CARBON RISK ANALYSIS OF THE SOUTH AFRICAN BANKS' LENDING TO THE JSE100 CDP COMPANIES

Alfred Bimha *

Abstract

There is a pertinent concern over the continued lending to companies that are still pursuing projects that increase the amount of carbon emissions in the atmosphere. South Africa has most of its energy generation being done through coal thermal powered turbines. More so there are a number of new power stations being built in South Africa that are coal powered. Coal on the other hand is deemed as having the highest amount of carbon that contributes to the greenhouse effect which in turn affects the climate leading to climate change consequences. There is also a growing concern on the uptake of renewable energy initiatives by companies that are deemed carbon intensive. Banks are being castigated for not using their economic transformation role to champion the agenda of combating climate change caused by carbon emissions. In this study, the extent of lending in the short and long term to carbon intensive companies by South African banks is examined. Using a sample of the Johannesburg Stock Exchange top 100 companies that participate in Carbon Disclosure Project, an analysis is done through four carbon metrics –carbon intensity, carbon dependency, carbon exposure, carbon risk. The analysis used public information from the banks' websites, South African Reserve Bank reports and other public databases that contain sustainability information of the JSE100 companies. The analysis was done by comparing the carbon metrics of the recognized seven (7) sectorial industry catergories (SIC) on the JSE, mainly Energy & Materials, Industrials, Consumer Staples, Consumer Discretionary, Financials, IT & Telecoms and Health Care. The major finding of the research is that there is a high carbon risk in short term loans compared to long term loans across the JSE100 companies that are analysed. More so, the Energy & Materials sector seem to have the highest carbon risk compared to the other sectors.

Keywords: Carbon Risk, Carbon Emissions, JSE100, South Africa, Carbon Disclosure Project

JEL Classification: G10, P28, Q50

**Senior Lecturer, Department of Finance, Banking and Risk Management, University of South Africa, P O Box 392, UNISA, 0003*

1. Introduction

The current global climate change crisis cannot be detached from the economic activities in the sense of consumerism and materialism. The world is in an age of advanced technological processes of production and a booming population base that is straining the finite natural resources. Population growth is being projected to extinguish the current finite natural resources and will leave nothing for the future generations to survive on. Anthropogenic activities underpinned by economic and productive activities have exerted an unprecedented strain on the environment. The Stern Report (2008) indicates that a continued "business as usual" is not warranted in this day and age since no one can predict the consequences of climate change with great certainty. The report goes on to emphasize the importance of investing in mitigating climate change impacts today in preventing a bleak future for the coming generations of this earth. Since economic activities are being deemed as the main factor greatly causing climate change, an increased concern of the intermediary role of banking institutions in economic systems in influencing climate change has risen.

A number of environmental lobby groups have raised concern of how banks have contributed to the increased destruction of the environment which in turn leads to climate change consequences. The lobby groups that are at the forefront of raising this awareness are Friends of the Earth, World Resources International (WRI), Ceres, Banktrack, Trucost, Profundo and Rainforest Action Network (RAN). The main issue relates to banking institutions not adequately concerned about the economic and industrial activities they are financing using depositors funds. Some of these economic activities are destructive to the environment and the climate as well. Under the literature review section, an extensive list of initiatives by these environmental lobby groups is

provided. However, the underlying measure of how banks are contributing to the climate change crisis that the lobbyists are using is carbon emissions. Banktrack & Rainforest (2012) have termed the measurement of loans and investments banks have made towards projects and companies that emit large amounts of greenhouse gas (GHG) which are also termed as carbon emissions (CO_2e) as financed emissions. Schucking et.al (2013) in their study found out that banks have increased financing to coal mining by 397% from 2005 to 2012. The year 2005 is significant in that this is the year where the International policy agreement was signed to reduce carbon emissions and avert current adverse climate impacts and the forecasted ones.

A brief synopsis of climate change and its consequences will be essential to understanding its relation to banking activities. Scientific studies have indicated that if the current rise in greenhouse gas is unchecked this will lead to a rise in global temperatures by 6.4^{o}C and this has devastating consequences for people and the planet. The sources of greenhouse gas caused by human activities on a global level are broken down as follows – (1) energy supply 26%; Industry 19%; land use, land –use change and forestry 17%; agriculture 14%; transportation 13%; commercial and residential buildings 8%; and finally waste and wastewater 3%. (Intergovernmental Panel on Climate Change (Barker et.al), 2007, page 29). For these GHG caused by the human activities, 50% goes to the atmosphere, 26% to the land and 24% to the ocean (Le Quere et.al, 2009). The 50% that goes to the atmosphere produces a greenhouse effect that leads to increased earth surface temperatures that affect the climate. The climate change consequences are extreme weather conditions like erratic rain, excessive rain, drought and floods. Most banking institutions are involved in the financing of these activities and this raises the importance of measuring the level of contribution banks are making in the increase of GHG emissions.

This study embarks on a South African contextualized methodology to measure the financed emissions of local South banks on an aggregated basis. The aggregate level will be suitable to set a bench mark that will assist banks in rating themselves amongst their peers in being environmentally conscious in their lending and investment decisions. Banks are being regarded as carbon-neutral – a term to mean they are non-carbon emitters- however their contribution to carbon emitting projects and companies is underestimated and unraveled enough. The South African banking sector will also be affected with the coming carbon tax in 2016 being legislated by the South African Government which will affect their lending portfolios if they have a high concentration of high carbon emitting companies. Therefore this study will contribute to the assortment of lending tools that banks can use to mitigate the quantitative risk of carbon. More so, environmentally conscious investors will be able to choose carbon-sensitive companies using this tool.

