for the years 1989-1992 to measure economic performance and the sum of the reductions in emissions to measure environmental performance. They used a regression analysis to come to a conclusion. King and Lenox (2001) analysed 652 US manufacturing companies and also found a relationship between lower pollution and higher financial gain. The study found that a company's fixed characteristics and strategic position might cause this association.

In South Africa, there have been several environmental reporting-related studies, but very few on environmental management accounting. The lack of studies on environmental management accounting in South Africa justifies the need for this study. A summary of a few studies is provided below.

- De Villiers and Barnard (2000) reviewed environmental reporting in South Africa from 1994-1999. They found that mining companies disclose environmental information because of their immense environmental impact.
- De Villiers and Lubbe (2001) studied 100 JSE companies. The authors found that companies with greater environmental impact disclose more environmental information to enhance their public image and to legitimise their methods in the eyes of the public.
- KPMG (2001) did a survey on South African companies and found that there is a growing awareness of environmental management accounting, but that the current application and practice remain very low.
- Mitchell and Quinn (2005) studied the expectations of the preparers and the users of environmental reports in South Africa. They found a gap between the expectations of the two groups and that there is a need for environmental reporting to improve.
- Ambe (2007) used survey and case study techniques to indicate that there is a growing awareness of environmental management accounting, but that their application remains very low. He suggested techniques to implement environmental management accounting.

1.3 Problem statement

Environmental management accounting is accounting that focuses on physical and monetary information. The physical component focuses on the flow of energy, water products and materials and monetary information on environmental costs and revenues (Jasch, 2006:1194). Environmental management accounting is a very important tool to identify environmental costs and benefits in a business. This information can then be used

for better decision-making on a strategic level (Bennett *et al.*, 2003). Many production costs have an environmental component. By identifying and controlling environmental costs, environmental management accounting systems can help environmental managers to reduce costs and to improve environmental performance at the same time. Conventional accounting systems have attributed many environmental costs to general overhead accounts. This results in environmental costs remaining hidden from the attention of management (Ambe, 2007:70). According to the United Nations Division for Sustainable Development (UNDSD, 2001:1), environmental costs are not separately identified by companies. The decision-makers of companies struggle to link environmental information to environmental costs. The opportunity for cost savings is lost because companies do not understand or are not fully aware of the magnitude of environmental costs (Ambe, 2007:11).

Research question: Is there a relationship between environmental performance and economic performance?

The relationship between environmental performance and economic performance is very important, because a positive correlation between them will make companies more aware of environmental issues and the financial gain they have if the environment is taken care of (Gallarotti, 1995; Hart, 1997; Orlitzky *et al.*, 2003). Orlitzky *et al.* (2003) also argues that certain environmental regulations can be relaxed if there is a positive correlation between environmental performance and economic performance.

1.4 Objectives

The main objective of this mini-dissertation is to:

Determine the relationship between environmental performance and economic performance in the South African mining industry.

The secondary objective of this mini-dissertation is to:

Identify and evaluate the opportunities to improve both a company's environmental performance and economic performance.

1.5 Hypothesis

The conceptual framework, based on the findings of Bhat (1999:499), is that better environmental performance will lead to higher profits. By reducing pollution, future cost savings are made by means of improved efficiency, reducing compliance costs and minimising future liabilities. The aim of this study is to examine the relationship between environmental performance and economic performance within the South African mining industry. A null-hypothesis will be helpful to test this statement.

H₀: There is no relationship between environmental performance and economic performance between the companies under review.

1.6 Research methodology

There are two types of research, namely quantitative and qualitative research. According to Punch (1998), qualitative research is concerned with non-numerical, while unstructured data and quantitative research are concerned with the collection and analysis of numerical data. In this mini-dissertation, quantitative research will be used to determine whether there is a relationship between environmental performance and economic performance within the South African mining industry.

The reason why the mining industry was chosen for this study is because mining companies have a much greater impact on the environment than other companies do (Antonites & De Villiers, 2003:7). Because of this greater impact on the environment, companies in the mining sector of South Africa disclose more environmental information than other companies, because there are specific accounting policies that apply to the mining sector and which they have to adhere to (Antonites & De Villiers, 2003:7).

The population for this study was selected from the following companies:

- South African mining companies that are listed on the JSE Limited;
- South African mining companies that subscribe to the South African Business Council for Sustainable Development hosted by the National Business Initiative (NBI) (www.nbi.org.za); and
- South African mining companies that report on environmental performance based on the Global Reporting Initiative (GRI) Guidelines and that are listed on the GRI database.

A convenience sample of ten South African mining companies was selected for the study and their financial information for the past five years was used. The reason why only ten mining companies were selected was due to the limited environmental data available and due to the limited mining companies who reported on environmental-related issues before 2005. All ten companies were listed on the JSE and were members of the National Business Initiative (NBI). All ten companies report on environmental performance according to the Global Reporting Initiative Guidelines and are listed on the GRI database.

The ten companies operate in the following sectors of the mining industry:

- Four in the platinum-mining sector;
- Three in the gold-mining sector; and
- Three in the coal-mining sector.

Documentary data from internal company sources, such as annual reports and sustainability reports, were used to acquire the information needed for this study. The overall purpose of documentation review is to get an overall impression on how a programme operates, without interrupting the programme. The advantages of such a method are that you get comprehensive and historical information without interrupting the routine of the programme, the information already exists and there are few biases about the information (Carter, 1999:15). The challenges facing such a method are that it

takes up a lot of time, information may be incomplete and it is not a flexible way of gathering data (Carter, 1999:15). The McGregor BFA database supplied the economic performance information used in this study.

Scatter plot diagrams were used to mathematically explain the relationship between environmental performance and economic performance instead of the simple linear regression model due to problems that occurred with the use of this model. These problems will be discussed in Chapter 5 (refer paragraph 5.2, page 62).

1.6.1 Economic performance

From an internal point of view, economic performance will be measured through:

- return on sales (ROS);
- return on equity (ROE);
- return on assets (ROA);
- residual income (RI); and
- economic value added (EVA).

The following ratios will provide an insight into how investors see the company:

- price-earnings ratio (P/E);
- price-book value (P/B);
- price-cash flow (P/CF);
- earnings per share (EPS); and
- earnings yield (EY).

1.6.2 Environmental performance

The external effects of a company's activities, which consist of water consumption, energy usage and CO₂ emissions, will be measured through the company's environmental performance. Environmental performance will be measured by normalising the emissions

of each pollutant with production (Telle, 2006:203). A company, whose normalised production is low relative to another company's normalised production, is greener. The company with the lowest emissions of pollutants will be used as the baseline. A company's environmental performance can be calculated by dividing the baseline emissions into the normalised emissions. This will result in a measure that ranges from zero to one. The company performs better the higher the value. This is known as the Jaggi-Freedman Index (JFI). JFI ranges from zero to one, and the closer the JFI is to one, the greener the company. Refer paragraph 4.2 page 45 for explanations on the calculations of environmental performance.

What makes this study unique from previous studies is that it takes into account how investors see the company in terms of environmental performance. This study uses economic performance measures from an internal and external point of view and not merely from an internal point of view like the previous studies.

This study will help companies and managers to realise the importance of environmental management accounting systems and the opportunity for cost reductions through effective environmental management accounting systems.

1.7 Overview

This mini-dissertation consists of six chapters. The layout is as follows:

Chapter 1: The introduction to the background of the study was discussed, which included previous studies done on environmental management accounting, the problem statement, objectives, hypothesis and research methodology.

Chapter 2: Environmental management accounting. This chapter will discuss physical and monetary environmental management accounting, its application and limitations.

Chapter 3: The risks and opportunities that climate change will have on the South African mining industry. It will also discuss the importance of preserving the environment and South Africa's view on climate change.

Chapter 4: Review of the research method that will be used to measure the relationship between environmental performance and economic performance. The theory behind simple linear regression analysis will be explained in this chapter as well as the method of measuring environmental performance and economic performance.

Chapter 5: Empirical study will be conducted using scatter plot diagrams to test the relationship between environmental performance and economic performance.

Chapter 6: Conclude with an explanation of the findings in Chapter 5. It will also answer the questions on how the main objective, "to determine the relationship between environmental performance and economic performance within the South African mining industry", and the secondary objective, "to identify and evaluate the opportunities to improve both a company's environmental performance and economic performance", are reached.

Chapter Two

Sustainable development and environmental management accounting

2.1. Introduction

In **Chapter 1**, the nature and scope of the study was discussed, which included previous studies done on environmental management accounting, the problem statement, objectives, hypothesis and research methodology.

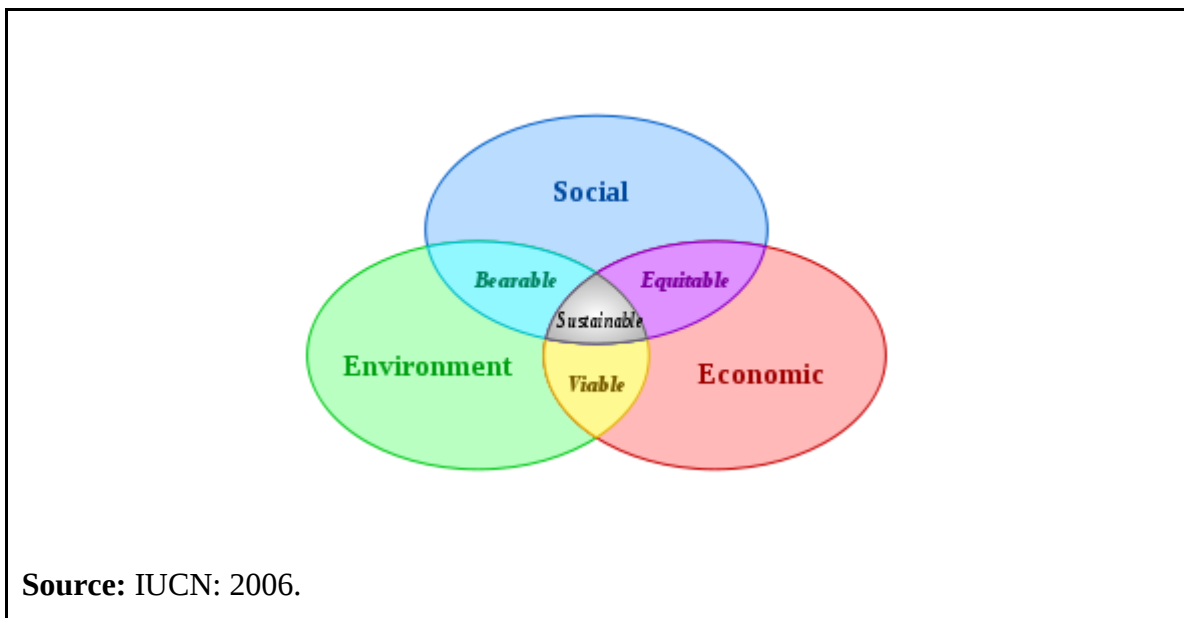
The purpose of this chapter is to review the literature on environmental management accounting and to discuss how environmental management accounting fits in with sustainable development. This chapter begins with a discussion on sustainable development and how environmental management accounting forms part of sustainable development. This is followed by an overview on environmental management accounting, physical environmental management accounting and monetary environmental management accounting. This chapter will also discuss the uses and applications for environmental management accounting and the chapter concludes with the chapter summary.

2.2. Sustainable development

“Sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations” as defined by The World Conservation Union (IUCN, 2006:29). According to Shi (2002), sustainable development is development that seeks economic growth while ensuring future generations’ ability to do the same while protecting the environment at the same time. It is clear that sustainable development consists of three dimensions, namely environmental sustainability, social sustainability

and economic sustainability. To meet the needs of future generations, these three dimensions need to be integrated to address the balance between dimensions of sustainability (IUCN, 2006:29). The interaction between these three dimensions is also known as triple bottom line accounting. Triple bottom line accounting takes into account not just financial performance, also but social/ethical performance and environmental performance. The three dimensions and the interaction between the three dimensions can be seen in Figure 2.1.

Figure 2.1: Three dimensions of sustainability development



Environmental management accounting incorporates two of the three dimensions of sustainability development – environmental sustainability and economic sustainability. Because environmental management accounting relates to a company's internal decision-making, it can be used as a very effective tool to sustain the environment and the economy (Savage & Jasch, 2005).

Besides a legislative approach, a strategic approach is needed to solve the environmental problem of climate change (Sendroiu & Roman, 1999). Changes in production and consumption need to be made for sustainability to be effective. Governments,

communities and businesses all see the importance of protecting the environment for future generations and have responded to the challenge of sustainability.

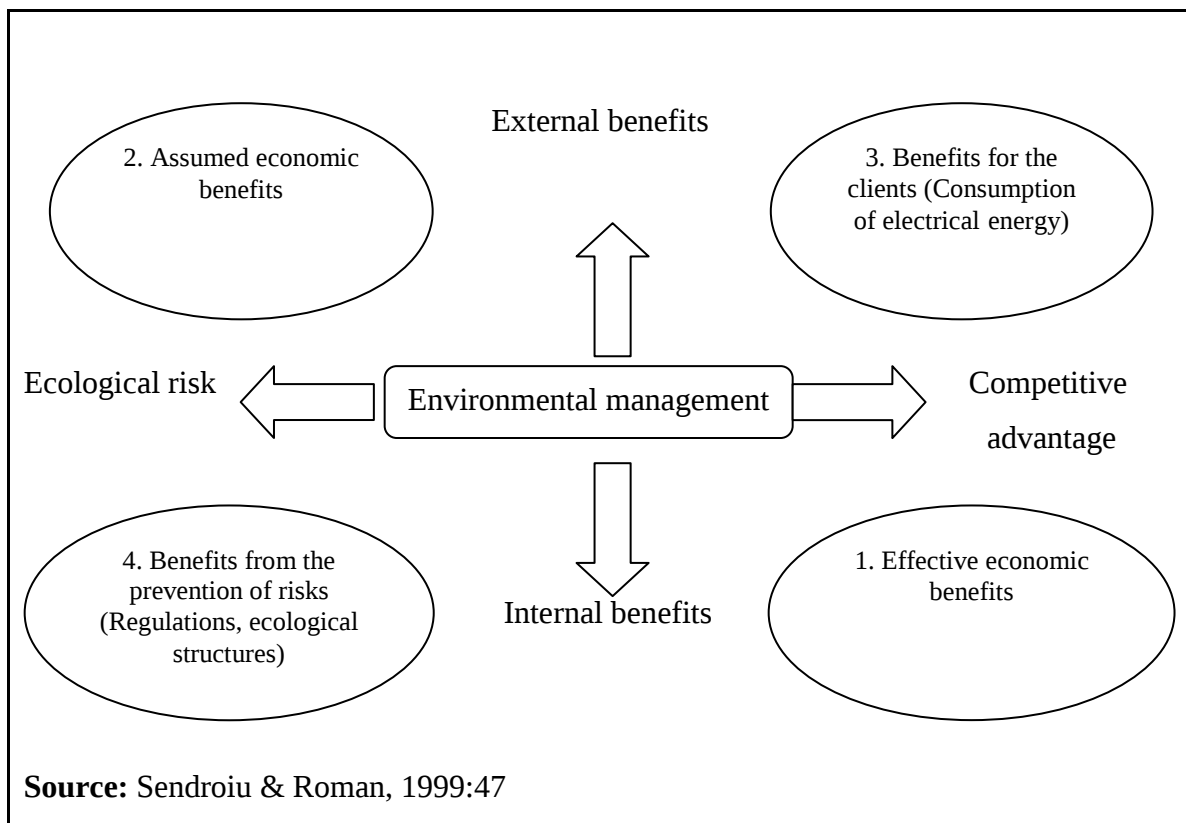
2.3. Environmental management accounting

Conventional accounting systems have attributed many environmental costs (e.g. reduction of pollution, management and monitoring of waste, regulatory reporting and insurance) to general overhead accounts. This results in environmental costs remaining hidden from the attention of management (Ambe, 2007:70). Therefore, the need for environmental management accounting was developed to identify and effectively manage these costs. Godschalk (2009:250) defines environmental management accounting as the identification, collection, analysis and the use of physical information and monetary information for internal decision-making. Environmental management accounting is management accounting that focuses on physical and monetary information. The physical component focuses on the flow of energy, water products and materials and monetary information on environmental costs and revenues (Jasch, 2006:1194). Environmental management accounting is thus an accounting tool that is used for internal company purposes that deals with environmental issues in both monetary and physical terms.

Environmental management accounting normally involves life-cycle costing, full-cost accounting, benefits assessment and strategic planning for environmental management (Savage & Jasch, 2005). Environmental management accounting information is normally used for calculations internal to the company and then that information is used for decision-making. The decisions that are made involve, e.g. the type of raw materials that need to be purchased, investment decisions of energy efficiency and altered product design to make the product more environmentally friendly (UNSD, 2001:1). It is important to note that environmental costs are just a subset of costs and all costs need to be considered when making decisions. Environmental management accounting is a very important tool to identify environmental costs and benefits in a business.

Environmental management accounting consists of an internal and external side. The internal management side focuses on physical and monetary resources and how to effectively track these resources. It also focuses on opportunities on how to lower costs and improve efficiency (Jasch, 2006:1194). The external side focuses on reporting and is sometimes also called environmental financial accounting (Jasch, 2006:1194). This information is reported in sustainability development reports and in the standard annual reports. These reports provide information to external stakeholders, such as shareholders, environmental regulatory agencies and statistical agencies on a company's performance and risks. Figure 2.2 below explains the internal and external benefits of environmental management accounting for management and it can also be used as an instrument for management to control environmental issues.