2. Literature review

2.1 Theoretical Concepts in Climate Finance

Richardson (2014) indicates that the financial sector is crucial in issues of international and national climate governance. Richardson further defines climate finance as the role of financial institutions in addressing climate change through investment transactions, identifying and measuring the financial risks in climate change impacts and, encouraging investments in clean and green energy. Falconer and Stadelmann (2014), however define climate finance as financial resources paid to cover costs of transitioning to a low global economy and to adapt to, or build resilience against, current and future climate change impacts. Gerardi, Grandjean and Martinez (2015) agree with Richardson that the financial sector is crucial in facilitating the transition from high carbon based economies to low carbon based economies. Gerardi et.al also reiterates the importance of the financial sector having methods and tools to estimate greenhouse gases (direct and indirect) in order for them to understand and manage the exposure and opportunities present in the climate change impacts to their business. There is a required prioritization of quantifying financed emissions which are indirect greenhouse gas from the financial sector's view. Thus the theory being pursued in this study is one of financed emissions and the carbon foot printing of loans as well as loan portfolios of banks. Financed emissions concept is basically the notion that though banks have no direct causation of carbon emission they are the catalyst. This is premised on banks having high loan exposures in high carbon emitting companies. The high carbon emitting companies are energy and utilities companies, mining companies, oil and gas companies and manufacturing companies. Therefore in this section the theory and issues motivating the need to measuring carbon emissions in bank loan portfolios and current methods being pursued to measure carbon emissions in loans and loan portfolios by banks are explored.

Besides the concepts of financed emissions and climate finance explained in the previous paragraph, there are a couple of concepts connected to this study and found in literature these are: carbon principles, equator principles, green lending, carbon finance and environmental finance. Longroy and Glaze (2011) envisages green lending in the form of banks considering energy-sectors borrower's greenhouse gases when making loans. The bedrock of the green lending concept is viewed as the "Carbon Principles". These principles were created by a consortium of major international banks and it is mainly guidelines of evaluating and managing the risk of financing

electric power projects in an environmentally responsible and cost-effective manner. Under the carbon principles an Enhanced Environmental Diligence Process has been developed to assess projects based on (1) Energy efficiency, (2) Renewable and low carbon energy technologies and (3) Conventional or advanced energy generation. With energy efficiency banks will motivate that their clients invest in systems that improve efficiency in electrical consumption. With regards to renewable and low carbon energy technologies, the banks will show intent to their client of investing and lending in renewable energy and low-carbon emitting technologies. Lastly, in the third item, banks still strike a balance by continuing to finance conventional energy generation projects for transition-sake to low carbon technologies.

Carbon finance involves the establishment of carbon markets through making greenhouse gas reductions projects commodities that can be tradable (Button, 2008). Therefore the emission reductions should be measured and verified before they can be sold as carbon credits. The most prominent carbon markets currently are the EU Emissions Trading Scheme, Chicago Climate Exchange, and New South Wales Greenhouse Gas Abatement Scheme (GGAS). Carbon finance can be explained as the exploration of financial implications of living in a carbon constrained world in which greenhouse gas and carbon emissions carry a price. Labatt and White (2009) indicate that carbon finance is a branch of environmental finance. Equator principles are a set of standards for assessing and managing social and environmental risks in project finance whilst the carbon principles focus on lending and investment processes of banks. However the concepts reviewed here tend to be mixed up and an extensive study is required to clearly understand the relationships and interactions between them. However Carbon finance, environmental finance and climate finance have been devised to counteract in a broader sense the implications of financed emissions.

2.2 State of Financed Emissions by Banks

There is a growing concern amongst the policy makers and the environmentalists with the amount of financed emissions particularly being done by banks. In table 1, a compilation of studies that have revealed the amount of carbon emissions and the monetary equivalent caused by banks is shown.

Table 1. Studies on Financed Emissions

Study Done by	Bank Understudy	Country	Year	Reported Carbon Emissions in Loans (tons CO2e)	Total Carbon emissions financing	Sector from which carbon emissions have been measured
World Development Movement	Royal Bank of Scotland	Scotland	2012	911,000,000	£131,000,000,000	Energy
Rain Forest Action Network.	Royal Bank of Canada	Canada	2007	198,000,000	$50,500,000,000	Energy – Fossil Fuels
Rain Forest Action Network.	Scotiabank	Canada	2007	87,000,000	$19,800,000,000	Energy – Fossil Fuels
Rain Forest Action Network.	TD Bank	Canada	2007	124,000,000	$27,700,000,000	Energy – Fossil Fuels
Rain Forest Action Network.	CIBC	Canada	2007	101,000,000	$27,000,000,000	Energy – Fossil Fuels
Rain Forest Action Network.	BMO	Canada	2007	97,000,000	$30,300,000,000	
Bank of America Sustainability Report for 2006	Bank of America	USA	2007	765,000,000	-	Utility Companies

From the few studies cited in table 1 it is possible to see the importance of analyzing the bank lending and investment portfolios that contain high carbon emitting companies. Schucking (2013) indicates that since the inception of the Kyoto Protocol in 2005, major international banks have nearly doubled their funding of the coal industry. The coal industry is deemed as the largest source of carbon emissions. Another study done by Rainforest Action Network, BankTrack and Sierra Club (2013) shows the amounts and the banks who have the highest bank lending and underwriting business to coal powered power stations. The results of this study are shown in table 2 with the top ten banks in financing coal fired power stations being led by Citigroup. A simple comparison of table 1 and 2 shows that it is more meaningful to measure the impact of bank's lending on climate change by relating the amount loaned against carbon emissions produced.

Table 2. Top Ten Coal Fired Power Lenders and Underwriters -2013

Underwriter	Rank	Market share	Amount (Millions)
Citigroup	1	23.6%	$6,545
Barclays	2	10.2%	$2,799
Royal Bank of Scotland	3	8.5%	$2,313
Credit Suisse	4	8.4%	$2,301
JPMorgan Chase	5	7.9%	$2,149
Wells Fargo	6	6.8%	$1,863
Bank of America	7	6.7%	$1,828
Morgan Stanley	8	6.0%	$1,639
Mitsubishi UFJ Financial	9	4.8%	$1,304
UBS	10	3.1%	$853

Adapted from: BankTrack, RAN, Sierra Club (2014)

2.3 Methods of Carbon foot printing Bank Loans

Carbon foot printing is a process of measuring and accounting for greenhouse gases which have a potential of causing global warming. Carbon footprinting is a process which stems from the Life Cycle Analysis (LCA) concept (Weidema et.al, 2008). The LCA concept speaks of the origination of a product, to its manufacture up to its consumption and consummation. It is the LCA which lays a foundation for all carbon footprinting standards (Weidamann and Minx, 2007). Thus carbon footprinting is measuring of the carbon emissions quantities produced in the life cycle of a product in terms of greenhouse gas (GHG) equivalents as stipulated in the Kyoto Protocol. Using the LCA concept, Ritchie and Dowlatabadi (2014) developed the Shadow Impact Calculator based on the economic input-output life cycle assessements (EIO-LCA) as a tool to examine broader impacts of investments decisions. The notion behind this tool is that an investment portfolio's indirect impacts represent the economic, social and environmental effects underlying an investor's decisions to place their funds in particular financial instruments. In this study by Ritchie and Dowlatabadi, greenhouse gases are used as a proxy to show which sectors of the United States economy have large or small carbon shadows and the results are interpreted in conjunction with volatility and earnings.

There is still a growing trend in the carbon footprinting of banking products and a lot of standards and concepts are being developed. Studies that have been done so far range from simple carbon footprinting of bank account to complex carbon footprinting of loan and investment portfolios. Most of the independent studies have been done by Environmental NGOs (Non-Governmental Organisations) with other studies being an engagement of banking institutions and experts in carbon footprinting. An analysis of the current carbon footprinting methods in table 3 which have been adapted from Nielsen et.al (2009) indicate that there is a common consensus to carbon footprinting of bank products. The most common foot printing is of loans and project finance with one study being done on retail banking products that is by Utopies. The Utopies project looked at carbon labeling of bank products which involved the forecasting of how much a savings account, loan account and an insurance product held by a bank can result in a financing of a highly carbon intensive project. In such a way the customers of banks would be able to choose a loan or savings account whose carbon label is low meaning the money will be used to finance low carbon activities. However the rest of the projects cited by Nielsen et.al indicate the measuring of loan and equity portfolios held by banks or financing enterprises and how much of those funds have sponsored highly carbon emitting activities (coal extraction, mining, gas and oil extraction and processing). Most of these methods use the GHG protocol Scope 1, 2 and 3 when quantifying emissions in their calculations.

The study by Rainforest Action Network (RAN) and BankTrack (2012) suggested the following three formulas for calculating financed emissions by banks at a portfolio level for project-specific lending, project finance, general corporate lending and debt underwriting:

1. Annual financed emissions from a bank's general corporate lending = ∑ for all outstanding loans (Annual emissions of investee x percent of total debt and equity capital of investee held by the bank)
2. Annual financed emissions from a bank's project finance = ∑ for all underwriting transactions (Annual emissions of project x Bank's percentage share of the project's financing)
3. Annual financed emissions from a bank's debt underwriting = ∑for all underwriting transactions (Annual emissions of underwriting client x percent of client's total debt and equity capital underwritten by the bank)

These calculations are mainly based on the scope 3 emissions of the bank. In the GHG protocol the Scope 1 and 2 mainly looks at the direct emissions caused by a company and then scope 3 is a category for emissions caused indirectly by the firm. On

applying these formulas the study found out that most American banks were many times more than the stated scope 3 emissions in their Sustainability reports. Therefore from the above analysis this far there are more studies that have been done in carbon footprinting financed emissions at bank product portfolio level than per bank product or service.