Figure 2.2: Environmental management accounting – instrument for management to improve environmental performance



2.3.1. Physical environmental management accounting

Internal management accounting focuses on physical resources and monetary resources. The first part of environmental management accounting, namely the tracking of physical information, is a very important tool in environmental management accounting, because it allows the company to analyse and manage their environmental performance (Savage & Jasch, 2005). Information, such as energy usage, water consumption and quantity of waste, is an example of physical information that will be analysed and reported on. Physical as well as monetary data on material use should be collected to assess costs correctly in a company. Unfortunately, the physical accounting information is not easily available to accounting personnel. Personnel in other departments, such as the production department and environmental department, have more detailed information available. It is very important that accounting personnel and personnel from other departments work together so that accurate physical environmental management accounting can be done. Table 2.1 below describes the input and output types under physical environmental management accounting and the flow of materials until the final product is complete that will help in categorising costs in their different types of cost categories.

Table 2.1: Physical environmental management accounting: Input and output types

Materials input	Product output
Raw and auxiliary materials	Products (including packaging)
Packaging materials	By-products (including packaging)
Merchandise	Non-product outputs (waste and emissions)

Operating materials	Solid waste
Water energy	Hazardous waste
Energy	Wastewater
	Air emissions

Source: Savage & Jasch, 2005

2.3.2. Monetary environmental management accounting

The first focus point on environmental management accounting was explained in paragraph 2.3.1 (refer page 14), which is physical environmental management accounting. The second focus point that will be explained in this paragraph is monetary environmental management accounting. Monetary environmental management accounting is accounting that focuses on the financial impact it has on environmental performance (Savage & Jasch, 2005). The problem with environmental management accounting, according to Jasch (2006), is that it lacks a standard definition for environmental costs. Different companies view environmental costs differently, depending on the company's view on environmental issues and their economic and environmental goals (Ambe, 2007:82). The US Environmental Protection Agency (US EPA) and the Japan Ministry of the Environment (Japan MOE, 2002) are two of the organisations that are most commonly used for defining environmental-related costs in a company. Japan MOE (2002) defines environmental costs as the investments and expenses related to the prevention, reduction and avoidance of environmental impact, removal of such impact and restoration of the environmental impact that is measured in monetary value.

Environmental costs are thus costs that occur from environmental damage and environmental protection. According to Jasch (2006), environmental protection costs include costs for prevention, disposal, planning, control and damage repair that can occur at companies, government or people. All expenditures for environmental protection, such

as expenditures to prevent, control or reduce waste as well as disposal, clean-up and treatment of environmental related aspects, form part of environmental expenditure. To ensure that environmental management accounting is accurate and consistent, physical inputs and outputs must be linked with their appropriate cost categories. If environmental costs are linked to their specific cost categories, then this will enable management to effectively identify and manage environmental costs (Savage & Jasch, 2005). Environmental cost categories form part of monetary environmental management accounting and will be discussed in paragraph 2.3.2.1.

2.3.2.1. Environmental cost categories

Environmental cost categories are a tool to help management to manage environmental costs. When analysing environmental costs, all types of environmental-related cost information needs to be identified to help managers and companies to manage both their environmental performance and economic performance (Savage & Jasch, 2005). To develop these cost categories, a variety of international sources were reviewed. According to Savage and Jasch (2005), there are six cost categories, namely:

1. Material costs of product outputs;
2. Material costs of non-product outputs;
3. Waste and emission control costs;
4. Prevention and other environmental management costs;
5. Research and development costs; and
6. Less tangible costs.

Category 1 – Material costs of product outputs

Material costs of product outputs include the purchase cost of natural resources, such as energy, water, and other materials that are converted into products, by-products and packaging (Savage & Jasch, 2005:41). In the mining industry, the actual mining of the natural resources has an environmental impact on the ecosystem. The environmental

impacts of the company's products can be better managed with the help of this cost data. For example, a company can rather use a less toxic product ingredient that will lower environmental performance and be more cost effective.

Category 2 – Material costs of non-product outputs

Material costs of non-product outputs include the purchase cost of energy, water and other materials that become non-product output, i.e. waste and emissions (Savage & Jasch, 2005:41). Companies can manage their environmental performance by installing more efficient process equipment that generates less waste. Not all waste and emissions can be reduced, but minimising the use of materials, energy and water will improve a company's environmental performance and economic performance. Potential cost savings can be made if these costs are effectively managed and managers see the potential benefits of environmental management.

Category 3 – Waste and emission control costs

Waste and emission control costs include costs for handling, treating and disposing of waste and emissions. "It also includes remediation and compensation costs related to environmental damage and any control-related regulatory compliance costs." (Savage & Jasch, 2005:42.)

Category 4 – Prevention and other environmental management costs

Prevention and other environmental management costs include the costs of preventive environmental management activities, such as cleaner production projects. It also includes costs for other environmental management activities, such as environmental planning and systems, environmental measurement, environmental communication and any other relevant activities (Savage & Jasch, 2005:43).

Category 5 – Research and development costs

This includes all research and development costs related to environmental issues. Examples of these costs includes research costs to reduce the toxicity of raw materials;

research to reduce greenhouse gas emissions; the development of more energy efficient products; and testing of equipment design that will increase efficiency of material use.

Category 6 – Less tangible costs

Includes both internal and external costs related to less tangible issues. Examples include liability (such as legal issues on natural resource damages), future regulations, productivity, company image, stakeholder relations and externalities like external effect on society, such as property values that decline due to high polluting factories (Savage & Jasch, 2005:44).

2.3.2.2. Distribution of costs by environmental domain

After environmental costs are linked to their different categories, it can also be helpful to distribute environmental costs by their different environmental domains as, shown in Table 2.2 (refer page 19). Environmental domain categories are normally used for external reporting purposes as it is required by some countries to report environmentally-related costs by environmental domain (Savage & Jasch, 2005:53). Environmental domain categories are not just useful for reporting purposes, but it is also useful for internal management purposes. Environmental domain categories are used by many companies to benchmark environmental costs by domain from year to year and among different departments (Savage & Jasch, 2005:53).

It is important to note that the total environmental costs do not necessarily reflect the environmental performance of a company. Table 2.2 shows how environmentally-related costs are assigned to environmental domains. The table is the method used by the System of Integrated Environmental and Economic Accounting (SEEA) of the United Nations.

Table 2.2: Summary of environmentally-related costs by environmental domain

ENVIRONMENTAL DOMAINS ENVIRONMENTALLY-RELATED COST CATEGORIES	Air and climate	Waste water	Waste	Soil, groundwater	Noise and vibration	Biodiversity and landscape	Radiation	Other	Total
1. MATERIAL COSTS OF PRODUCT OUTPUTS									
• Raw and auxiliary materials									
• Packaging materials									
• Water									
2. MATERIAL COSTS OF NON-PRODUCT OUTPUTS									
• Raw and auxiliary materials									
• Packaging materials									
• Operating materials									
• Water									
• Energy									
• Processing costs									
3. WASTE AND EMISSION CONTROL COSTS									
• Equipment depreciation									
• Operating materials									
• Water and energy									
• Internal personnel									
• External services									
• Fees, taxes and permits									
• Fines									
• Insurance									
• Remediation and compensation									
4. PREVENTIVE AND OTHER ENVIRONMENTAL MANAGEMENT COSTS									
• Equipment depreciation									
• Operating materials									
• Water, energy									
• Internal personnel									
• External services									
• Other									

5. RESEARCH AND DEVELOPMENT COSTS									
6. LESS TANGIBLE COSTS									

Source: Savage & Jasch, 2005:55

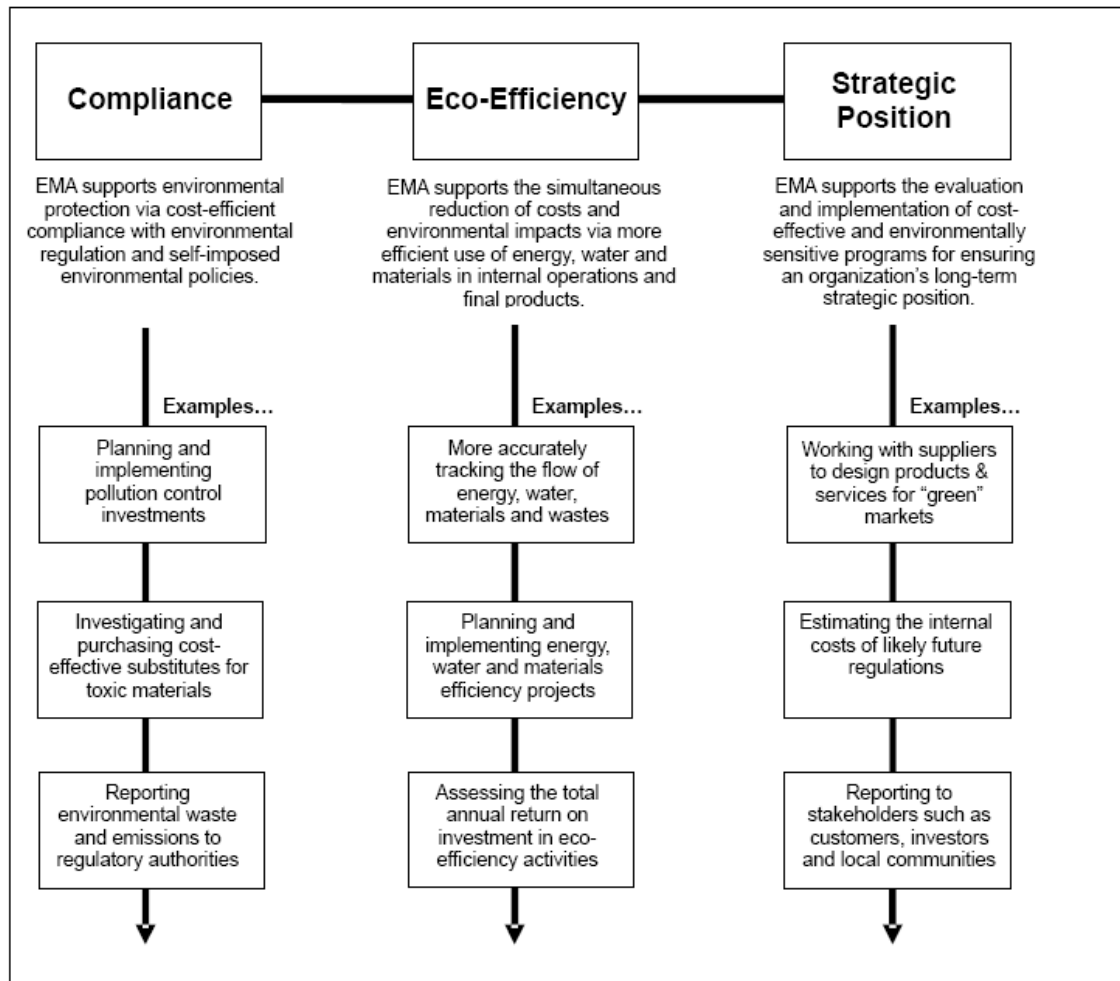
2.4. A critical evaluation of environmental management accounting

2.4.1. Uses and applications for environmental management accounting

The use and applications for environmental management accounting vary from company to company and from sector to sector. Environmental management accounting data is not only being used for internal decision-making but it is also being used for external reporting purposes (UNSD, 2001:9). Many companies disclose voluntary sustainability reports that report on physical environmental management accounting and monetary environmental management accounting. Environmental management accounting is not just a management tool anymore, but has developed into a broad set of principles and approaches that is essential for all environmental management activities. Environmental issues and legislations grew in recent years and the range of decisions affected by environmental issues has also increased, thus environmental management accounting's role has also increased in all management activities.

Figure 2.3 (refer page 21) illustrates the uses and benefits for environmental management accounting (EMA). It can be summarised into three categories, namely compliance, eco-efficiency and strategic position.

Figure 2.3: The uses and benefits of environmental management accounting



Source: Guidance to corporate environmental cost management (German Environmental Ministry, 2003).

According to the United Nations for Sustainable Development (UNSD, 2001:9), environmental management accounting data can be used for the following:

- Assessment of annual environmental costs/expenditure;
- Product pricing;
- Budgeting;
- Investment appraisal, calculating investment options;
- Calculating costs, savings and benefits of environmental projects;
- Design and implementation of environmental management systems;
- Environmental performance evaluation, indicators and benchmarking;

- Setting quantified performance targets;
- Cleaner production, pollution prevention, supply chain management and design for environmental projects;
- External disclosure of environmental expenditures, investments and liabilities;
- External environmental or sustainability reporting; and
- Other reporting of environmental data to statistical agencies and local authorities.

2.4.2. Limitations and challenges of environmental management accounting

Environmental management accounting was developed to address some of the limitations of conventional management accounting that involves environmental costs and decisions involving the environmental impact that companies have on the environment (Ambe, 2007:6). These limitations can lead to inaccurate decision-making by management, because they had to make decisions that are based on missing, inaccurate or misinterpreted information. This can have negative financial consequences on the company and environmental performance will reflect poorly.

Savage and Jasch (2005:26) have identified the following challenges facing environmental management accounting:

- Environmental costs remain hidden from the attention of management, because environmental costs are allocated to overhead accounts;
- Environmental costs are not correctly allocated from overhead accounts back to processes, products and process lines;
- The communication between accounting and other departments is poor;
- Environment-related cost information is not found in the accounting record;
- Investment decisions are made on information that is incomplete;
- Volumes are inaccurate for wasted raw materials and costs will then also be inaccurate.

There are also external factors that have influenced companies to develop and implement environmental management accounting. The external factors are as follows (Ambe, 2007:7):

- The growing interest that stakeholders have on the wellbeing of the planet;
- Environmentally-related costs have become very important in recent years;
- A growing demand for an integrated consideration of the financial and physical aspects of environmental management; and
- The combined consideration of financial, environmental and social aspects in sustainable development and corporate social responsibility.

2.5. Chapter summary

This chapter gave a background on sustainable development and showed how environmental management accounting forms part of triple bottom line accounting. It also identified and evaluated the opportunities to improve both a company's environmental performance and economic performance, which is the secondary objective of this mini-dissertation.

This chapter shows how important environmental management accounting is in identifying environmental costs and then managing these costs to improve environmental performance and economic performance in a company. Physical environmental management accounting (refer paragraph 2.3.1, page 14) and monetary environmental management accounting (refer paragraph 2.3.2, page 15) are accounting tools that management uses to manage environmentally-related issues and to improve a company's environmental performance. The approaches, limitations and uses for environmental management accounting were discussed in paragraph 2.4 (refer page 20) of this chapter.

This chapter forms the basis to examine whether there is a relationship between environmental performance and economic performance within the South African mining industry and to answer the research question: "does it pay to be green?".

Chapter 3 will review the risks and opportunities that climate change have on the South African mining industry. It will also discuss the importance of preserving the environment and South Africa's view on climate change. It will also discuss the United Nations Climate Change Conference that was held in Copenhagen in December 2009 and the criticism it received.

Chapter Three

The risks and opportunities of climate change

3.1. Introduction

Chapter 2 gave a background on sustainable development and showed how environmental management accounting forms part of triple bottom line accounting. It also identified and evaluated the opportunities to improve both a company's environmental performance and economic performance, which is the secondary objective of this mini-dissertation.

Chapter 3 will review the importance of preserving the environment and the effects that climate change will have on the environment and on the inhabitants of the earth. It will discuss South Africa's views on climate change and also the government's policy in dealing with the effects of global warming. It will also discuss the United Nations Climate Change Conference that was held in Copenhagen in December 2009 and the criticism it received. The risks and opportunities that climate change has on the South African mining industry will also be discussed and the chapter concludes with the chapter summary.

The aim of this chapter is to identify opportunities to improve a company's environmental performance and economic performance, which is the secondary objective of this mini dissertation. Chapter 3 will also aim to contribute to the research question of "Does it pay to be green?"

3.2. Climate change

Climate change is defined by the United Nations Framework Convention on Climate Change as the change in the climate that is attributed directly or indirectly to human activity that alters the composition of the atmosphere and that is, in addition to natural climate variability, observed over comparable time periods (IPCC, 2007:29). Recent scientific research conducted by the United Nations for Sustainable Development and the Intergovernmental Panel on Climate Change has shown that global warming is a reality and it is man-made. The effect of climate change can be seen in the increase of global air and ocean temperatures, widespread melting of sea ice and the rising of global sea levels. The average temperature went up with 4% or 0.55°C from 1970 to 2005 (IPCC, 2007:30). The effect that these changes have on the earth and the mining industry will be discussed in this chapter.