2.4 Measurement of Carbon Risk

Carbon risk emanates from the Kyoto protocol that came in force in 2005. The Kyoto Protocol is thus far an important agreement on Greenhouse gases. There are many angles of defining carbon risk, with mainly the establishment of a European Union Emissions Trading Scheme (EU ETS) in order for countries that are signatory to the Kyoto Protocol International agreement to be compliant with the protocol. There are many ways of measuring carbon risk that have been proposed so far. Hoffman and Busch (2008) have recommended conceptual analysis of carbon performance after reviewing existing indicators and metrics. They recommend four indicators that capture physical and financial aspects of carbon performance for a firm – carbon intensity, carbon dependency, carbon exposure and carbon risk. Carbon intensity relates to carbon usage to business performance and this is calculated as the firm's carbon usage for the year divided by a financial metric, for example, sales, for the same time period. Carbon dependency is the change in a company's use of carbon (intensity) over a given period, expressed as a percentage. Carbon exposure is the financial implications of carbon use for a given time period and relates a company carbon costs to another financial metric, for example, sales. Carbon risk is the change in monetary carbon performance over a given period expressed percentage. These recommended indicators are essential in comparing carbon performance amongst industry peers, however if integrated in bank credit analysis they will prove useful. More so, Hoffmann & Busch (2008) view carbon risk into monetary terms and define the reduction of carbon reduction costs as an indicator of a company successfully managing their carbon risk.

Serrano Marin (2013) proposes a multi-factor model in measuring carbon risk in the energy markets of Poland. A two factor model is proposed underpinned by assumptions of (1) companies participating in the EU ETS and so not have free access to free allocation allowances[6], (2) carbon risk is treated as systematic risk and (3) companies operating EU ETS regulations have no ability to pass cost of carbon emissions to customers. The two factor model is based on the premise that by carbon risk to the cost of equity, investors and managers will be able to incorporate carbon risk when making investment valuations and setting asset prices by considering a high premium for high-emitting companies and lower risk premium for low emitting companies. The main results of the method used by Marin indicated that the companies sampled where not affected by carbon risk, carbon emissions did represent a source of risk for these companies and there was no evidence of carbon risk being of material effect on the investment decisions of these companies.

Remco et.al (2013), recommend a portfolio approach in measuring carbon risk for investment portfolios of banks. They postulate that the carbon risk exposure of a company is made up of external and internal factors and these have been presented in table 4 below.

Remco et.al emphasize how for banks it is important to expand the measurement of GHG emissions in their indirect downstream activities which include loans and investments and is under scope 3 in the GHG protocol for carbon footprinting[7]. They even suggest a scope 4 to the method of carbon foot printing or accounting and reporting of GHG emissions. The reason to this stems from that the carbon foot printing process is mainly retrospective and not futuristic. Therefore a comparison of fossil fuel reserves to carbon budgets has revealed a contradiction presently in the financial markets between existing carbon assets (fossil fuels) and potential emissions constraints to those assets. Thus a need is there to know the current fossil fuel reserves and their potential future GHG emissions so as to ensure that banks have a futuristic dimension in the quantification of GHG emissions. Remco et.al suggests the assessing of carbon risk at two different levels, (1) at the individual investee company level and (2) at the investment portfolio level. The carbon risk exposure of an investment portfolio is expressed as the weighted mean of the carbon risk exposures of the single positions within the portfolio. In terms of equity or corporate loan portfolios, this is the weighted mean of the carbon risk exposures of the investee companies in the portfolio. Each company's carbon risk exposure is a function of the external factors and internal factors that it faces as described in table 4. However the main disadvantage of measuring carbon risk at portfolio level is that the carbon footprint data is aggregated from company to the portfolio level. This renders the unique data that links the company specifically to its external and internal factors of carbon risk exposure being lost and making the portfolio carbon risk exposure inaccurate.

[6] European Union allowances (EUA´s) represent the rights to emit one metric ton of CO_2 equivalent granted under the EU ETS (CO_2 e).

[7] See the section titled "Methods of Carbon footprinting of Bank Loans" for full explanation of Carbon footprinting using the GHG Protocol scopes 1,2 and 3

Table 3. Financed Emissions Methodologies

Developing Organisation	Trucost	Profundo	Platform	Utopies	CenSA	PACE	Ecofys
Developed for	Fund managers and investors	Milieudefensie/ General public	Various NGOs	Caisse d'Épargne	Highlands and Islands Enterprise (HIE)	OPIC	Rabobank Group
Financial Products covered (financial boundaries)	Equity share holding of UK Investment Funds and Trusts	Corporate loans, project finance, investment banking services, asset management provided by Dutch banks to oil, gas and coal extraction (mining) companies	Project finance provided to oil and gas extraction companies	Savings, insurance and loans; both private and business	Loans, equity investment, or, in some cases, capital grants provided to all kind of activities	Project finance for projects with emission profile of up and above estimated 100 kton CO2/yr	Credit loan book
Way of attributing emissions to financial products	Proportional to equity share in companies in investment and trust funds	Proportional to equity and debt share regarding all financial products provided to oil, gas and coal exploitation companies	Proportional to share of project finance provided to oil, gas exploitation companies	Proportional to financial loans provided to consumers or business	Average emission intensity per sector which receive financial support	All projected missions above 100 ktonnes are allocated to OPIC	Two ways: Proportional to share of credit loans in different sectors Proportional to loans provided to 100 largest customers;
Emission Scopes of companies that receive finance (Scope 1, 2 or 3)[8]	Scope 1 and 2, First Tier Scope 3	Scope 3 of fossil fuels produced	Scope 3 of fossil fuel produced	Scope 1, 2 and 3	Scope 1, 2 and 3	Scope 1	Scope 1 and 2
Type of Emissions included	All Kyoto gasses are included	Limited to CO2	Limited to CO2	All Kyoto gasses are included	Limited to CO2	Both CO2 and CH4	All Kyoto gasses are included

[8] *Scope's according to the GHG-protocol (WRI, 2009).*

Materiality, thresholds:	.						
Emissions attributed to the financial products	No threshold for emissions	Emissions from burning fossil fuels produced by oil, gas and coal producers	Emissions from burning fossil fuels produced by oil, gas and coal producers	Scope 3 only if significant compared to scope 1 and 2 emissions; scope 3 must be measurable	"Larger" investments.	Projects above 100 ktonnes;	No threshold for emissions
Financial threshold	No threshold for volume of financial transaction	no financial threshold	no financial threshold	financial risk tied to product or activity.		no financial threshold	financial threshold (top 100 customers) for bottom-up approach
Time frame for financial transaction	Not mentioned	Corporate loans and project finance provided over period 2004-2006, shareholdings at the end of 2006.	Project finance of last 3 years	1 year	2007/2008	1 year	Not explicitly mentioned
Information sources	Trucost-Databases	Financial information from Dutch banks, emission figures derived from publicly available data on fossil fuel production volumes	Financial information from RBS, emission figures derived from publicly available data on fossil fuel production volumes	Environmental reports for Scope 1 and 2; sectoral environmental input/output data analyses for Scope 3	Financial data with respect to activities of HIE; emission data from sectoral input/output analysis	OPIC Project information	Balance Sheet accounts of sectors and companies; Emission accounts of geographical regions and companies; Credit loans to sectors and companies of researched bank
Normative references	Kyoto, IPCC	Not used	Not available	GHG-protocol, ISO14040	Not available	GHG-protocol	GHG-protocol
Verification	Internal	Not used	Not used	Not used	Not used	First party	Not used

Table 4. Carbon Risk Exposure Factors of a Company

	External Factors	Internal Factors
Primary Factors	• Carbon-focused policies • Carbon-focused regulations • Carbon focused sanctions and incentives	• GHG Emissions of Company's Activities & Business Model – Carbon foot print or emissions inventory of a company • GHG emissions over time or business period
Secondary Factors	• Level of sensitivity of clients, of consumers and the public in general.	

Venugopal, Ridgon and Daviet (2009) propose methods for carbon footprinting indirect carbon emissions of banks proprietary investments. They propose banks to use an equity share approach to capture emissions from relevant bank investments. Further, Venugopal et.al advocate for a measurement of indirect relevant emissions which result from debt and equity investments, other products, services and financial contracts that banks have made. For the equity approach, Venugopal et.al agree with Remco et.al for banks to quantify the emissions of their investee. The proprietary investments are made by a bank using its own capital and balance sheet as opposed to investments managed on its behalf by its clients, using their capital. These proprietary investments should be equity investments that are financial material in which the company holds influence or control over the emitting company that are held for longer than 1 year. So in this case a bank can use an equity approach or a proportional share that is by percentage ownership of the investee's GHG emissions as investor's emissions. Thus in a nutshell, Venugopal et.al propose the the Bank's Scope 3 in GHG Protocol Accounting Report should include, (1) Minor equity investments defined as investments over which the investor has no significant influence or control or that have been held less than one year, (2) Corporate debt holdings, including corporate debt instruments (such as bonds or convertible bonds prior to conversion) or commercial loans and (3) Other debt holdings or financial contracts, for example, securitized products, insurance contracts, credit default swaps and other financial contracts. In figure 1, the summary of business area or products and services that should be incorporated by banks when calculating their indirect GHG emissions is presented.

3. Methodology

The research used the JSE100 companies as the sample for the analysis. The JSE 100 are the top 100 companies on the Johannesburg Stock Exchange in South Africa by market capitalization. These are targeted annually to participate in a survey by the Carbon Disclosure Project to answer survey questions on climate change issues that affect their business operations. Data for the long term and short term loans of the JSE100 companies was collected from the McGregor BFA database as well as from the annual reports of these companies. The carbon emissions of the JSE 100 companies were collected from the CDP reports published annually by the Carbon Disclosure Project South Africa. The data for long term loans, short term loans and carbon emissions was collected from 2010 to 2014.

The study has adopted the carbon performance indicators as presented by Hoffmann and Busch (2008) in constructing a Carbon Risk Index. First of all the carbon performance indicators for each company were calculated following the carbon performance indicators proposed by Hoffman and Busch. Secondly, the companies were grouped by sector and then the carbon performance indicators were aggregated as per each sector. There were seven sectors that were used for this study which are Energy & Materials, Industrials, Consumer Staples, Consumer Discretionary, Financials, IT & Telecoms and Health Care. The last step was to construct a Carbon risk index for each sector with 2010 being the base year. Table 5 explains the proposed business metrics relevant for measuring carbon performance indicators to be used in constructing a Carbon risk index of the JSE100 companies.