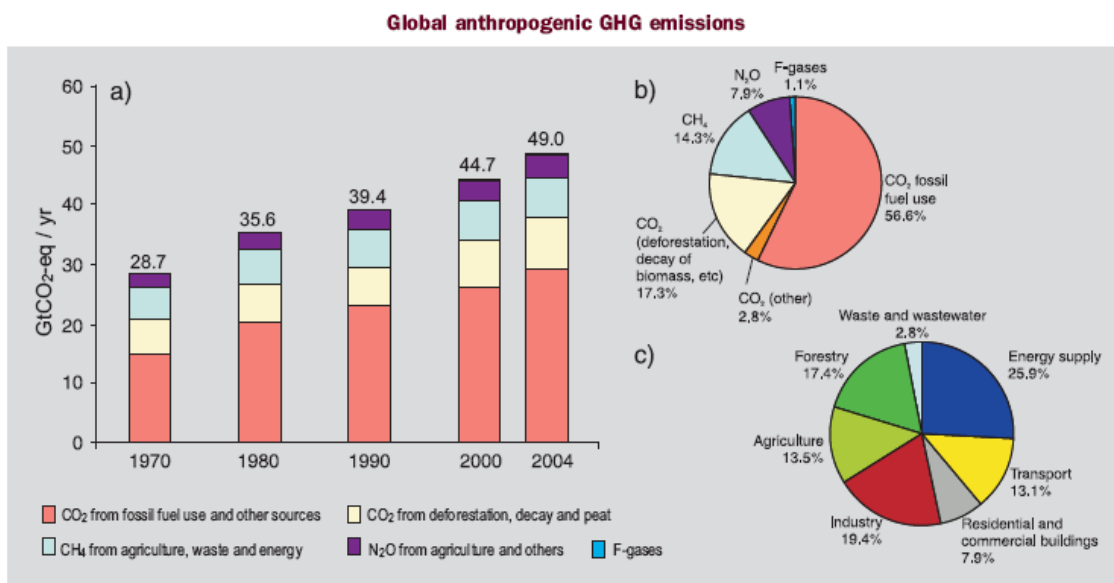
Global warming is caused by the overproduction of greenhouse gases when the increase of emissions is larger than the removal process. Carbon dioxide (CO₂) is the most common greenhouse gas that is being overproduced due to the increase in the demand for energy and the burning of fossil fuels. CO₂ emissions have grown by 80% between 1970 and 2004, from 21 to 38 Gt (IPCC, 2007:30). CO₂ represents approximately 77% of the total greenhouse gas emissions in 2004, as illustrated in Figure 3.1(b) (refer page 27) (Miller, 2006:10). Figure 3.1(b) shows the contribution that each greenhouse gas has made to the total greenhouse gas emissions during 2004 and it can be seen that CO₂ emissions are the most common greenhouse gases.

Human activities result in four long-lived greenhouse gases, namely CO₂, methane (CH₄), nitrous oxide (N₂O) and halocarbons. Halocarbons are a group of gases containing fluoride, chlorine and bromine. Figure 3.1(a) (refer page 27) shows the annual greenhouse gas emissions since 1970 due to human activities (IPCC, 2007:37). Figure 3.1(a) shows how global greenhouse gas emissions have grown by 70% between 1970 and 2004 from 28.7 GtCO₂ per year in 1970 to 49 GtCO₂ per year in 2004. The increase of greenhouse gas emissions due to human activities is called anthropogenic global warming. The energy supply sector, transport sector and the industry sector were the

sectors that contributed the most to global greenhouse gas emissions in 2004, as illustrated in Figure 3.1(c), while the agriculture sector, forestry sector, residential and commercial building sector were lesser contributors. The main sources of greenhouse gases due to human activities are (IPCC, 2007:37):

- The burning of fossil fuels and deforestation resulting in a higher concentration of CO₂ emissions;
- Fully-vented septic systems that enhance and target the fermentation process, livestock enteric fermentation, manure management and paddy rice farming are sources of atmospheric CH₄;
- The use of fertilisers in agricultural activities is a source of N₂O emissions; and
- Halocarbons are emitted from the use of refrigeration systems, fire suppression systems and manufacturing processes.

Figure 3.1 (a, b and c): Global anthropogenic GHG emissions



Source: IPCC, 2007: 36

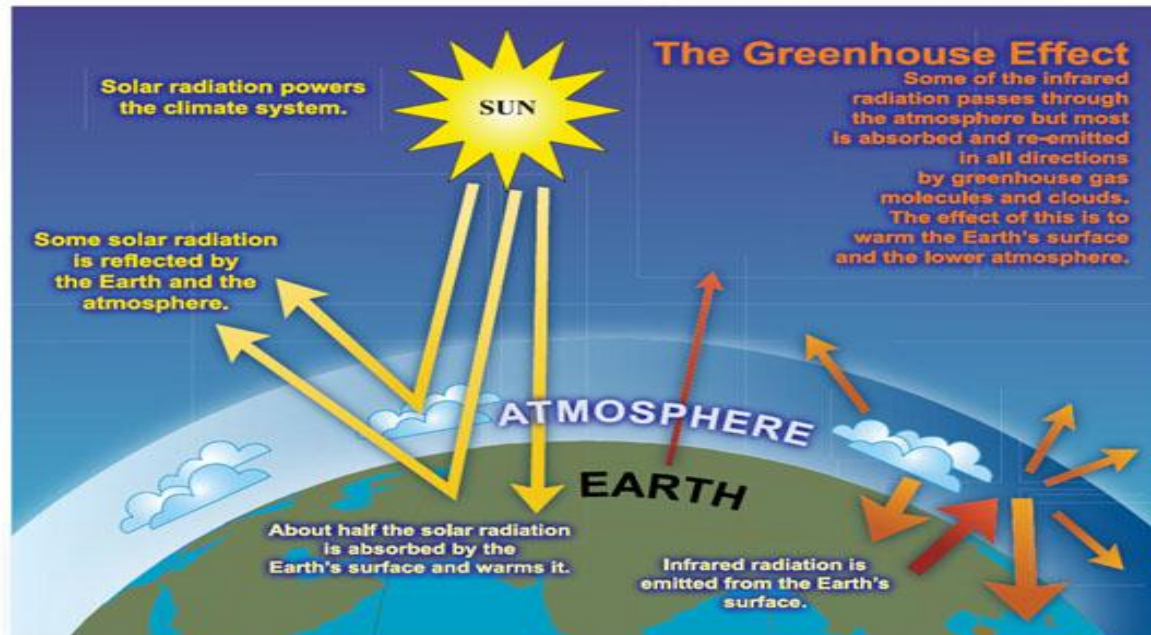
The graphs in Figure 3.1 show the following:

- (a) show global annual emissions of anthropogenic greenhouse gases from 1970 to 2004;
- (b) show the share of different anthropogenic greenhouse gases in total emissions in 2004 in terms of CO₂ emissions;
- (c) show the share of different sectors in total anthropogenic greenhouse gas emissions in 2004 in terms of CO₂ emissions.

3.2.1 The Greenhouse effect

The earth can be seen as a greenhouse. The atmosphere consists of water vapour, CO₂, CH₄, N₂O and when the sun rays pass through them, it has a similar effect as glass windows in a greenhouse do. The effect is shown in Figure 3.2 (refer page 29). These gases are responsible for keeping the earth's temperature at approximately 15°C – without these greenhouse gases the earth's temperature would be at approximately -18°C (AFS, 2007:6). To keep the earth warm, greenhouse gas molecules and clouds absorb and re-emit the sun's rays that pass through the earth's atmosphere to warm up the surface of the earth. Climate change is happening because man-made greenhouse gases are increasing in the earth's atmosphere and the earth's surface is getting warmer as a result thereof. The mining industry, the economy and all of earth's inhabitants will be influenced by these changes. Mining companies and all companies around the world have a responsibility to increase their environmental performance and to decrease the amount of greenhouse gases they emit into the air. Environmental management accounting has a big role to play in assisting companies to increase its environmental performance and saving the planet at the same time.

Figure 3.2: The greenhouse effect



Source: AFS, 2007:9

3.3. Effects of climate change

Humans and the environment will be greatly affected by the change in climate. Extreme weather events, glacier retreat and disappearance, rising of sea levels and negative economic and social impacts are some of the effects of climate change (Turpie *et al.*, 2002:3). The effects of climate change can already be seen with some extreme weather events that have increased over the last fifty years, namely the Arctic sea ice that has shrunk by 2.7% per decade and sea levels that have risen by 1.8mm per year (IPCC, 2007:29).

The problem that South Africa has, is that it faces the challenge of poverty, developing the economy and the challenge of climate change (SECCP, 2009:14). The development of infrastructure, transport, power and communication networks implies that South Africa's greenhouse gas emissions will increase and thus the problem of climate is not solved. With South Africa being a climatically sensitive and water-stressed country, the

effects of climate change will have a very big impact on crops and other agricultural activities (SECCP, 2009:17).

A study by Turpie *et al.* (2002) on the impact that climate change will have on South Africa, indicated the following areas of concern:

- Change in ecosystem function and biodiversity;
- Impact on rangelands;
- Impact on agricultural crops;
- Impact on plantation forestry;
- Property damage from sea-level rise; and
- Health impacts – Malaria.

3.3.1. Change in ecosystem function and biodiversity

Changes in rainfall and temperature patterns will have a significant impact on water resources, marine biodiversity, terrestrial vegetation and terrestrial fauna (Turpie *et al.*, 2002:24). Due to these changes, tourism activities in South Africa will be greatly affected. These changes are largely due to the impact that climate change will have on (Turpie *et al.*, 2002:24):

- Change in supply due to loss of habitat (for example coastal resorts);
- Change in supply and demand due to loss of biodiversity (for example loss of species from Kruger National Park); and
- Change in demand due to increases in temperature, humidity and malaria.

Tourism in South Africa contributes 10.9% of the country's Gross Domestic Product (GDP) and supports 1.12 million jobs in the formal sector (DEAT, 1996). The accessible wildlife, unspoiled wilderness, impressive scenery and warm climate are some of the main attractions for visiting South Africa (DEAT, 1996). The impact that climate change will have on the natural habitat and biodiversity threatens some of the country's most important tourist attractions. Taking into account the importance of tourism to the South

African economy, this threat could have a significant impact on the country's GDP and foreign exchange.

3.3.2. Impact on rangelands

Rangelands are those ecosystems that are suitable for grazing livestock where agricultural practices are not performed on a frequent basis (Scholes *et al.*, 1999:2). Rangelands occupy almost 70% of the land surface of South Africa and this includes all of the Nama and Succulent Karoo Biomes, the Savannah Biomes and the fraction of the Grassland Biomes that is not converted to cereal production and forestry. According to the Department of Environmental Affairs and Tourism (DEAT) (2000:6), the rangeland industry in South Africa contributes 5.3% of the country's annual GDP and employs 1.224 million people directly. Drought caused by lower rainfall and higher air temperatures due to climate change is the main risk facing rangelands. Marginal costs associated with ranching will also be impacted by the lower rainfall and higher temperatures (Scholes *et al.*, 1999:2).

The fertilisation effect indicates that under enhanced levels of CO₂, plants will be more productive and use water more efficiently (Du Toit *et al.*, 2000). Climate change will cause CO₂ levels to rise and, because of the fertilisation effect, grass and plants will be more productive and use water more efficiently. This will improve the grazing conditions for livestock and have a positive impact on the rangeland industry. Climate change will only marginally affect the net primary production in the South African rangelands, because the rise in temperatures and lower rainfall will be offset by the rise in CO₂ levels.

3.3.3. Impact on agricultural crops

Agricultural crops, especially maize, are a key provider for supporting rural livelihoods. According to the DEAT (2000:6), agricultural crops contribute 3.7% to the annual GDP. The global climate models predict that a hotter, drier climate that is a result of climate

change will decrease the maize production in South Africa by 20% (SECCP, 2009:37). This prediction will massively increase food insecurity, malnutrition, poverty and will have a negative impact on the economy with a 20% fall in GDP.

Recent research has shown that climate change might increase crop yields if the CO₂ fertilisation effect is strong (Du Toit *et al.*, 2000). The fertilisation effect indicates that under enhanced levels of CO₂, plants will be more productive and use water more efficiently. The fertilisation effect will increase crop yield; however, the effects have not yet been quantified for South African field conditions.

3.3.4. Impact on plantation forestry

Plantations currently cover 1.1% of South Africa's surface of which most is located in Mpumalanga and KwaZulu-Natal (Turpie *et al.*, 2002:24). The plantation forestry sector contributes 4.4% to South Africa's annual GDP, with an annual turnover of about R1 200 million and most of its income is derived from export sales (Fairbanks & Scholes, 1999:2). The South African tree plantation industry is vulnerable to the effects of climate change because of the following reasons (Fairbanks & Scholes, 1999:2):

- Plants are very sensitive to changes in the climate and changes in atmospheric conditions;
- The area climatically suitable for plantations in South Africa is limited and is subjected to water use pressure;
- The time between the investment and realisation of profit is very long – about 25 years; and
- It is very sensitive to transport costs.

According to a study done by Turpie *et al.* (2002:42), the plantation forestry sector will make an economic loss, as a result of an increase in annual mean temperatures of 2.5-3.5°C by 2050, of R727 million or a decrease of 43% in forestry output.

3.3.5. Property damage from sea-level rise

Increasing temperatures caused by climate change have resulted in the melting of sea ice causing the sea levels to rise by 1.88 mm per year (IPCC, 2007:29). This rise in sea levels will result in millions of beachfront property damage and damage to the environment. Sea level rise will not just have an impact on property damage, but will have an impact on the shoreline as well. The following impacts on the shoreline will occur (Hughes, 1992:140):

- Increased coastal erosion;
- Flooding of areas;
- Saltwater intrusion;
- Elevated coastal groundwater tables; and
- Reduced protection from storms and floods.

According to a study done by the Department of Environmental Affairs and Tourism (DEAT) (2000), the direct and indirect annual benefits from coastal ecosystems were estimated to be R179.1 billion and a GDP share of 35%. The loss of these coastal ecosystems will have a very negative impact on the economy of South Africa and preventative steps must be taken to protect coastal property and ecosystems from the risk of sea level rise.

3.3.6. Health impacts – Malaria

One of the diseases that was identified that will be most impacted by climate change because the transmission is sensitive to temperature and rainfall, is malaria (Kovats *et al.*, 2000). According to Turpie *et al.* (2002:46), a three-step methodology is used to estimate the economic impacts of increased malaria due to climate change:

1. Estimate the number of excess cases of malaria due to climate change, based on:
 - increased population at risk of contracting malaria because of climate change;
 - incidence ratios within that population at risk;
2. Estimate the economic cost of malaria morbidity due to climate change, based on:

- The cost of treating the additional cases;
 - Short-term productivity losses from patients or their carers being unable to work;
3. Estimate the economic cost of malaria mortality due to climate change, based on:
- Lost work years due to premature death from malaria;
 - Willingness to pay for reduced risk of death, adapted from the international literature.

Turpie *et al.* (2002:53) calculated that the economic cost of malaria due to climate change in 2010 will be R1 033 million, representing about 0.1% of GDP.

The increasing risk of malaria due to climate change can also have a significant impact on tourism, because tourists might choose to travel to malaria-free areas for their nature experience and South Africa's economy will suffer as a result.

3.4. Climate change in South Africa

South Africa contributes only 1% of the global CO₂ emissions, but its greenhouse gas emissions are very high compared to its population and economy (DEAT, 2007). South African decision-makers face the challenge of reducing greenhouse gas emissions and developing the economy at the same time. The availability and quality of water is a major concern that will have a very big impact on the South African economy and it is anticipated that the problem will only worsen (Kiker, 2000). Other concerns that will have an impact on South Africa were discussed earlier in the chapter.

South Africa as a developing country does not have to adopt the mandatory emission reduction targets as set out in the Kyoto Protocol (CDP, 2008:16). However, South Africa has played a key role in climate change negotiations in recent years and recognises the need to take measures in reducing greenhouse gas emissions. Science requires that the global temperature increase be limited to 2°C above pre-industrial levels, and South Africa's climate response policy is built around this requirement (CDP, 2008:20). The

South African government's vision for climate change is built around six policy direction themes (CDP, 2008:20):

1. Greenhouse gas emission reductions and limits;
2. Build on, strengthen and/or scale up current initiatives;
3. Implementing the "Business Unusual" call for action;
4. Preparing for the future;
5. Vulnerability and adaptation; and
6. Alignment, coordination and cooperation.

According to a media statement by Minister Marthinus van Schalkwyk (2008), these six themes will lay the basis for measurable, reportable and variable domestic emission reduction and limitation outcomes. He also stated that South Africa will continue to proactively build their knowledge base and the capacity to adapt to the inevitable impact of climate change by enhancing early warning and disaster reduction systems and in the roll out of basic services, water resource management, infrastructure planning, agriculture, biodiversity and the health sector.

3.5. United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is an international environmental treaty produced at the United Nations Conference on Environment and Development and the objective of the treaty is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (UNFCCC, 2009). Since 1995, annual conventions are held to assess the progress of climate change. In 1997, the Kyoto Protocol established legally binding obligations for developed countries to reduce their greenhouse gas emissions. Under the Kyoto Protocol, 37 countries committed themselves to reduce their greenhouse gas emissions by 5.2% by the year 2012, below the 1990 levels. All the other member countries gave a general commitment to reduce their greenhouse gas emissions; however, these member countries (of which South Africa is one) are not legally bound to reduce their greenhouse gas emissions (UNFCCC, 2009).