Figure 1. Accounting and Measuring Carbon Emissions in Banking Products and Services

First, Choose organisational boundary approach – any bank institution that holds significant amount of equity investments should use the equity approach

PROPRIETARY INVESTMENTS

1 **Equity or Shareholding with influence or financial control or held for > 1 year**

⇩

If using ***equity share*** approach, then report under scope 1 and scope 2 emissions proportional to equity stake or shareholding proportion
If ***control*** approach is used, report 100% ***relevant**** emissions under scope 3

2 **Equity Stakes with no influence** **Corporate Debt (Loans)** **Other: Insurance, Credit Guarantees, Contracts**

⇩

Report relevant emission under Scope 3 regardless of organisational boundary approach, proportion to depends on organisational boundary approach

MANAGED INVESTMENTS AND CLIENT SERVICES

3

Managed Equity or Debt Funds	**Corporate Underwriting/Issuance**	**Financial Advisory (e.g., Mergers and Acquisitions)**
⇩	⇩	⇩
Build separate GHG inventories for funds; equity share approach is appropriate for equity-focused funds; report in fund documents	Encourage clients to report GHG inventory in prospectuses and other disclosure	Encourage clients to consider GHG inventory in mergers, acquisitions and other decisions

Note: * Please refer to the Corporate Standard and Section IV for additional information on the principle of relevance

Source: World Resources Institute, Venugopal et.al (2009), Author

Table 5. Explanation of Carbon Performance Metrics

Business Metric	Description
Unit of Production	Business Output in physical units; no consideration in monetary units
Long term loans	Loans taken for more than one year which are interest bearing and contributed to the emissions accruing to the company
Short term loans	Loans taken for less than one year which are interest bearing contributed to the emissions accruing to the company

The following base model for corporate carbon performance indicators as proposed by Hoffmann and Busch (2008) is used:

	Static Approach	***Dynamic Approach***
Physical Units	Carbon Intensity	Carbon Dependency
Monetary Units	Carbon Exposure	Carbon Risk

Carbon intensity is defined as a company's physical carbon performance and describes the extent to which its business activities are derived from carbon usage for a defined scope and fiscal year. Therefore the carbon intensity is measured by the ratio of a company's gross carbon fuel usage to a business metric. Carbon usage is the measured carbon emissions by the company in a defined scope as per GHG protocol measure and the financial year. The business metric can be a financial performance measure for the company like sales or cost of sales in our case. In this study a combined carbon input intensity and carbon output intensity will be done. The carbon output intensity formula to be used is ;

$$C_{I-O}In_{i,t} = \frac{\sum_{k=1}^{K_{I-O}} K_{I-O_k,t}}{BM} \quad (1)$$

Where;

C_{I-O} is the carbon inputs and outputs in tons of carbon for inputs and GHG emissions for the output

k =1,…, K_{I-O} is the index for the K_{I-O} different inputs and outputs of carbon sources

t is the physical year of analysis

i is your scope 1,2 and 3 emissions

Carbon dependency is the change in the company's physical carbon performance within a given time period. The indicator is measured as the company's physical relative performance change from the current state to the projected carbon intensity. A company's carbon dependency indicates what percentage of the current state (t_o) carbon intensity will remain assuming that the company will continue to operate under the conditions that will give the projected carbon intensity at (t_1). Therefore carbon dependency is the degree at which the company can reduce its carbon intensity. Given the same scope i = 1,2,3 for both carbon intensities (t_o and t_1), the carbon dependency CDe is expressed as a percentage of the t_o carbon intensity for the time period $\Delta t = t_1 - t_0$.

$$C_{I-O}D_{ei,\Delta t} = \frac{C_{I-O}In_{i,t_1}}{C_{I-O}In_{i,t_0}} \times 100 \quad (2)$$

Carbon exposure relates to a company's monetary carbon performance and describes the monetary implications of the business activities due to carbon usage for a defined scope and fiscal year. The exposure is determined using a ratio which relates the carbon usage in monetary terms to a defined or chosen business metric. Through the use of prices , the carbon input intensity and carbon output intensity ratios are combined into one monetary figure which is the carbon exposure. On the basis of equation (1), a company's carbon exposure (CEx) can be derived for a financial year t;

$$CEx_{i,t} = \frac{\sum_{k=1}^{K_{I-O}} C_{I-O_k,t} \times p_{I-O_k,t}}{BM} \quad (3)$$

Where;

$C_{I-O_k,t}$ is the combined input and output unit of carbon emissons

$p_{I-O_k,t}$ is the combine price of the input and output price of each unit of combine emissions.

To determine our carbon price of South Africa we use the proposed price for carbon tax in South Africa as a proxy for the carbon price in calculating the carbon exposure. As per the National Treasury Carbon Tax Policy paper (2013) the proposed carbon tax rate is R120 per tCO2e and to be increased at a rate of 10% per annum from 2015 to 2019. The implementation date was supposed to be 2015, but it has been postpone to an indefinite date. Therefore for this study, the literal application of carbon tax is taken for the years 2010 to 2014 under study.

Carbon Risk describes the change in a company's monetary performance within a given time period. The indicator is measured as the relative performance change from the current state to the projected carbon exposure, in our case from one year to another. A company's carbon risk will show the percentage change from this year (t_o) of carbon exposure to the coming year (t_1). It is assumed that the same scope i= 1,2,3 of carbon exposures (t_o and t_1), the resulting carbon risk (CRi) is derived for the time period $\Delta t = t_1 - t_0$.

$$CR_{i,\Delta t} = \left(\frac{CEx_{i,t_1}}{CEx_{i,t_0}} - 1\right) \times 100 \quad (4)$$

4. Discussion and analysis

In this section the results of the analysis of the models described in the methodology section are presented and discussed. The section firstly presents the aggregated data per sector of the JSE 100 used in the analysis or model runs. So table 6, 7, 8 and 9 specifically displayed the data used in the proposed models. Table 6 shows the number of JSE 100 companies that were consistently reporting their carbon emissions per sector from 2010 to 2014. Table 7 displays the sectorial aggregates of the short and long term loans that the JSE 100 companies had from 2010 to 2014. In table 8 the aggregated carbon emissions per sector as per CDP reports from 2010 to 2014 are also displayed. In table 9 the carbon costs per sector calculated as per the explanation in the methodology section are shown. subsequent tables display the results of the four carbon metrics as enunciated in the methodology section.

Table 6. Number of Companies in the JSE 100 CDP with reported Carbon Emissions information

	2014	2013	2012	2011	2010
Consumer Discretionary	8	8	7	8	8
Consumer Staples	8	9	7	10	10
Energy & Materials	20	20	20	20	20
Financials	17	19	16	19	19
Health Care	5	5	4	5	5
Industrials	7	9	8	10	10
IT & Telecoms	3	3	3	3	3
Grand Total	**68**	**73**	**65**	**75**	**75**

Not all companies which were part of the analysis had the required carbon emissions data as shown in table 6. In order to have a fair analysis we ended up using data from companies which had disclosed their carbon emissions information only. It can be observed from the table that there has been a decline in companies that are disclosing their carbon emissions since 2010. However it can also be observed that at least two thirds of the JSE 100 companies that are targeted by the CDP are consistently disclosing their emissions. It can be observed that by 2014, only 68 of the JSE 100 companies were consistent in reporting compared to our base year 2010 in which 75 companies of the JSE 100 companies were consistent in reporting their emissions. Our results can be also biased given the unequal number of companies in each sector. There are more companies in the Energy and Materials sector reporting their emissions consistently compared to other sectors over the period under study.

Table 7. Aggregated JSE 100 Long & Short Term Loans in million rand by Sector

	2014	2013	2012	2011	2010
Long Term Loans					
Consumer Discretionary	117,049.08	96,524.05	67,885.83	53,915.16	39,268.47
Consumer Staples	329,206.90	316,007.55	277,519.43	156,111.99	163,938.60
Energy & Materials	509,455.10	455,371.00	330,927.17	180,349.82	200,314.60
Financials	716,444.51	815,424.27	749,446.19	635,375.54	557,750.02
Health Care	66,907.36	41,237.67	65,599.73	59,169.45	53,501.41
Industrials	60,849.02	53,371.58	42,193.47	25,588.91	20,851.98
IT & Telecoms	53,116.25	46,556.55	36,784.24	38,989.56	40,533.43
Grand Total	**1,853,028.21**	**1,824,492.66**	**1,570,356.05**	**1,149,500.42**	**1,076,158.50**
Short Term Loans					
Consumer Discretionary	49,890.48	44,000.17	29,528.02	21,636.73	18,855.33
Consumer Staples	104,687.62	66,048.79	39,205.90	41,353.51	37,322.83
Energy & Materials	79,964.89	77,294.70	64,471.98	54,046.32	38,546.76
Financials	4,125,617.76	3,658,217.87	3,463,707.09	3,570,690.70	3,338,820.94
Health Care	12,976.05	12,556.20	9,345.57	10,989.80	8,789.28
Industrials	33,539.95	26,005.79	18,551.36	17,476.80	15,239.28
IT & Telecoms	23,489.82	23,274.58	16,207.43	15,092.14	16,874.15
Grand Total	**4,430,166.57**	**3,907,398.10**	**3,641,017.35**	**3,731,286.00**	**3,474,448.58**

From table 7 it can be observed that the JSE 100 companies have more short term loans in rand terms than long term loans. The financial sector has the highest figure in rand terms both for short term and long term loans. For the same sector the short term loans are quite high in rand figure terms making up almost 90% of the total short term loans in each year for the period under study.

The highest carbon emitting sector is the Energy and Materials sector which contributes almost 90% of the reported carbon emissions by the JSE 100 companies as show in table 8. There has been a huge decline in the carbon emissions reported for the Industrials sector which is quite unexpected since this sector is expected to emit more carbon emissions compared to other sectors. The Health sector is the lowest emitting sector with only five companies in the sector compared to the IT & Telecoms sector which has three companies in the sector but its emissions are almost on average three times of the Health sector.

Table 8. Aggregated Carbon Emissions (tCO_2e) per Sector of the JSE 100 companies

	2014	2013	2012	2011	2010
Consumer Discretionary	3,298,946.00	3,222,841.00	2,433,765.00	1,280,913.00	528,656.00
Consumer Staples	6,357,087.00	6,320,573.00	5,445,713.00	6,187,460.00	6,720,760.00
Energy & Materials	190,424,954.00	196,581,271.00	199,761,675.00	210,205,502.00	206,032,183.00
Financials	3,617,986.00	3,627,003.00	3,189,843.00	3,310,539.00	2,805,619.00
Health Care	799,225.00	687,741.00	520,169.00	547,194.00	600,053.00
Industrials	2,638,289.00	3,351,400.00	2,373,858.00	12,166,482.00	16,224,189.20
IT & Telecoms	2,549,072.00	2,192,182.00	2,092,013.00	2,241,359.00	927,879.00
Grand Total	**209,685,559.00**	**215,983,011.00**	**215,817,036.00**	**235,939,449.00**	**233,839,339.20**