The 2009 UNFCCC was held in December 2009 in Copenhagen, where countries discussed how to proceed with the threat of climate change. Climate change conferences are held annually and representatives from over 180 countries, together with observers from intergovernmental and nongovernmental organisations, attend the conference. The 2008 conference was held in December 2008 in Poznań, Poland. The goal of this conference was to establish an agreement to address climate change from the period 2012 when the first commitment period under the Kyoto Protocol expires. The Copenhagen Accord is a document that was drafted by South Africa, Brazil, China, India and the United States of America that documents the agreements of the final session held on 18 December 2009. The Accord is not legally binding and does not commit countries to achieve their emission targets (UNFCCC, 2009). The Accord received a lot of criticism and South Africa, the European Union and many other countries labelled it as not acceptable and a disaster (BBC News, 2009).

Some of the key criticisms on the accord were (UNFCCC, 2009):

- It is not legally binding;
- It is not a legal successor for the Kyoto Protocol;
- No emission reduction targets to reduce emissions;
- The accord was only drafted by five countries;
- Countries only have to take note of the Copenhagen Accord rather than adopting it; and
- There is no agreement on how much individual countries have to contribute to the climate change fund.

In spite of all the criticism, the Accord and The United Nations do realise the importance of climate change and realise that climate change is one of the greatest challenges facing our planet. Some countries do see the conference as successful, but agree that a great deal still has to be done to fight climate change.

3.6. The South African mining industry and climate change

The South African mining industry faces a number of challenges with regard to climate change. The International Council of Mining and Metals sees the impact of climate and especially the impact of greenhouse gases as the most important issue facing the mining industry (IPCC, 2007:15). Because of the mining industry's strong link to water, it makes companies very vulnerable to the effects of climate change. The risks that the mining industry faces are not just the regulatory requirements and the reduction of greenhouse gas emissions, but they also face reputational risks related to sustainability concerns, the risk that customers will switch to alternative products, higher insurance premiums and physical risks due to extreme weather conditions (CDP, 2008:58). Companies see reputational risks as a key issue facing their companies as Anglo American points out that there is a potential reputational risk arising from failing to reduce emissions and otherwise failing to respond to the challenge of climate change (CDP, 2008:58). Companies are expecting that greenhouse gas emission regulations and carbon taxes will soon be implemented by the South African government. These regulatory requirements will have direct and indirect implications on companies, such as energy price increases, reporting compliance costs, emissions trading costs and costs of investing in new less carbon-intensive materials (CDP, 2008:61).

Despite the risks facing the mining industry, climate change has also created a number of opportunities. The potential for emission trading projects, the opportunities around clean development mechanism projects and carbon-trading opportunities are being considered by companies as opportunities to invest in (CDP, 2008:62).

According to a study done by the Carbon Disclose Project (2008), mining companies have identified the following opportunities based on the effect of climate change:

- The development of new technologies will result in large-scale energy savings and a reduction in greenhouse gas emissions;
- Some companies anticipate an increase of sales in mining products;

- Anglo Platinum anticipates that the demand for platinum will increase with the technological development of fuel cells;
- Investing in projects in renewable energy that will provide long-term carbon trading opportunities; and
- Companies with offshore listings can use the knowledge that they have gained in their offshore operations to achieve competitive advantage in the South African market.

Emission trading is one of the opportunities that companies have identified to invest in. Emission trading is an approach used to control pollution by giving economic incentives for achieving a reduction in emissions (Convery, 2009). A limit is set pertaining to the amount of emissions that can be emitted by a company by a central authority that gives out an emissions permit that gives them the right to emit a specific amount of pollutants. Companies who pollute more than their limit can buy emission credits from other companies who pollute less (Convery, 2009). Emission trading creates economic opportunities for companies and helps to reduce greenhouse gas emissions and creates a win-win situation for both the environment and the economy.

3.7. Chapter summary

This chapter gave a background on climate change and how the effects will influence the economy and the quality of human life. Paragraph 3.3 (refer page 29) highlights some of the effects that climate change will have on the earth if steps are not taken to prevent climate change and shows the importance of preserving the environment. Paragraph 3.4 (refer page 34) explains that South Africa does realise the importance of climate change and an action plan to help fight the effects of global warming in South Africa is in place. Paragraph 3.5 (refer page 35) shows that South Africa and all the countries of the world have a moral responsibility to take action to reduce greenhouse gas emissions and to illustrate how important climate change conferences like Copenhagen are in achieving a consensus between countries on how to deal with climate change.

This chapter also shows that it makes business sense to reduce greenhouse gas emissions and that a lot of opportunities do exist to increase a company's economic performance, as shown in paragraph 3.6 (refer page 37). This chapter contributes to the secondary objective of this mini-dissertation, which is to identify and evaluate opportunities to improve a company's environmental and economic performance.

Chapter 4 will review the research methodology that will be used to measure the relationship between environmental performance and economic performance. The theory behind simple linear regression analysis will be explained in this chapter as well as the method of measuring environmental performance and economic performance.

Chapter Four

Research design and research methodology

4.1. Introduction

In **Chapter 3**, the importance of preserving the environment was discussed as well as the risk and opportunities that climate change has on the South African mining industry. The South African government's policy in dealing with the effects of global warming and the decisions that were made at the United Nations Climate Change Conference in Copenhagen were also reviewed.

In this study, the relationship between environmental and economic performance will be investigated with the use of linear regression analysis. Chapter 4 will review the research design and methodology that will be used to measure the relationship between environmental performance and economic performance. The theory behind simple linear regression analysis will be explained in this chapter as well as the method of measuring environmental performance and economic performance. Simple linear regression analysis will not be used to test the relationship between environmental performance and economic performance due to problems that occurred with the use of this model. These problems will be discussed in Chapter 5. It is relevant to discuss the theory behind simple linear regression analysis because the principles of simple regression analysis will be used in the analysis of the data. This chapter explains the methodology of the statistical analysis that will be done on the data from the mining companies selected for testing.

4.2. Research design

According to Mouton (2003:55), the research design is how the researcher plans to perform the research in order to solve the research question, while the methods,

techniques and procedures of implementing the research design are called the research methodology.

Figure 4.1 below and Figure 4.2 (refer page 42) will be used to choose the type of research design that will be used in this study. The dimensions in Figure 4.1 indicate empirical studies versus non-empirical studies and also using primary data versus existing data, while Figure 4.2 is limited to empirical studies only and is mapped according to primary/existing data and the degree of control. Figure 4.2 also indicates whether the research design focuses on numerical data or textual data (Mouton, 2003:145). Figure 4.1 and Figure 4.2 will help to categorise the research design of this study.

Figure 4.1: Mapping designs (Level 1)

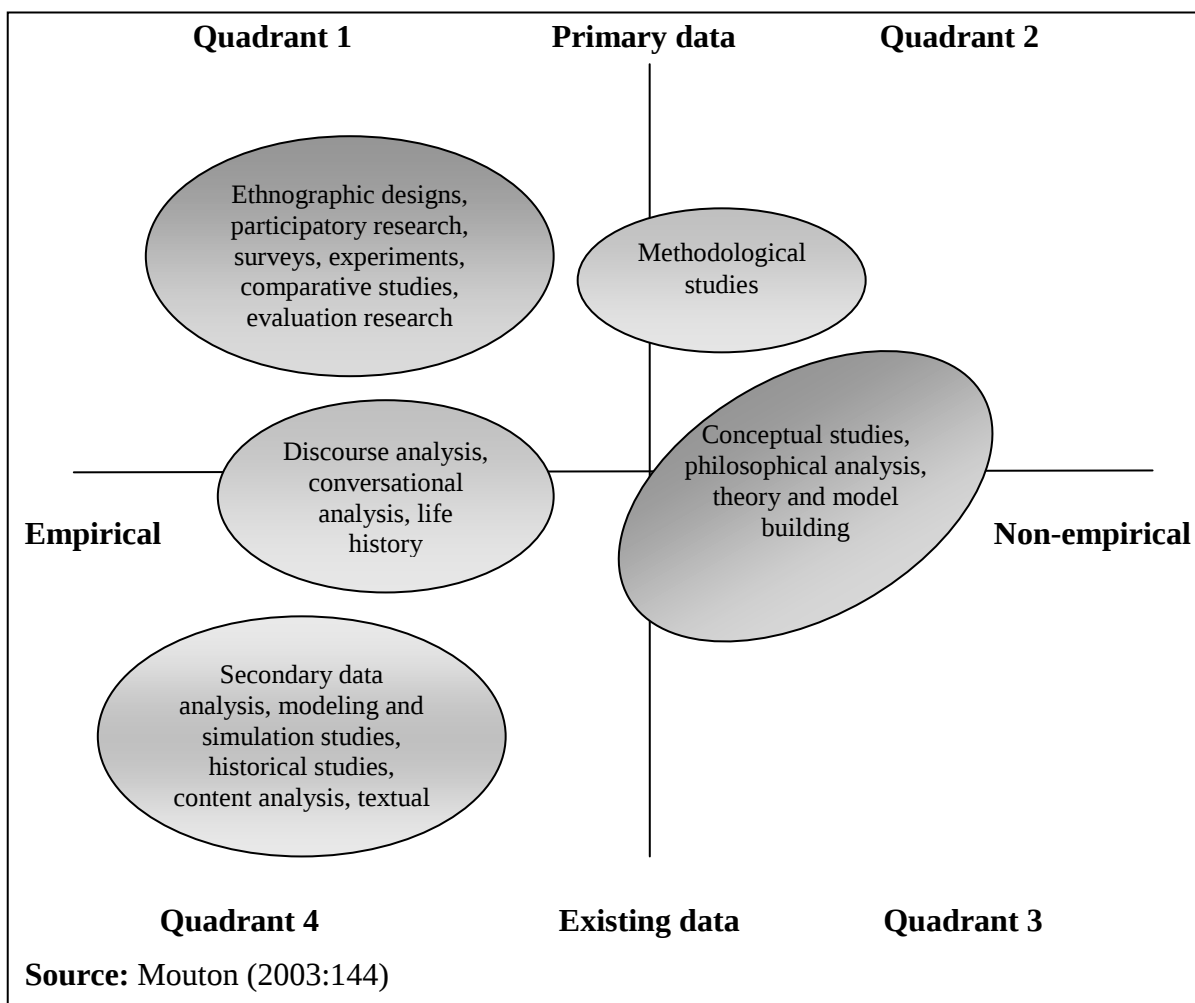
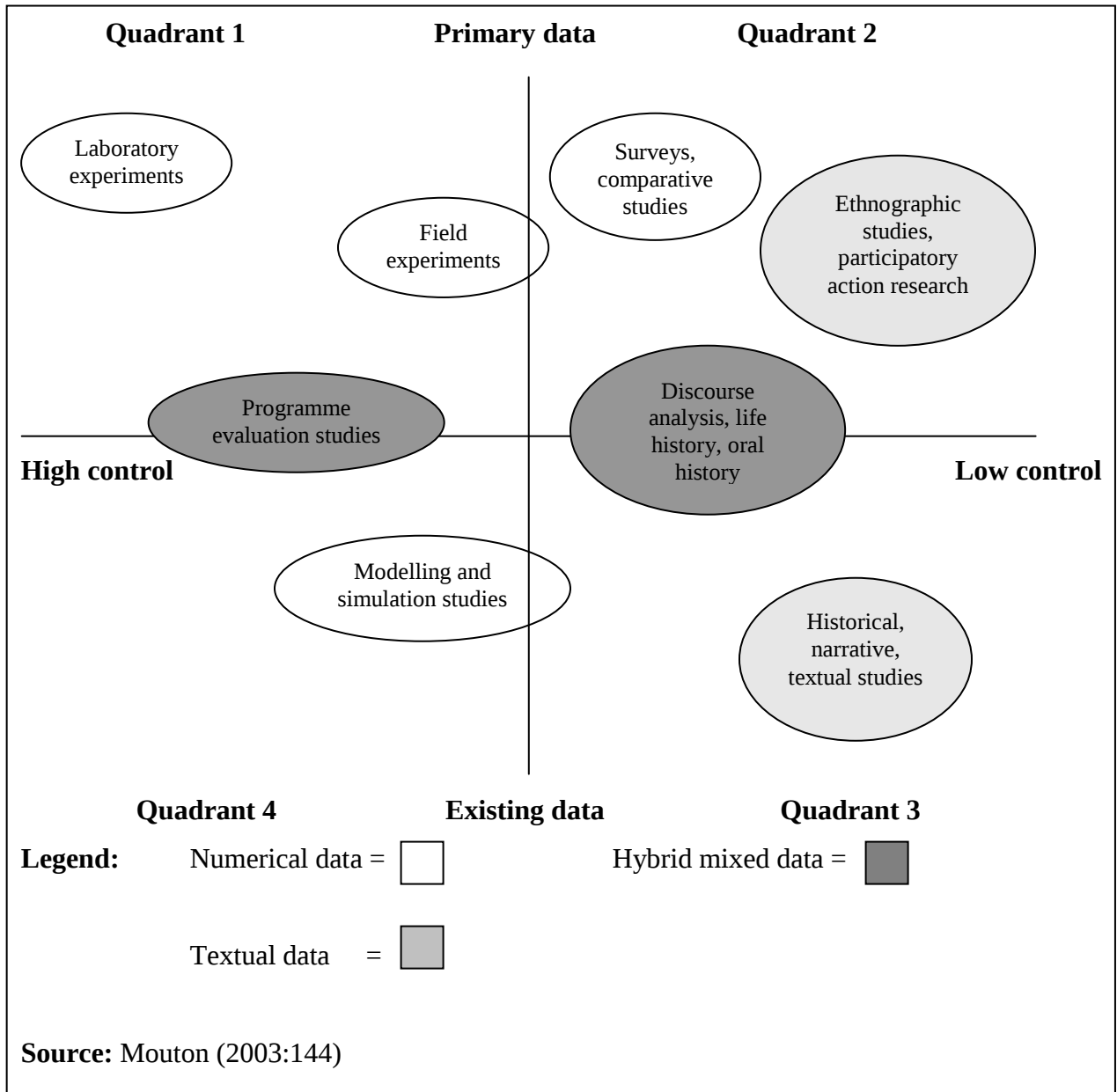


Figure 4.2: Mapping designs (Level 2)



According to Figure 4.1 (refer page 41), the design classification falls under quadrant four, secondary data analysis. This is because the study is empirical and because numerical, existing data will be used in this study.

According to Figure 4.2, the design classification falls under the first and fourth quadrant, programme evaluation studies and modelling and simulation studies. This is because

numerical, existing data will be used and because the degree of control is medium (statistical).

Therefore, the research design is categorised as statistical modelling and computer simulation studies (Mouton, 2003:144). The strength of this design is the ability to model large-scale phenomena and to simplify relationships in order to explain and predict better, while its limitations and main source of error are the quality of data that can be poor, under specification of the model and the plausibility of assumptions (Mouton, 2003:144).

4.3. Research methodology

The main objective of this mini-dissertation is to determine the relationship between environmental performance and economic performance in the South African mining industry (refer page 4). Documentary data from internal company sources, such as annual reports and sustainability reports, were used to acquire the information needed for this study. The McGregor BFA database supplied the economic performance information used in this study. After the raw data was processed, scatter plot diagrams were used to mathematically explain the relationship between environmental performance and economic performance instead of the simple linear regression model, due to problems that occurred with the use of this model (refer paragraph 5.2, page 62). It is relevant to discuss the theory behind simple linear regression analysis, because the principles of simple regression analysis will be used to investigate how environmental performance measures, the independent variable (plotted on the x-axis), will influence economic performance measures, the dependent variable (plotted on the y-axis), in the South African mining industry.

The population for this study was selected from the following companies:

- South African mining companies that are listed on the JSE Limited;
- South African mining companies that subscribe to the South African Business Council for Sustainable Development hosted by the National Business Initiative (NBI) (www.nbi.org.za);

- South African mining companies that report on environmental performance based on the Global Reporting Initiative (GRI) Guidelines and that are listed on the GRI database.

A convenience sample of ten South African mining companies was selected for the study and their financial information for the past five years was used. The reason why only ten mining companies were selected was due to the limited environmental data available and due to the limited number of mining companies that reported on environmental-related issues prior to 2005. All ten companies were listed on the JSE and were members of the National Business Initiative (NBI). All ten companies report on environmental performance according to the Global Reporting Initiative Guidelines and are listed on the GRI database.

The ten companies operate in the following sectors of the mining industry:

- Four in the platinum-mining sector;
- Three in the gold-mining sector; and
- Three in the coal-mining sector.

It should be noted that possible double counting may have taken place with the analysis of Anglo American/Anglo Coal's external economic performance measures when coal mining companies were tested. The reason is that Anglo Coal is not listed on the JSE Limited and thus no external economic performance measures are available. Anglo American's external economic performance measures were used to test Anglo Coal's external economic performance measures, as Anglo Coal is a subsidiary of Anglo American. It should also be noted that BHP Billiton and Exxaro is diversified natural resources companies and that data from their coal mining operations were used to test environmental performance.

4.4. Environmental performance

The environmental effects of a company's activities, which consist of water consumption, energy usage and CO₂ emissions, will be measured through the company's environmental performance. It is very difficult to create measures that capture a company's external effects of its activities. Some of the frequently applied measures are those of Hart and Ahuja (1996) and King and Lenox (2001) that measured the percentage change in emissions of an aggregate of pollutants. However, the approach of Jaggi and Freedman (1992), who created an index of emissions of various pollutants to measure environmental performance, will be used in this study.

Environmental performance will be measured by normalising the emissions of each pollutant with production (Telle, 2006:203). A company, whose normalised production is low relative to another company's normalised production, is greener.

$$e_{pit} = \text{Emissions}_{pit} / \text{Production}_{it}$$

Where:

e_{pit} = Normalised emissions

p = Pollutant

i = Company

t = Time period

The company with the lowest emissions of pollutant p will be used as the baseline.

$$e_{min,p} = \min_i (e_{pit})$$

To capture improvement over time, $e_{min,p}$ is identical for all years. A company's environmental performance (E_{pit}) with regard to pollutant p in t , can be measured as follows:

$$E_{pit} = e_{min,p} / e_{pit}$$

This will result in a measure that ranges from zero to one. The company performs better the higher the value. This is known as the Jaggi-Freedman Index (JFI).

$$JFI_{it} = \frac{1}{P} \sum_{p=1}^P E_{pit}$$

JFI ranges from zero to one, and the closer JFI is to one, the greener the company.

The following example will explain how environmental performance will be measured.

Example 1:

Table 4.1 exhibits the production in tons for companies A, B and C for four years. This data will be used to calculate the normalised emissions for each company.

Table 4.1: Production (Tons)

COMPANY	Year 1	Year 2	Year 3	Year 4
A	40 000	30 000	50 000	45 000
B	44 000	39 000	40 000	37 000
C	20 000	25 000	30 000	35 000

Table 4.2 exhibits the CO₂ emissions in tons for companies A, B and C for years one to four. Only CO₂ emissions are used in this example; however, in this study water usage, measured in m³, and energy usage, measured in GJ, will also be used to measure pollutants. Table 4.2 shows the CO₂ emissions in tons for each company over a period of four years.

Table 4.2: Tons of CO₂

COMPANY	Year 1	Year 2	Year 3	Year 4
A	20 000	15 900	28 500	23 850
B	40 480	33 930	39 200	41 810
C	14 600	18 500	24 000	29 750

Three steps are used to calculate environmental performance.

Step 1: Normalise emissions with production.

This is calculated by dividing emissions with production for each company for the specific year. Table 4.3 indicates the normalised emissions for companies A, B and C for the four years.

$$e_{pit} = \text{Emissions}_{pit} / \text{Production}_{it}$$

Table 4.3: Normalised emissions

Normalised emissions (e_{pit})	Year 1	Year 2	Year 3	Year 4
A	0.50*	0.53	0.57	0.53
B	0.92	0.87	0.98	1.13
C	0.73	0.74	0.8	0.85

* R40 000/20000 ton = 0.50

Step 2: Calculate the baseline pollutant.

After the normalised emissions have been calculated, the company with the lowest emissions of pollutant p will be used as the baseline. The other pollutants will then be valued relative to the baseline company. The pollutants for company A will be used as the baseline, because it has the lowest normalised emissions for all four years. See Table 4.4 below for baseline pollutants for the four years.

Table 4.4: Baseline pollutants

Baseline pollutant	Year 1	Year 2	Year 3	Year 4
A	0.50	0.53	0.57	0.53

Step 3: Calculate environmental performance by dividing the baseline emissions into the normalised emissions. The company who's JFI is closest to one, performs the best.

Table 4.5: JFI

JFI Index	Year 1	Year 2	Year 3	Year 4
A	1**	1	1	1
B	0.54 ***	0.61	0.58	0.47
C	0.68	0.72	0.71	0.62

** $0.50/0.50 = 1$

*** $0.5/0.92 = 0.54$

Company A has the best environmental performance for all four years because its JFI is closest to one (note that Company A is the baseline company). Company C has the second best environmental performance, and Company B has the third best environmental performance.

The same three steps will be used to measure the environmental performance for water usage and energy usage. Therefore, three environmental performance figures for CO₂ emissions, energy usage and water usage will be calculated. A figure that combines CO₂ emissions, energy usage and water usage into one figure for the years tested needs to be calculated to test whether a relationship between environmental performance and economic performance exists. The weighted average JFI will be calculated for the three environmental performance measures and the company with the JFI closest to one has the best environmental performance measure. This single JFI measure will be used to test whether a relationship between environmental performance and economic performance exists.

4.5. Economic performance measures

Economic performance will be measured from an internal as well as an external point of view and not merely from an internal point of view like the studies of King and Lenox (2001), Hart and Ahuja (1996) and Jaggi and Freedman (1992). This study is unique because it takes into account how investors see the company. Five ratios from an internal point of view and five ratios from an external point of view will be used to measure performance.

From an internal point of view, economic performance will be measured through:

- return on sales (ROS);
- return on equity (ROE);
- return on assets (ROA);
- residual income (RI); and
- economic value added (EVA).

The ratios ROS, ROE and ROA were chosen because they are the ratios that are used in the Du Pont analysis, which is an easy and frequently used analysis technique (Brigham & Ehrhardt, 2005:454-455). ROE is the overall indicator of success used in this model. Income, investment and capital structure are combined in the Du Pont analysis, which is one of the strengths of this model (Correia *et al.*, 2008:5-22). The Du Pont analysis was chosen because the ratios used in the Du Pont analysis are commonly used and are easy to understand (Brigham & Ehrhardt, 2005:454-455). EVA and RI will also be used as a performance measure. One of the problems of RI is that different sizes of companies can not be compared, since the bigger company will have a bigger RI compared to the smaller company's RI due to the size difference (Garrison *et al.*, 2006:564). EVA is an adaptation of RI and EVA will be used to compensate for the shortcomings of RI. EVA has the same problem and therefore these values need to be standardised.

The following ratios will provide an insight into how investors see the company:

- price-earnings ratio (P/E);

- price-book value (P/B);
- price-cash flow (P/CF);
- earnings per share (EPS); and
- earnings yield (EY).

The market value ratios, P/E, P/B and P/CF give an indication of what investors think about a company's past performance and future prospects. If the ratios are high, then the prospects are also high and the risks lower (Brigham & Ehrhardt, 2005:454-455). Share price is a common component in the above five ratios and thus these ratios were chosen to measure economic performance. It should be noted that EPS has the same problem as RI and EVA and needs to be standardised.

4.5.1. Internal economic performance measures

4.5.1.1. Return on sales

Return on sales (ROS) is one of the most commonly used measures for economic performance. ROS is calculated by dividing operating income by revenue (Horngren *et al.*, 2009:831):

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

This ratio indicates a company's profitability relative to sales. It shows the percentage of profit for every one rand that is sold. Therefore, if the ratio is high, then the performance will also be high.

4.5.1.2. Return on equity

Return on equity (ROE) is a very a popular measuring tool with investors as ROE indicates the return that investors get on their money (Brigham & Ehrhardt, 2005:454). Return on equity is the ratio between net profit after tax to equity (Correia *et al.*, 2008:5-18). If the ratio is high, then the performance will also be high. The following equation shows how ROE is calculated:

$$\text{ROE} = \frac{\text{Net income}}{\text{Total shareholders fund}}$$

One of the shortcomings of ROE is that the ratio can be manipulated legally within the framework of Generally Accepted Accounting Practice (GAAP) through changes in the accounting policy. If a company's gearing increases, the company's ROE will also increase; this creates the risk that the value of the company will fall as well as the share price (De Wet & Du Toit, 2007:60). It should also be remembered that ROE is a short-term measure of profitability as it determines the return for a single period.

4.5.1.3. Return on assets

The profitability of the company as a whole in relation to the total assets is measured by return on assets (ROA) (Correia *et al.*, 2008:5-18). Return on assets is calculated by dividing earnings before interest and tax (EBIT) with total assets:

$$\text{ROA} = \frac{\text{EBIT}}{\text{Total assets}}$$

If the ratio is high, then the performance will also be high (Correia *et al.*, 2008:5-18). This ratio shows how profitable a company's assets are in generating revenue and it also shows the percentage of profit for every rand of asset it controls. ROA gives an idea as to how efficient management is at using its assets to generate earnings.

According to Sakunasingha (2006:32), the strengths of traditional performance measures, like ROA, is that these performance measures are easy to understand and are commonly used.

4.5.1.4. Residual income

Residual income (RI) is an accounting measure of income minus the required return on an investment (Horngren *et al.*, 2009:829):

$$\text{RI} = \text{Income} - (\text{Required rate of return} \times \text{Investment})$$

RI measures the net operating income that an investment earns above the minimum required return on its operating assets. When an investment earns more than the required rate of the investment, the company should continue to invest in that investment. Many companies prefer to use the RI measure because the measure gives an absolute amount and not a percentage (Horngren *et al.*, 2009:829). Because of the different sizes of the companies that are being tested and because RI is given as an absolute amount and not a percentage, the data needs to be standardised to test whether a relationship between environmental performance and economic performance exists. Standardisation is the process where the relative size of an amount is measured in terms of the average and standard deviation of data (Steyn *et al.*, 1998:141). Calculations regarding standardisations will be performed in Chapter 5.

4.5.1.5. Economic value added

Economic value added (EVA) was introduced and trademarked by Stern Stewart and Company consultants group and is a method to measures a company's true profitability (Stewart, 1999:50). EVA is calculated as the operating income after tax minus weighted-average cost of capital multiplied by total assets minus current liabilities (Horngren *et al.*, 2009:830):

$$\text{EVA} = \text{NOPAT}_t - \text{WACC}_t \times (\text{Total assets} - \text{current liabilities})_{t-1}$$

Where:

t = at time t

NOPAT = Net operating profit after tax

WACC = Weighted average cost of capital

EVA measures the excess of earnings over the minimum return that shareholders could get by investing capital in companies of similar risk. If operating income after tax exceeds the total cost of capital, then EVA is positive and if operating income after tax is insufficient to cover the total cost of capital, then EVA will be negative. Many companies use EVA to guide them through their decision process and they find EVA helpful because it allows division managers to incorporate the cost of capital that is normally only used at the companywide level (Horngren *et al.*, 2009:830). According to Erasmus and Lambrechts (2006:15), EVA is similar to conventional profit measures, but EVA takes the total cost of capital into account and it is also not constrained by GAAP.

Companies can improve their EVA by (Horngren *et al.*, 2009:830):

- Investing capital in high-return projects;
- Earning more after tax operating income with the same capital; and
- Using less capital to earn the same after tax operating income.

It is important to note that EVA needs to be standardised for calculations in this study because EVA is not measured as a ratio but as a rand value. Calculations regarding standardisations will be performed in Chapter 5.

4.5.2. External economic performance measure

4.5.2.1. Price-earnings ratio

The price-earnings ratio (P/E) shows how much an investor is willing to pay for shares and shows the confidence that the market has for high earnings growth and low risk (Correia *et al.*, 2008:5-18). Interest rate changes will mean a fall in the P/E ratio as shares become less attractive and as the P/E ratio depends on market expectations and confidence. The P/E ratio is calculated by dividing the market price per share with earnings per share as indicated below (Correia *et al.*, 2008:5-18):

$$\text{P/E ratio} = \frac{\text{Price per Share}}{\text{Earnings per Share}}$$

P/E ratio is an indication of a company's past performance and future prospects. If the ratio is high, then the future prospect will also be high and the risks lower (Brigham & Ehrhardt, 2005:454).

4.5.2.2. Price-book value

The price-to-book (P/B) ratio is used to compare a company's stock market value to its book value. It is calculated by dividing the current market price per share by the book value per share as shown below (CIMA, 2008:33):

$$\text{P/B Ratio} = \frac{\text{Price per Share}}{\text{Book value per Share}}$$

A higher P/B ratio implies that investors expect management to create more value from a given set of assets. If the ratio is high, then the future prospect will also be high and the risks lower (Brigham & Ehrhardt, 2005:454). P/B ratio is popular with companies with a great deal of hard assets or ore reserves like companies in the mining industry. This ratio

is popular because it is easy to calculate and to understand. It also gives a good idea on how the market is valuing assets to earnings (CIMA, 2008:33).

4.5.2.3. Price-cash flow

The price-cash flow ratio is a ratio that compares a company's share price with the cash flow that a company generates on a per share basis. It is calculated by dividing a company's stock price per share with its operating cashflow per share:

$$\text{P/CF} = \frac{\text{Price per share}}{\text{Operating cash flow per share}}$$

If the ratio is high, then the future prospect will also be high and the risks lower (Brigham & Ehrhardt, 2005:454). If the ratio is low, then the future prospects will be low and the risk high. This ratio is similar to the price-earnings ratio, but it uses operating cashflow instead of earnings. It is seen as a more reliable measure as earnings can be easily manipulated where cash flow cannot. Earnings are also affected by depreciation and other non-cash factors (CIMA, 2008:33).

4.5.2.4. Earnings per share

EPS is an indication of a company's profitability and is calculated by dividing the profits distributed to ordinary shareholders divided by the total number of ordinary shares (Correia *et al.*, 2008:5-18):

$$\text{EPS} = \frac{\text{Earnings}}{\text{Number of ordinary shares}}$$

EPS can easily be altered by changing the company's accounting methods or the capital structure of the company. According to Sakunasingha (2006:33), "an increase or decrease in EPS does not necessarily mean an increase or decrease in market value, because these

earnings do not reflect the effect of the company's risk, or working capital and fixed investment that are required to produce growth.” When comparing performance of companies, it is important not to rely on one financial measure but to use it in conjunction with statement analysis and other measures.

It is important to note that EPS needs to be standardised for calculations in this study. Calculations regarding standardisations will be performed in Chapter 5.

4.5.2.5. Earnings yield

Earnings yield (EY) shows the return that investors are demanding and allows you to compare companies with different dividend policies, showing growth rather than earnings (Correia *et al.*, 2008:5-19). Earnings yield is the inverse of the P/E ratio and is calculated as the earnings per share divided by the market price of the shares:

$$\text{Earnings yield} = \frac{\text{Earnings per share}}{\text{Price per share}}$$

The earnings yield shows the percentage of each rand invested in the stock that was earned in the company. A high yield suggests that stock is undervalued, while a low yield may indicate an overvaluation of stock. This rule is not absolute and other factors also need to be taken into account (Correia *et al.*, 2008:5-19).

4.6. Simple regression analysis

The method of studying the relationship between two or more variables to arrive at a method for predicting a value of the dependent variable is called regression analysis. For simple regression analysis, only one predictor variable, *X*, is used to describe the behaviour of the dependent variable, *Y* (Kvanli *et al.*, 2006:413). In this study, the two

variables that will be used to study the relationship are economic performance (Y) and environmental performance (X).

In the simple regression analysis model there is (Maindonald & Braun, 2007:144):

- One predictor variable X ;
- The value Y is independent; and
- It is assumed that the relationship between X and Y is basically linear.

The purpose of both simple linear regression and correlation analysis is to measure to what extent there is a linear relationship between two variables. The major difference between the two is that correlation makes no distinction between independent and dependent variables, while linear regression does (Maindonald & Braun, 2007:144). Therefore, in this study, the principle of simple linear regression analysis and correlation analysis will be used to determine the relationship between environmental performance and economic performance.

4.6.1. Bivariate data and correlation

Bivariate data is data consisting of two variables, namely environmental performance and economic performance in this study. The graphical representation of bivariate data is called a scatter diagram. When the values on the horizontal axis (X) are associated with larger values on the vertical axis (Y), the variables have a positive relationship. When larger values of X are associated with smaller values of Y , these variables have a negative relationship (Kvanli *et al.*, 2006:404).

The strength of the linear relationship between two variables is computed by using the coefficient of correlations (r) (Kvanli *et al.*, 2006:405). The following equation can be used to calculate the coefficient of correlations of a sample:

$$r = \frac{\sum XY - (\sum X)(\sum Y)/n}{\sqrt{\sum X^2 - (\sum X)^2/n} \sqrt{\sum Y^2 - (\sum Y)^2/n}}$$

Or it can also be written as:

$$r = \frac{SCP_{XY}}{\sqrt{SS_X} \sqrt{SS_Y}}$$

Important issues regarding correlation coefficient:

- r ranges from -1 to 1;
- The larger the absolute value of r , the stronger the linear regression;
- The sign of r shows whether the relationship between X and Y is positive or negative; and
- X and Y are perfectly correlated when $r = 1$ or $r = -1$. Which means that a single line will go through each point (Kvanli *et al.*, 2006: 406).

4.6.2. Simple linear regression model

When using a straight line equation, there will always be a certain amount of error present (Maindonald & Braun, 2007:144). The straight line regression model has the following form:

$$Y = \beta_0 + \beta_1 X + e$$

Where:

- Y = dependent variable
- X = independent variable
- B_0 = Y intercept for the population
- B_1 = slope for the population
- E = random error in Y

$\beta_0 + \beta_1 X$ is the assumed line where all values of X and Y will fall and is called the deterministic portion of the model. e is the error component and is called the random error part of the model (Kvanli *et al.*, 2006:413). The deterministic portion, $\beta_0 + \beta_1 X$, refers to the straight line for the population and will remain unknown. By obtaining a random sample of data, we are able to estimate the unknown parameters, β_0 and β_1 . b_0 is the intercept of the sample regression line and is the estimate of the population intercept, β_0 . b_1 is the slope of the sample regression line and is the estimate of the population slope, β_1 (Kvanli *et al.*, 2006:408). b_0 and b_1 can be calculated as follows:

$$b_1 = \frac{SCP_{XY}}{SS_X}$$

$$b_0 = \bar{Y} - b_1 \bar{X}$$

4.6.3. Assumptions for the simple linear regression model

Certain assumptions are necessary to have an effective predictor and a model that will enable us to make statistical decisions (Kvanli *et al.*, 2006:414).

Assumptions:

1. **Linearity** – The relationship between the variables must be linear.
2. **Independence of errors** – It is required that the errors are independent of one another.
3. **Normality** – The data used in the analysis are normally distributed.
4. **Equal variance** – The variances in the errors are constant for all values of X .
5. **Autocorrelation** – When data is collected over a period of time, autocorrelation is important. This is detected by plotting errors over time. The Durbin-Watson statistic is another way of testing for autocorrelation.

4.6.4. Estimating the error variance, σ_e^2

Error occurs in the linear regression model because for a fixed value of X , the Y values would vary resulting in an inaccurate model. We would prefer that the values were grouped closely to the mean. To determine the error variance, the sum of squares of error (SSE) needs to be calculated first (Maindonald & Braun, 2007:153). The empirical rule is that 95% of the data should lie within two standard deviations of the mean.

$$SSE = \sum (Y - \hat{Y})^2$$

The error variance can be calculated as follows:

$$S^2 = \hat{\sigma}_e^2 = \text{estimate of } \sigma_e^2 = \frac{SSE}{n - 2}$$

4.6.5. A test of hypothesis on the slope of the regression line

The aim of this study is to examine the relationship between environmental performance and economic performance within the South African mining industry. To test whether environmental performance (X) provides information in predicting economic performance (Y), the hypotheses are (Kvanli *et al.*, 2006:414):

$$H_0: \beta_1 = 0 \text{ (No linear relationship exists between } X \text{ and } Y)$$

$$H_a: \beta_1 \neq 0 \text{ (A linear relationship does exist)}$$

The statistical significance or P-value is the probability that the relationship between environmental performance and economic performance occurred by pure chance and that no relationship exists (Kvanli *et al.*, 2006:419). In other words, the P-value represents the reliability of the results.

Example:

If the P-value is 0.05, it indicates that there is a 5% probability that the variables in our sample are a “fluke”, meaning that the null hypothesis will be rejected.

4.7. Chapter summary

This chapter explained the research methodology and research design that will be used to determine whether a relationship between economic performance and environmental performance exists. The research design and research methodology were explained in paragraph 4.2 (refer page 40) and 4.3 (refer page 43), while paragraphs 4.4 (refer page 45) and 4.5 (refer page 49) explain how to measure economic performance and environmental performance. The statistical analysis, namely simple regression analysis, was explained in paragraph 4.6 (refer page 56). This performance measure will be used to determine whether a relationship between environmental performance and economic performance exists with the use of the principles of simple linear regression analysis and to answer the research question, does it pay to be green?

In **Chapter 5**, the statistical analysis on the data will be performed as discussed in Chapter 4 above to test whether a relationship between environmental performance and economic performance exists.

Chapter Five

Empirical results

5.1. Introduction

In **Chapter 4**, the research design and research methodology were explained pertaining to how to measure the relationship between environmental performance and economic performance. In Chapter 5, the analysis of the statistical data will be performed with the use of scatter plot diagrams. Chapter 5 will contribute to the main objective of this study (refer paragraph 1.4, page 4), which is to determine the relationship between environmental performance and economic performance in the South African mining industry.

In paragraph 5.2, the problems with using the simple regression model for this study will be explained and why the use of the simple regression model was rejected. It will also explain why the scatter plot diagrams were used instead of the simple regression model. In paragraphs 5.4 (refer page 65) and 5.5 (refer page 74), the outcomes of the scatter diagram testing will be analysed and trends will be identified, and in paragraph 5.6 (refer page 82), a summary of the relationships between environmental performance and economic performance for the period 2005 to 2009 will be analysed.

5.2. Problems using the simple linear regression model

A few problems occurred when the relationship between economic performance and environmental performance was tested with the use of simple regression analysis. As a result, simple regression analysis could not be used to test the relationship between

economic performance and environmental performance. The following problems occurred:

- Limited data available due to limited mining companies that report on environmental-related issues prior to 2005. A study performed by the Carbon Disclosure Project (2008), which analysed the response from the 100 largest corporations on the JSE, found that 87% of responding companies have disclosed their greenhouse gas emissions for the year 2009. This study shows that there is an increase in companies that report on environmental-related issues. However, for the purpose of this study, there was not sufficient data available before 2005 to use the simple linear regression model to investigate the relationship between environmental performance and economic performance. In a time series analysis, the simple linear regression model needs at least 10 data points (10 time periods) to be scientific, thus the five data points (5 years, 2005 to 2009) of this study are not enough to be scientific (Kvanli *et al.*, 2006:413). As a result of this limited data available, only four platinum-mining companies, three coal-mining companies and three gold-mining companies for the period between 2005 and 2009 were tested.
- Environmental performance measures are industry and mineral specific. Because the production output, e.g. gold, platinum and coal, is measured in ounces and tons respectively, and because the pollutants are normalised with production, the environmental performances between the minerals cannot be compared. The environmental performance will not give an accurate reflection of the company's environmental performance if it is compared to other companies that mine with different minerals. Therefore, the environmental performance of platinum can only be compared with the environmental performance of other platinum mines, and so forth.
- The economic performance measures of each company are company and industry specific and cannot be compared with the economic performance measures of other companies. For example, the norm for ROA for gold-mining companies is much less than the norm for ROA for platinum-mining companies. The norm for ROA for gold-mining companies is, for example, 8% and the norm for ROA for platinum-mining companies is, for example, 20%.

- Autocorrelation. The previous year's data have a direct impact on next year's data and their performance measures. For example, ROA for 2008 will have a direct impact on the ROA of 2009. Therefore, the simple linear regression model could not be used to study the relationship between environmental performance and economic performance.
- Gold-mining companies are depleting asset companies. Because gold-mining companies are depleting asset companies, the economic performance measures of gold-mining companies should not be compared with the economic performance measures of other mining companies (McGregor BFA, 2010).

As a result of the above-mentioned problems, the results of the environmental performance and economic performance were plotted onto a graph to test the relationship between environmental performance and economic performance, which is more scientific than the simple linear regression model for the purpose of this study. In paragraph 5.3, the outcomes of the scatter plot diagram testing will be analysed and trends will be identified.

5.3. Statistical analysis

The relationship between economic performance and environmental performance will be tested with the use of scatter plot diagrams because of the problems that occurred with the simple linear regression model. Environmental performance measures consist of environmental performance (which is the average of water consumption, energy usage and CO₂ emissions), water consumption and energy usage. Environmental performance measures are the independent variable and are plotted on the x-axis and economic performance measures are the dependent variable and are plotted on the y-axis. This is because we want to study how environmental performance will influence economic performance in the South African mining industry. If a positive relationship exists, then it implies that if environmental performance measures improve, then economic performance measures will improve as well and if a negative relationship exists, then

economic performance measures will weaken if environmental performance measures improve. The following illustrates this:

For a positive relationship:

If Environmental performance ↑ then Economic performance ↑

For a negative relationship:

If Environmental performance ↑ then Economic performance ↓

The results of the testing will be discussed in the paragraphs that follow. (See Appendix A, page 115, for scatter plot diagrams and Appendix B, page 172, for the summary of the economic performance measures and environmental performance measures).

5.4. Internal economic performance measures and environmental performance

5.4.1. Return on sales

Figure 5.1 to Figure 5.12 show the relationship between ROS and the different environmental performance measures for the period 2005 to 2009 for gold mines, platinum mines and coal mines. ROS is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.1, 5.2 and 5.3, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.4 to 5.6 show the relationship between ROS and water consumption. Figures 5.7 to 5.9 show the relationship between ROS and energy usage and Figures 5.10 to 5.12 show the relationship between ROS and CO₂ emissions (Refer to Appendix A, page 112 to 117 for Figures 5.1 to Figure 5.12).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.1 (refer page 66).

Table 5.1: Summary of Figures 5.1-5.12: Relationship between ROS and environmental performance

ROS	*Environmental performance	Water consumption	Energy usage	**CO ₂ emissions
Gold mines				
2005	✓	✓	✓	✓
2006	inconclusive	✗	inconclusive	inconclusive
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗
Platinum mines				
2005	✗	✗	✗	✗
2006	✗	✗	✗	✗
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗
Coal mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✓	✓	✓	✓
2008	✓	inconclusive	✓	✓
2009	inconclusive	✓	inconclusive	Inconclusive

Tick Mark Legend	Remarks
✓	A positive relationship exists.
✗	A negative relationship exists.
Inconclusive	It is inconclusive whether a positive or negative relationship exists.

Note: This tick mark legend is also applicable to the rest of the analysis.

*Aggregation of water consumption, energy usage and CO₂ emissions. Is applicable to the rest of the analysis.

** CO₂ emissions refer to GHG emissions in this study because CO₂ is the biggest contributor and the better known term.

- A positive relationship between ROS and environmental performance, water consumption, energy usage and CO₂ was noted for gold-mining companies in 2005.

- It was inconclusive whether relationships exist between ROS and environmental performance, energy usage and CO₂ emissions for gold-mining companies in 2006.
- A negative relationship was noted between ROS and the different environmental performance measures for the period 2007 to 2009 for gold-mining companies.
- Negative relationships were noted between ROS and the different environmental performance measures for the period 2005 to 2009 for platinum-mining companies.
- Positive relationships between ROS and the different environmental performance measures were noted for the periods 2005 to 2007 for coal-mining companies. A positive relationship was noted between ROS and environmental performance in 2008, water consumption in 2009, energy usage in 2008 and CO₂ emissions in 2008 for coal-mining companies.

5.4.2. Return on equity

Figures 5.13 to 5.24 show the relationship between ROE and the different environmental performance measures for the period 2005 to 2009 for gold mines, platinum mines and coal mines. ROE is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.13, 5.14 and 5.15, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.16 to 5.18 show the relationship between ROE and water consumption. Figures 5.19 to 5.21 show the relationship between ROE and energy usage and Figures 5.22 to 5.24 show the relationship between ROE and CO₂ emissions (Refer to Appendix A, page 118 to page 123 for Figures 5.13 to 5.24).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.2 below.

Table 5.2: Summary of Figures 5.13 - 5.24: Relationship between ROE and environmental performance

ROE	Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	✓	✓	✓	✓

2006	Inconclusive	inconclusive	✓	✓
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗
Platinum mines				
2005	✗	✗	✗	✗
2006	✗	✗	✗	✗
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗
Coal mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✓	✓	✓	✓
2008	inconclusive	inconclusive	inconclusive	inconclusive
2009	inconclusive	inconclusive	inconclusive	inconclusive

- A positive relationship between ROE and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies in 2005. A positive relationship for energy usage and CO₂ emissions was also noted for 2006. It was inconclusive whether a relationship exists for 2006 and 2007 for environmental performance and water consumption.
- A negative relationship between ROE and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies from 2007 to 2009.
- Negative relationships were noted between ROE and the different environmental performance measures for the period 2005 to 2009 for platinum-mining companies.
- A positive relationship between ROE and environmental performance, water consumption, energy usage and CO₂ emissions was noted for 2005 to 2007 for coal-mining companies.
- It was inconclusive whether a relationship exists for 2008 and 2009 between ROE and environmental performance, water consumption, energy usage and CO₂ emissions for coal-mining companies.

5.4.3. Return on assets

Figures 5.25 to 5.36 show the relationship between ROA and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-mining companies and coal-mining companies. ROA is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.25, 5.26 and 5.27, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.28 to 5.30 show the relationship between ROA and water consumption. Figures 5.30 to 5.32 show the relationship between ROA and energy usage and Figures 5.33 to 5.35 show the relationship between ROA and CO₂ emissions (Refer to Appendix A, page 124 to page 129 for Figures 5.25 to 5.36).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.3 below.

Table 5.3: Summary of Figures 5.25 - 5.36: Relationship between ROA and environmental performance

ROA	Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✗	✗	✗	✗
2008	✗	✗	inconclusive	✗
2009	✗	✗	inconclusive	✗
Platinum mines				
2005	✗	✗	✗	✗
2006	✗	✗	✗	✗
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗
Coal mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✓	✓	✓	✓
2008	Inconclusive	inconclusive	inconclusive	inconclusive
2009	Inconclusive	inconclusive	inconclusive	inconclusive

- A positive relationship between ROA and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies in 2005 and 2006.
- A negative relationship between ROA and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies in 2007 to 2009, with the exception of 2008 and 2009 for energy usage, where it was inconclusive whether a relationship exists.
- A negative relationship was noted between ROA and the different environmental performance measures for the period 2005 to 2009 for platinum-mining companies.
- A positive relationship between ROA and environmental performance, water consumption, energy usage and CO₂ emissions was noted for 2005 to 2007 for coal-mining companies.
- It was inconclusive whether a relationship exists for 2008 and 2009 between ROA and environmental performance, water consumption, energy usage and CO₂ emissions for coal-mining companies.

5.4.4. Residual income

Figures 5.37 to 5.48 show the relationship between RI and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-mining companies and coal-mining companies. RI is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.37, 5.38 and 5.39, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.40 to 5.42 show the relationship between RI and water consumption. Figures 5.43 to 5.45 show the relationship between RI and energy usage and Figures 5.46 to 5.48 show the relationship between RI and CO₂ emissions (Refer to Appendix A, page 130 to page 135 for Figures 5.37 to 5.48).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.4 below.

Table 5.4: Summary of Figures 5.37 - 5.48: Relationship between RI and environmental performance

RI	Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	✓	✓	✓	✓
2006	✓	✗	✓	✓
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗
Platinum mines				
2005	✗	inconclusive	✗	✗
2006	✓	✓	✗	✓
2007	✓	✓	✗	✓
2008	inconclusive	inconclusive	✗	✓
2009	✗	✗	✗	✗
Coal mines				
2005	✗	✗	✗	✗
2006	✗	✗	✗	✗
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗

- A positive relationship between RI and environmental performance, water consumption and energy usage was noted for gold-mining companies in 2005 and 2006 with the exception of 2006's water consumption, where a negative relationship was noted.
- A negative relationship between RI and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-Mining companies in 2007 to 2009.
- A negative relationship between RI and environmental performance, energy usage and CO₂ emissions was noted for 2005 for platinum-mining companies. It was inconclusive whether a relationship exists between RI and water consumption for 2005.
- A positive relationship between RI and environmental performance, water consumption and CO₂ emissions was noted for 2006 and 2007 for platinum-mining companies.

- A positive relationship exists between RI and CO₂ emissions in 2008, a negative relationship for energy usage in 2008 and it was inconclusive whether a relationship exists for environmental performance and water consumption for platinum-mining companies.
- A negative relationship between RI and environmental performance, water consumption, energy usage and CO₂ emissions exists for 2009.
- A negative relationship was noted between RI and the different environmental performance measures for the period 2005 to 2009 for coal-mining companies.

5.4.5. Economic value added

Figures 5.49 to 5.60 show the relationship between EVA and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-mining companies and coal-mining companies. EVA is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.49, 5.50 and 5.51, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.52 to 5.54 show the relationship between EVA and water consumption. Figures 5.55 to 5.57 show the relationship between EVA and energy usage and Figures 5.58 to 5.60 show the relationship between EVA and CO₂ emissions (Refer to Appendix A, page 136 to page 141 for Figures 5.49 to 5.60).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.5 below.

Table 5.5: Summary of Figures 5.49 - 5.60: Relationship between EVA and environmental performance

EVA	*Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	✓	✓	✓	inconclusive
2006	✗	✗	✗	✗
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗

Platinum mines				
2005	inconclusive	✓	✗	inconclusive
2006	✓	✓	✗	✓
2007	✓	✓	✗	✓
2008	✓	✓	inconclusive	✓
2009	✗	✗	✗	✗
Coal mines				
2005	✗	✗	✗	✗
2006	✗	✗	✗	✗
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗

- A positive relationship between EVA and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies in 2005 with the exception of CO₂ emissions where it was inconclusive whether a relationship exists.
- A negative relationship was noted between EVA and the different environmental performance measures for the period 2006 to 2009 for gold-mining companies.
- For platinum-mining companies, it was inconclusive whether a relationship exists for environmental performance in 2005. A positive relationship exists for 2006 to 2008 and a negative relationship for 2009.
- A positive relationship exists between EVA and water consumption for 2005 to 2008 and a negative relationship exists for 2009 for platinum-mining companies.
- A negative relationship was noted between EVA and energy usage for 2005 to 2007 and 2009 and it was inconclusive whether a relationship exists for 2008 for platinum-mining companies.
- It was inconclusive whether a relationship exists between EVA and CO₂ emissions for 2005. A positive relationship exists for 2006 to 2008 and a negative relationship for 2009 for platinum-mining companies.
- A negative relationship was noted between EVA and the different environmental performance measures for the period 2005 to 2009 for coal-mining companies.

5.5. External economic performance measures and environmental performance

5.5.1. Price-earnings ratio

Figures 5.61 to 5.72 show the relationship between P/E and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-mining companies and coal-mining companies. P/E is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.61, 5.62 and 5.63, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.64 to 5.66 show the relationship between P/E and water consumption. Figures 5.67 to 5.69 show the relationship between P/E and energy usage and Figures 5.70 to 5.72 show the relationship between P/E and CO₂ emissions (Refer to Appendix A, page 142 to page 147 for Figures 5.61 to 5.72).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.6 below.

Table 5.6: Summary of Figures 5.61 - 5.72: Relationship between P/E and environmental performance

P/E	Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	×	×	×	×
2006	×	×	×	inconclusive
2007	×	×	×	×
2008	×	×	×	×
2009	×	×	×	×
Platinum mines				
2005	inconclusive	inconclusive	inconclusive	inconclusive
2006	inconclusive	inconclusive	inconclusive	inconclusive
2007	inconclusive	inconclusive	inconclusive	inconclusive
2008	inconclusive	inconclusive	inconclusive	inconclusive
2009	✓	✓	✓	✓
Coal mines				
2005	✓	✓	✓	✓
2006	inconclusive	✓	inconclusive	×
2007	✓	✓	✓	✓
2008	×	×	×	✓
2009	×	×	×	✓

- A negative relationship was noted between P/E and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies with the exception of CO₂ emissions for 2006, where it was inconclusive whether a relationship exists.
- It was inconclusive whether relationships exist between P/E and the different environmental performance measures for the period 2005 to 2008 for platinum-mining companies. Positive relationships were noted for 2009 between P/E and the different environmental performance measures.
- Positive relationships were noted for 2005 and 2007 between P/E and environmental performance, water consumption and energy usage for coal-mining companies and a positive relationship was also noted for CO₂ emissions in 2008 and 2009.
- A negative relationship was noted between P/E and environmental performance, water consumption and energy usage for 2008 and 2009 for coal-mining companies and it was inconclusive whether a relationship exists for environmental performance and energy usage in 2006. A negative relationship was also noted for CO₂ emissions in 2006.

5.5.2. Price-book value

Figures 5.73 to 5.84 show the relationship between P/B and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-mining companies and coal-mining companies. P/B is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.73, 5.74 and 5.75, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.76 to 5.78 show the relationship between P/B and water consumption. Figures 5.79 to 5.81 show the relationship between P/B and energy usage and Figures 5.82 to 5.84 show the relationship between P/B and CO₂ emissions (Refer to Appendix A, page 148 to page 153 for Figures 5.73 to 5.84).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.7 below.

Table 5.7: Summary of Figures 5.73 - 5.84: Relationship between P/B and environmental performance

P/B	Environmental performance	Water consumption	Energy usage	CO₂ emissions
Gold mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✓	✓	✓	✓
2008	✓	✓	✓	✓
2009	✓	✓	✓	✓
Platinum mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✓	✓	✓	✓
2008	✗	✗	✗	✗
2009	✓	✓	✓	✓
Coal mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	inconclusive
2007	✓	✓	✓	✓
2008	✗	✗	✗	inconclusive
2009	✓	✓	✓	✓

- A positive relationship between P/B and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies for the period 2005 to 2009.
- A positive relationship between P/B and environmental performance, water consumption, energy usage and CO₂ emissions was noted for platinum-mining companies for the period 2005 to 2007 and 2009 and it was noted that a negative relationship exists for 2008.
- A positive relationship between P/B and environmental performance, water consumption, energy usage and CO₂ emissions was noted for coal mining companies for the periods 2005 to 2007 and 2009, with the exception of CO₂ emissions in 2006, where it was inconclusive whether a relationship exists.

- A negative relationship between P/B and environmental performance, water consumption and energy usage was noted for 2008 and it was inconclusive whether a relationship exists for CO₂ emissions in 2008.

5.5.3. Price-cash flow

Figures 5.85 to 5.96 show the relationship between P/CF and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-mining companies and coal-mining companies. P/CF is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.85, 5.86 and 5.87, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.88 to 5.90 show the relationship between P/CF and water consumption. Figures 5.91 to 5.93 show the relationship between P/CF and energy usage and Figures 5.94 to 5.96 show the relationship between P/CF and CO₂ emissions (Refer to Appendix A, page 154 to page 159 for Figures 5.85 to 5.96).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.8 below.

Table 5.8: Summary of Figures 5.85 - 5.96: Relationship between P/CF and environmental performance

P/CF	Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	✓	✓	✓	✓
2006	✗	✗	✗	✗
2007	✗	✗	✗	✗
2008	✗	inconclusive	✗	✗
2009	inconclusive	inconclusive	✗	✗
Platinum mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✓	✓	✓	✓
2008	✓	✓	✓	✓
2009	✓	✓	✓	✓
Coal mines				
2005	inconclusive	inconclusive	inconclusive	inconclusive

2006	×	✓	×	×
2007	✓	✓	×	×
2008	inconclusive	×	inconclusive	✓
2009	✓	✓	✓	✓

- A positive relationship between P/CF and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies for the period 2005.
- A negative relationship between P/CF and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies for the period 2006 to 2009; however, it was inconclusive whether a relationship exists for environmental performance in 2009 and for water consumption in 2008 and 2009.
- A positive relationship between P/CF and environmental performance, water consumption, energy usage and CO₂ emissions was noted for platinum-mining companies for the period 2005 to 2009.
- It was inconclusive whether a relationship exists between P/CF and environmental performance, water consumption, energy usage and CO₂ emissions for 2005 for coal-mining companies. It was also inconclusive whether a relationship exists for environmental performance in 2008 and energy usage in 2008.
- A positive relationship between P/CF and environmental performance, water consumption, energy usage and CO₂ emissions for 2009 for coal-mining companies was noted and also for environmental performance in 2007, for water consumption in 2006 and 2007 and for CO₂ emissions in 2008.
- A negative relationship was noted between P/CF and environmental performance in 2006, for water consumption in 2008, for energy usage and CO₂ emissions in 2006 and 2007 for coal-mining companies.

5.5.4. Earnings per share

Figures 5.97 to 5.108 show the relationship between EPS and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-

mining companies and coal-mining companies. EPS is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.97, 5.98 and 5.99, is the total environmental performance, which includes water consumption, energy usage and CO₂ emissions. Figures 5.100 to 5.102 show the relationship between EPS and water consumption. Figures 5.103 to 5.105 show the relationship between EPS and energy usage and Figures 5.106 to 5.108 show the relationship between EPS and CO₂ emissions (Refer to Appendix A, page 160 to page 165 for Figures 5.97 to 5.108).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.9 below.

Table 5.9: Summary of Figures 5.97 - 5.108: Relationship between EPS and environmental performance

EPS	Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	✓	✓	✓	✓
2006	✓	✗	✓	✓
2007	✗	✗	✗	✗
2008	✗	✗	✗	✗
2009	✗	✗	✗	✗
Platinum mines				
2005	✗	✗	✗	✗
2006	inconclusive	✓	✗	inconclusive
2007	✓	✓	✓	✓
2008	✓	✓	✓	✓
2009	✗	✗	✗	✗
Coal mines				
2005	✓	✓	✓	✓
2006	inconclusive	✓	✗	✗
2007	✗	inconclusive	✗	✗
2008	✗	✓	✗	✗
2009	✗	✓	✗	✗

- A positive relationship between EPS and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies for the period 2005 and 2006, with the exception of water consumption in 2006, where a negative relationship was noted.

- A negative relationship between EPS and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies for the period 2007 to 2009.
- A negative relationship between EPS and environmental performance, water consumption, energy usage and CO₂ emissions was noted for platinum-mining companies for the period 2005 and 2009.
- A positive relationship between EPS and environmental performance, water consumption, energy usage and CO₂ emissions was noted for platinum-mining companies for the period 2007 and 2008.
- In 2006, a positive relationship between EPS and water consumption was noted for platinum-mining companies. A negative relationship was noted for 2006 between EPS and energy usage and it was inconclusive whether a relationship exists for environmental performance and CO₂ emissions.
- A negative relationship was noted between EPS and environmental performance in 2007 to 2009 for coal-mining companies. In 2006, it was inconclusive whether a relationship exists and in 2005 a positive relationship was noted.
- A positive relationship was noted between EPS and water consumption in 2005, 2006, 2008 and 2009. It was inconclusive whether a relationship exists in 2007 for coal-mining companies.
- A negative relationship between EPS and energy usage and CO₂ emissions was noted for 2006 to 2009 for coal-mining companies and a positive relationship was noted in 2005.

5.5.5. Earnings yield

Figures 5.109 to 5.120 show the relationship between EY and the different environmental performance measures for the period 2005 to 2009 for gold-mining companies, platinum-mining companies and coal-mining companies. EY is shown on the y-axis and the pollutants on the x-axis. The environmental performance, as shown in Figures 5.109, 5.110 and 5.111, is the total environmental performance, which includes water

consumption, energy usage and CO₂ emissions. Figures 5.112 to 5.114 show the relationship between EY and water consumption. Figures 5.115 to 5.117 show the relationship between EY and energy usage and Figures 5.118 to 5.120 show the relationship between EY and CO₂ emissions (Refer to Appendix A, page 166 to page 171 for Figures 5.109 to 5.120).

The following trends and relationships were noted. A summary of the findings is shown in Table 5.10 below.

Table 5.10: Summary of Figures 5.109 - 5.120: Relationship between EY and environmental performance

EY	Environmental performance	Water consumption	Energy usage	CO ₂ emissions
Gold mines				
2005	✓	✓	✓	✓
2006	✓	✓	✓	✓
2007	✗	✗	✗	✗
2008	✗	✗	inconclusive	✗
2009	✗	✗	✗	✗
Platinum mines				
2005	✗	✗	✗	✗
2006	✗	✗	inconclusive	✗
2007	✗	✗	✗	✗
2008	✓	✓	✓	✓
2009	✗	✗	✗	✗
Coal mines				
2005	✗	✗	✗	✗
2006	✓	✗	✓	✓
2007	✗	✗	✗	✗
2008	✓	✓	✓	✓
2009	✓	✓	✓	✓

- A positive relationship between EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies for the period 2005 and 2006.
- A negative relationship between EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted for gold-mining companies

for the period 2007 to 2009, with the exception of energy usage for 2008, where it was inconclusive whether a relationship exists.

- A positive relationship between EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted for platinum-mining companies for the period 2008.
- A negative relationship between EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted for platinum-mining companies for the period 2005, 2006, 2007 and 2009, with the exception of energy usage in 2006, where it was inconclusive whether a relationship exists.
- A positive relationship between EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted for coal-mining companies for the period 2006, 2008 and 2009, with the exception of water consumption in 2006, where a negative relationship was noted.
- A negative relationship between EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted for coal mining companies for the period 2005 and 2007.

5.6. Summary of relationships between environmental performance and economic performance for the period 2005 to 2009

Table 5.11 shows the average relationship for the period 2005 to 2009 between environmental performance and economic performance. When more positive relationships than negative relationships were noted for the period 2005 to 2009, then it was noted as a positive relationship in Table 5.11, and if more negative relationships were noted than positive relationships, then a negative relationship was noted in Table 5.11. If two positive relationships, two negative relationships and an inconclusive relationship were noted for the period 2005 to 2009, then an inconclusive relationship was noted in Table 5.11.

Table 5.11 Summary of the relationships between environmental performance and economic performance for the period 2005 to 2009

	Internal economic performance measures					External economic performance measures				
	ROS	ROE	ROA	RI	EVA	P/E	P/B	P/CF	EPS	EY
Gold mining										
Environmental performance	×	×	×	×	×	×	✓	×	×	×
Water consumption	×	×	×	×	×	×	✓	inc	×	×
Energy usage	×	×	inc	×	×	×	✓	×	×	inc
CO2 emissions	×	×	×	×	×	×	✓	×	×	×
Platinum mining										
Environmental performance	×	×	×	inc	✓	inc	✓	✓	inc	×
Water consumption	×	×	×	inc	✓	inc	✓	✓	✓	×
Energy usage	×	×	×	×	×	inc	✓	✓	×	×
CO2 emissions	×	×	×	✓	✓	inc	✓	✓	inc	×
Coal mining										
Environmental performance	✓	✓	✓	×	×	inc	✓	inc	×	✓
Water consumption	✓	✓	✓	×	×	✓	✓	✓	✓	×
Energy usage	✓	✓	✓	×	×	inc	✓	inc	×	✓
CO2 emissions	✓	✓	✓	×	×	✓	✓	inc	×	✓

The following trends and relationships were noted for gold-mining companies:

- A negative relationship between ROS, ROE, ROA, RI, EVA, P/E, P/CF, EPS and EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted, with the exceptions of energy usage for ROA and EY and water consumption for P/CF, where it was inconclusive whether a relationship exists.
- A positive relationship between P/B and environmental performance, water consumption, energy usage and CO₂ emissions was noted.

The following trends and relationships were noted for platinum-mining companies:

- A negative relationship between ROS, ROE, ROA, and EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted.
- A positive relationship between P/B, P/CF and environmental performance, water consumption, energy usage and CO₂ emissions was noted. A positive relationship was

also noted between RI and CO₂ emissions; between EVA and environmental performance, water consumption and CO₂ emissions; and also between EPS and water consumption.

- It was inconclusive whether a relationship exists between RI, P/E, EPS and environmental performance. It was also inconclusive whether a relationship exists between RI, PE and water consumption; PE and energy usage; and PE, EPS and CO₂ emissions.

The following trends and relationships were noted for coal-mining companies:

- A negative relationship between RI, EVA, EPS and environmental performance, water consumption, energy usage and CO₂ emissions was noted, with the exception of water consumption for EPS.
- A positive relationship between ROS, ROE, ROA, P/B, EY and environmental performance, water consumption, energy usage and CO₂ emissions was noted, with the exception of water consumption for EY.
- It was inconclusive whether a relationship exists between P/E and environmental performance; P/CF and environmental performance; P/E and energy usage; P/CF and energy usage; and P/CF and CO₂ emissions.

5.7. Chapter summary

This chapter contributed to the main objective of this study, which is to determine the relationship between environmental performance and economic performance in the South African mining industry. Scatter plot diagrams were used to determine the relationship between environmental performance and economic performance instead of simple regression analysis, because of problems that occurred as discussed in paragraph 5.2 (refer page 62) in this chapter.

The analysis of the scatter plot diagrams were analysed in paragraph 5.4 (refer page 65) and 5.5 (refer page 74). There it was noted that mostly positive relationships between economic performance measures and environmental performance measures exist for coal-

mining companies. However, it was noted that mostly negative relationships between economic performance measures and environmental performance measures exist for platinum- and gold-mining companies.

Chapter 6 will conclude with an explanation of the findings in Chapter 5. It will also answer the questions on how the objectives were reached.

Chapter Six

Summary and conclusions

6.1. Introduction

Chapter 5 contributed to the main objective of this study, which is to determine the relationship between environmental performance and economic performance in the South African mining industry. Scatter plot diagrams were analysed to determine the relationship between environmental performance and economic performance.

The growing importance of environmental and social issues has put pressure on companies to implement environmental and social systems to improve environmental performance (Laurinkevičiūtė *et al.*, 2008:69).

The main objective of this mini-dissertation is to:

Determine the relationship between environmental performance and economic performance in the South African mining industry (refer paragraph 1.4, page 4).

The secondary objective of this mini-dissertation is to:

Identify and evaluate the opportunities to improve both a company's environmental performance and economic performance (refer paragraph 1.4, page 4).

These objectives have been addressed through relevant literature and empirical studies as discussed in Chapters 2 to 5. This chapter will conclude through a summary of the above-mentioned chapters and also the research conclusions that will be made of the objectives of this study.

6.2. Internal economic performance measures

Paragraph 6.2 will summarise the findings between internal economic performance measures and environmental performance and will also make conclusions on the findings.

6.2.1. Return on sales

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.1 to 5.12 (refer to Appendix A, page 112 to 117), the following findings and conclusions can be made:

- A negative relationship between ROS and the different environmental performance measures was noted for gold-mining companies and platinum-mining companies. It was found that gold- and platinum-mining companies that performed poorly in terms of environmental performance, water emissions, energy consumption and CO₂ emissions, performed well in their ROS performance measure and companies that performed well in terms of their environmental performance, performed poorly in their ROS performance measure. The following was noted for gold-mining companies and platinum-mining companies:

Environmental performance ↑	ROS ↓
Environmental performance ↓	ROS ↑

Therefore, it does not pay to be green for gold- and platinum-mining companies in terms of ROS.

- A positive relationship between ROS and the different environmental performance measures was noted for coal-mining companies. It was found that coal-mining companies that performed well in terms of their environmental performance, also performed well in their ROS performance measure.

The following was noted for coal-mining companies:

Environmental performance ↑	ROS ↑
Environmental performance ↓	ROS ↓

Therefore, it does pay to be green for coal-mining companies in terms of ROS.

6.2.2. Return on equity

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.13 to 5.24 (Refer to Appendix A, page 118 to page 123), the following findings and conclusions can be made:

- A negative relationship between ROE and the different environmental performance measures was noted for gold-mining companies and platinum-mining companies. It was found that gold- and platinum-mining companies that performed poorly in terms of environmental performance, water emissions, energy consumption and CO₂ emissions, performed well in their ROE performance measure and companies that performed well in terms of their environmental performance, performed poorly in their ROE performance measure. The following was noted for gold-mining companies and platinum-mining companies:

Environmental performance ↑	ROE ↓
Environmental performance ↓	ROE ↑

Therefore, it does not pay to be green for gold- and platinum-mining companies in terms of ROE.

- A positive relationship between ROE and the different environmental performance measures was noted for coal-mining companies. It was found that coal-mining companies that performed well in terms of their environmental performance, also

performed well in their ROE performance measure. The following was noted for coal-mining companies:

Environmental performance ↑	ROE ↑
Environmental performance ↓	ROE ↓

Therefore, it does pay to be green for coal-mining companies in terms of ROE.

6.2.3. Return on assets

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.25 to 5.36 (Refer to Appendix A, page 124 to page 129), the following findings and conclusions can be made:

- A negative relationship between ROA and the different environmental performance measures was noted for gold-mining companies and platinum-mining companies. It was inconclusive whether a relationship exists between ROA and energy usage for gold-mining companies. It was found that gold- and platinum-mining companies that performed poorly in terms of environmental performance, water emissions, energy consumption and CO₂ emissions, performed well in their ROA performance measure and companies that performed well in terms of their environmental performance, performed poorly in their ROA performance measure. The following was noted for gold-mining companies and platinum-mining companies:

Environmental performance ↑	ROA ↓
Environmental performance ↓	ROA ↑

Therefore, it does not pay to be green for gold- and platinum-mining companies in terms of ROA.

- A positive relationship between ROA and the different environmental performance measures was noted for coal-mining companies. It was found that coal-mining

companies that performed well in terms of their environmental performance, also performed well in their ROA performance measure. The following was noted for coal-mining companies:

Environmental performance ↑	ROA ↑
Environmental performance ↓	ROA ↓

A conclusion can be made that if coal-mining companies invest in preserving the environment and invest in performing well in their environmental performance, they will also perform well in their ROA performance measure. This positive relationship shows that coal-mining companies are more efficient in using its assets to generate earnings than gold- and platinum-mining companies. This efficiency also results in better environmental performance as resources are more efficiently used. Therefore, it does pay to be green for coal-mining companies in terms of ROA.

6.2.4. Residual income

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.37 to 5.48 (Refer to Appendix A, page 130 to page 135), the following findings and conclusions can be made:

- A negative relationship between RI and the different environmental performance measures was noted for gold-mining companies and coal-mining companies. It was found that gold- and coal-mining companies that performed poorly in terms of environmental performance, water emissions, energy consumption and CO₂ emissions, performed well in their RI performance measure and companies that performed well in terms of their environmental performance, performed poorly in their RI performance measure. The following was noted for gold-mining companies and coal-mining companies:

Environmental performance ↑	RI ↓
Environmental performance ↓	RI ↑

Therefore, it does not pay to be green for gold- and coal-mining companies in terms of RI.

- For platinum-mining companies, it was inconclusive whether a relationship exists between RI and environmental performance and water consumption. A positive relationship between RI and CO₂ emissions was noted and a negative relationship between RI and energy usage was also noted. Because of the inconsistencies between the relationships of the different environmental performance measures and RI for platinum-mining companies, it can be concluded that it is inconclusive whether it pays to be green for platinum-mining companies and RI.

6.2.5. Economic value added

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.49 to 5.60 (Refer to Appendix A, page 136 to page 141), the following findings and conclusions can be made:

- A negative relationship between EVA and the different environmental performance measures was noted for gold-mining companies and coal-mining companies. It was found that gold- and coal-mining companies that performed poorly in terms of environmental performance, water emissions, energy consumption and CO₂ emissions, performed well in their EVA performance measure and companies that performed well in terms of their environmental performance, performed poorly in their EVA performance measure. The following was noted for gold-mining companies and coal-mining companies:

Environmental performance ↑	EVA ↓
Environmental performance ↓	EVA ↑

Therefore, it does not pay to be green for gold- and coal-mining companies in terms of EVA.

- A positive relationship between EVA and the different environmental performance measures was noted for platinum-mining companies with the exception of energy usage, which was negative. It was found that platinum-mining companies that performed well in terms of their environmental performance also performed well in their EVA performance measure. The following was noted for platinum-mining companies:

Environmental performance ↑	EVA ↑
Environmental performance ↓	EVA ↓

Therefore, it does pay to be green for platinum-mining companies in terms of EVA.

6.3. External economic performance measures

Paragraph 6.3 will summarise the findings between external economic performance measures and environmental performance and will also make conclusions on the findings.

6.3.1 Price-earnings ratio

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.61 to 5.72 (Refer to Appendix A, page 142 to page 147), the following findings and conclusions can be made:

- A negative relationship between P/E and the different environmental performance measures was noted for gold-mining companies. It was found that gold-mining companies that performed poorly in terms of environmental performance, water emissions, energy consumption and CO₂ emissions, performed well in their P/E performance measure and companies that performed well in terms of their environmental performance, performed poorly in their P/E performance measure. The following was noted for gold-mining companies:

Environmental performance ↑	P/E ratio ↓
Environmental performance ↓	P/E ratio ↑

This negative relationship implies that the market sees gold-mining companies that perform poorly in terms of their environmental performance and well in P/E as companies with high earnings growth and low risk. This also implies that the investors have more confidence and will rather invest in gold-mining companies that perform better in terms of P/E than in gold-mining companies that perform better in terms of environmental performance. Therefore, it does not pay to be green for gold-mining companies in terms of P/E.

- It is inconclusive whether a relationship exists between P/E and different environmental performance measures for platinum-mining companies. Therefore, it is inconclusive whether it pays to be green for platinum-mining companies in terms of P/E.
- It is inconclusive whether a relationship exists between P/E and environmental performance and energy usage for coal-mining companies. A positive relationship between P/E and water consumption and CO₂ emissions was noted. Because the relationship between P/E and environmental performance (which is the aggregation of water consumption, energy usage and CO₂ emissions) it was inclusive whether it pays to be green for coal-mining companies in terms of P/E.

6.3.2. Price-book value

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.73 to 5.84 (Refer to Appendix A, page 148 to page 153), the following findings and conclusions can be made:

- A positive relationship between P/B and the different environmental performance measures was noted for gold-, platinum- and coal-mining companies. It was found that gold-, platinum- and coal-mining companies that performed well in terms of their environmental performance also performed well in their P/B performance measure.

The following was noted for gold-mining companies, platinum-mining companies and coal-mining companies:

Environmental performance ↑	P/B Ratio ↑
Environmental performance ↓	P/B Ratio ↓

This positive relationship implies that investors expect management to create value from their capital with good environmental performance and little damage to the environment with high future prospects and low risk. Therefore, it does pay to be green for gold-, platinum- and coal-mining companies in terms of P/B.

6.3.3. Price-cash flow

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.85 to 5.96 (Refer to Appendix A, page 154 to page 159), the following findings and conclusions can be made:

- A negative relationship between P/CF and the different environmental performance measures was noted for gold-mining companies. However, it was inconclusive whether a relationship exists between P/CF and water consumption. It was found that gold-mining companies that performed poorly in terms of environmental performance, energy consumption and CO₂ emissions, performed well in their P/CF performance measure and companies that performed well in terms of their environmental performance, performed poorly in their P/CF performance measure. The following was noted for gold-mining companies:

Environmental performance ↑	Price/Cash flow ↓
Environmental performance ↓	Price/Cash flow ↑

This negative relationship implies that the market sees gold-mining companies that perform poorly in terms of their environmental performance and well in P/CF as companies with high earnings growth and low risk. This also implies that the

investors have more confidence and will rather invest in gold-mining companies that perform better in terms of P/CF than in gold-mining companies that perform better in terms of environmental performance. Therefore, it does not pay to be green for gold-mining companies in terms of P/CF.

- A positive relationship between P/CF and the different environmental performance measures was noted for platinum-mining companies. It was found that platinum-mining companies that performed well in terms of their environmental performance also performed well in their P/CF performance measure. The following was noted for platinum-mining companies:

Environmental performance ↑	Price/Cash flow ↑
Environmental performance ↓	Price/Cash flow ↓

This positive relationship implies that the market sees platinum-mining companies that perform well in terms of their environmental performance and well in P/CF as companies with high earnings growth and low risk. This also implies that the investors have confidence and will invest in platinum-mining companies that perform well in both P/CF and environmental performance. Therefore, it does pay to be green for platinum-mining companies in terms of P/CF.

- It is inconclusive whether a relationship exists between P/CF and environmental performance and energy usage and CO₂ emissions for coal-mining companies. A positive relationship between P/CF and water consumption was noted. Because the relationship between P/CF and environmental performance (which is the aggregation of water consumption, energy usage and CO₂ emissions) was inconclusive, it is also inclusive whether it pays to be green for coal-mining companies in terms of P/CF.

6.3.4. Earnings per share

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.97 to 5.108 (Refer to Appendix A, page 160 to page 165), the following findings and conclusions can be made:

- A negative relationship between EPS and the different environmental performance measures was noted for gold-mining companies. It was found that gold-mining companies that performed poorly in terms of environmental performance, water consumption, energy consumption and CO₂ emissions, performed well in their EPS performance measure and companies that performed well in terms of their environmental performance, performed poorly in their EPS performance measure. The following was noted for gold-mining companies:

Environmental performance ↑	EPS ↓
Environmental performance ↓	EPS ↑

Therefore, it does not pay to be green for gold-mining companies in terms of EPS.

- It is inconclusive whether a relationship exists between EPS and environmental performance and CO₂ emissions for platinum-mining companies. A positive relationship between EPS and water consumption was noted and a negative relationship between EPS and energy usage was also noted. Because the relationship between EPS and environmental performance (which is the aggregation of water consumption, energy usage and CO₂ emissions) was inconclusive, it is also inclusive whether it pays to be green for coal-mining companies in terms of EPS.
- A negative relationship exists between EPS and environmental performance, energy usage and CO₂ emissions for coal-mining companies. A positive relationship between EPS and water consumption was noted for coal-mining companies. It was found that coal-mining companies that performed poorly in terms of environmental performance, energy consumption and CO₂ emissions, performed well in their EPS performance measure and companies that performed well in terms of their environmental performance, performed poorly in their EPS performance measure. The following was noted for coal-mining companies:

Environmental performance ↑	EPS ↓
Environmental performance ↓	EPS ↑

Therefore, it does not pay to be green for coal-mining companies in terms of EPS.

6.3.5. Earnings yield

After analysing Table 5.11 (refer paragraph 5.6, page 82) and Figures 5.109 to 5.120 (Refer to Appendix A, page 166 to page 171), the following findings and conclusions can be made:

- A negative relationship between EY and the different environmental performance measures was noted for gold- and platinum-mining companies. It was found that gold- and platinum-mining companies that performed poorly in terms of environmental performance, water consumption, energy consumption and CO₂ emissions, performed well in their EY performance measure and companies that performed well in terms of their environmental performance, performed poorly in their EY performance measure. The following was noted for gold-mining companies and platinum-mining companies:

Environmental performance ↑	Earnings yield ↓
Environmental performance ↓	Earnings yield ↑

Therefore, it does not pay to be green for gold- and platinum-mining companies in terms of EY.

- A positive relationship between EY and the different environmental performance measures was noted for coal-mining companies, with the exception of water consumption, where a positive relationship was noted. It was found that coal-mining companies that performed well in terms of their environmental performance, also performed well in their EY performance measure. The following was noted for coal-mining companies:

Environmental performance ↑	Earnings yield ↑
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Environmental performance ↓

Earnings yield ↓

A conclusion can be made that if coal-mining companies invest in preserving the environment and invest in performing well on their environmental performance, they will also perform well on their EY performance measure. This also implies that the investors have confidence and will invest in coal-mining companies that perform well in both EY and environmental performance. Therefore, it does pay to be green for coal-mining companies in terms of EY.

6.4. Conclusion for internal and external performance measures

In paragraph 6.2 (refer page 87 to 92) and paragraph 6.3 (refer page 92 to 98) the relationships between the internal and external economic performance measures with environmental performance were discussed. The following were noted:

- For gold-mining companies
 - A positive relationship was noted for 1 of the 10 relationships tested.
 - Negative relationships were noted for 9 of the 10 relationships tested.
- For platinum-mining companies
 - Positive relationships were noted for 3 of the 10 relationships tested.
 - Negative relationships were noted for 4 of the 10 relationships tested.
 - It was inconclusive whether relationships existed for 3 of the 10 relationships tested.
- For coal-mining companies
 - Positive relationships were noted for 5 of the 10 relationships tested.
 - Negative relationships were noted for 3 of the 10 relationships tested.
 - It was inconclusive whether relationships existed for 2 of the 10 relationships tested.

The following conclusions can be made:

- It does not pay to be green for gold-mining companies.
- It does not pay to be green for platinum-mining companies.

- It pays to be green for coal-mining companies.

Therefore, the null hypothesis is not rejected for gold-mining companies and platinum-mining companies and the null hypothesis is rejected for coal-mining companies (refer to page 5).

6.5. Opportunities to improve both a company's environmental performance and economic performance

The opportunities to improve both a company's environmental performance and economic performance were discussed in Chapter 2 (refer page 10) and Chapter 3 (refer page 25). Sustainable development and environmental management accounting was discussed in Chapter 2, and Chapter 3 discussed the risks and opportunities of climate change.

Chapter 2 shows that environmental management accounting is essential to identify and effectively manage environmental costs and then to make strategic decisions to improve environmental performance. Environmental issues and legislations grew in recent years and the range of decisions affected by environmental issues has also increased, thus environmental management accounting's role has also increased in all management activities. Environmental management accounting is a very important tool to help companies improve their environmental performance and to implement cost effective and environmentally friendly programmes for ensuring a company's long-term strategic position.

Climate change will have a very big impact on the economy and on the mining industry, as discussed in Chapter 3. This chapter shows that it is not just important to improve a company's environmental performance because it makes business sense, but that it is also important to improve environmental performance to help minimise the effects that climate change will have on life on earth. Despite all the risks and challenges facing the mining industry, there are a lot of opportunities to improve economic performance and

environmental performance within the mining industry (refer to paragraph 3.6, page 37). Some opportunities include emissions trading, developing new technologies, investing in projects in renewable energy and an increase in demand of mining products.

6.6. Practical implications

This study will add value to mining companies by identifying opportunities to improve both environmental performance as well as economic performance. Companies in the mining industry as well as investors can use the findings presented in this study to realise the importance of preserving the environment as well as the importance of triple bottom line accounting. This study also shows how management can use environmental management accounting systems to reduce environmental costs and use the information from these systems for better decision-making to improve both environmental performance and economic performance.

Management of mining companies, where a negative relationship was noted between environmental performance and internal economic performance measures, should realise that they are making money at the expense of the environment and should act more responsibly in terms of preserving the environment.

Mining companies, where a positive relationship was noted between environmental performance and internal economic performance measures, should be used as a benchmark by other companies to improve their environmental performance. Further research must be done to determine the reason behind their success and these controls should be adopted by other companies to also improve their environmental performances.

Investors of mining companies where a negative relationship was noted between environmental performance and external economic performance measures should be made more aware of the impact their investment decisions have on the environment and investors should be made more aware of triple bottom line accounting that takes into account not just financial performance but also social/ethical performance and

environmental performance. These investors should follow the investors who invest in companies with good environmental performance and that look after the environment.

6.7. Value of the study

This study is unique as it is the first study to investigate the relationship between environmental performance and economic performance in the South African mining industry. This study is also unique as it takes into account how investors see the company in terms of environmental performance. This study uses economic performance measures from an internal and external point of view and not merely from an internal point of view like the previous studies.

6.8. Limitations of the study

There are a few limitations of the study that restricted the scope and in turn affected the outcomes of the study.

- Limited data was available due to limited mining companies that reported on environmental-related issues prior to 2005. If more mining companies reported on their environmental performance, the sample size would have been bigger and better testing could have been done to test the relationship between environmental performance and economic performance.
- Only the market leaders in the mining industry reported on their environmental performance and the smaller players did not report on their environmental performance.
- Environmental performance and economic performance measures are industry and mineral specific (see paragraph 5.2, page 62).
- Possible double counting may have taken place with the analysis of Anglo American/Anglo Coal's external economic performance measures when coal mining companies were tested. The reason is that Anglo Coal is not listed on the JSE Limited

and thus no external economic performance measures are available. Anglo American's external economic performance measures were used to test Anglo Coal's external economic performance measures, as Anglo Coal is a subsidiary of Anglo American. It should also be noted that BHP Billiton and Exxaro is diversified natural resources companies and that data from their coal mining operations were used to test environmental performance.

6.9. Further studies

- Further research must be done to determine the reason why some companies have a positive relationship between economic performance and environmental performance and others not.
- Further research can also be done to determine why some companies' environmental performance is better than others.
- Further research can be done to improve environmental management accounting and how environmental management accounting can help management to improve both economic performance and environmental performance.
- Since more companies report on environmental performance, this study can be extended to include more time periods to mathematically explain the relationship between environmental performance and economic performance using scatter plot diagrams or the simple linear regression model. Hence, making the study more scientific.

6.10. Final conclusion

The main objective of this mini-dissertation was reached where it was concluded that it pays to be green for coal-mining companies, but not necessarily for gold- and platinum-mining companies. The null hypothesis was not rejected for gold-mining companies and platinum-mining companies, but was rejected for coal-mining companies. The secondary objective of this mini-dissertation was also reached, where it was concluded that

environmental management accounting is essential to identify and effectively manage environmental costs and then to make strategic decisions to improve environmental performance. Some opportunities to improve a company's environmental performance and economic performance include emissions trading, development of new technologies, investing in projects in renewable energy and an increase in demand for mining products due to the effects of climate change.

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