Table 9. Aggregated Total Carbon costs (South African rand) by Sector of the JSE 100 companies

	2014	2013	2012	2011	2010
Consumer Discretionary	395,873,520.00	425,415,012.00	353,382,678.00	204,587,424.36	92,880,629.95
Consumer Staples	762,850,440.00	834,315,636.00	790,717,527.60	988,261,111.20	1,180,783,765.92
Energy & Materials	22,850,994,480.00	25,948,727,772.00	29,005,395,210.00	33,574,022,779.44	36,198,206,295.64
Financials	434,158,320.00	478,764,396.00	463,165,203.60	528,759,289.08	492,924,813.35
Health Care	95,907,000.00	90,781,812.00	75,528,538.80	87,397,825.68	105,424,511.68
Industrials	316,594,680.00	442,384,800.00	344,684,181.60	1,943,230,505.04	2,850,460,248.75
IT & Telecoms	305,888,640.00	289,368,024.00	303,760,287.60	357,989,859.48	163,020,917.27
Grand Total	**25,162,267,080.00**	**28,509,757,452.00**	**31,336,633,627.20**	**37,684,248,794.28**	**41,083,701,182.55**

With regards to carbon costs, it is evident that the more carbon emissions are emitted the higher the carbon costs a company sector incurs. It should be noted however that these are rudimentary calculations that have been done without considering carbon abatements incentives to assist companies in subsidizing the carbon tax. It can be observed as well that these carbon taxes juxtaposed to the company's revenues, the company's would go bankrupt. It shows how the debate about addressing climate change through carbon tax cannot be the right financial instrument. However the data in tables 6 to 9 used to calculate carbon risk in this study might present small biases, but these biases might be not that strong to distort the accuracy of the results of this study. One of the identified biases is the comparison bias of one sector having more companies than the other. The methodology by itself calculates the average of all carbon metrics in each sector and therefore we are able to compare from sector to sector and even company to company. In subsequent tables, the results of the carbon metrics are presented and the conclusion of the study results will follow.

In the carbon intensity metric it can be observed that for each million rand a company takes there is a corresponding carbon emission it produces. The results in table 10 present a comparison of short term and long term loan average carbon intensity per each sector over the period under study. It can be observed that for the Energy & Materials Sector short term loans tend to have more carbon intensity in the short term loans than long term loans. This can also be observed in other sectors albeit not as consistent as the Energy and Materials Sector. Such a position means that companies are using long term loans more in retooling and changing their business production activities not to be dependent on energy and production processes that emit greenhouse gases. The short term loans are being used mostly in using energy and production processes that emit greenhouse gases. The other view of these results is that companies are being futuristic in changing their dependency on carbon inputs to their production processes which is explained in the next table.

The carbon dependency is presented in percentages and shows a volatile situation across all sectors. In terms of carbon dependency performance on long term loans from the base year of 2010 there has been a fluctuation on the carbon dependency for all sectors expect for the IT & Telecoms which has a steady decline on being carbon dependent for its carbon production. However it can be observed that the carbon dependency performance on short term loans is higher than the long term loans on a general across the sectors. However as of 2014 the IT & Telecoms, Energy & Materials and Health Care sectors were above the aggregate average carbon dependency of the JSE100 companies, whilst the rest of the sectors were below. A carbon dependency which is above 100% is a sign that a company is still struggling to wean itself from production processes and activities that emit greenhouse gases. Energy & Materials Sector seem to be above 100% on its carbon dependency through the period under study except in 2013 and 2012 where the carbon dependency is 60% and 59% respectively.

Table 10. Aggregated Carbon Intensity per Sector (tCO_2e per million rand of Long & Short Term Loan)

	Consumer Discretionary	Consumer Staples	Energy & Materials	Financials	Health Care	Industrials	IT & Telecoms	Average for JSE 100
2014 LTL	228.71	286.79	3,452.76	69.65	39.87	180.72	66.42	867.77
2014 STL	758.81	1,004.16	11,831.72	24.53	123.55	179.89	463.47	2,862.84
2013 LTL	122.99	179.47	1,633.93	30.87	1,851.43	447.57	66.88	555.70
2013 STL	487.32	289.88	4,759.39	88.91	120.15	305.38	102.51	1,212.50
2012 LTL	1,067.39	166.41	3,372.18	250.15	100.73	423.08	53.08	1,028.60
2012 STL	360.99	579.09	19,442.47	660.76	62.10	262.79	202.52	4,625.70
2011 LTL	223.30	266.59	2,817.14	174.62	38.81	12,139.53	47.30	2,128.85
2011 STL	889.28	242.31	12,071.58	2,827.78	61.63	1,615.49	718.24	3,913.49
2010 LTL	610.79	361.14	2,246.14	127.09	22.02	1,908.08	15.88	874.31
2010 STL	259.56	2,378.81	13,708.46	317.86	166.12	3,100.97	40.44	3,796.82

Table 11. Aggregated Average Carbon Dependency of the JSE 100 companies (Long & Short Term Loans)

	2014 LTL	2014 STL	2013 LTL	2013 STL	2012 LTL	2012 STL	2011 LTL	2011 STL	2010 LTL	2010 STL
Consumer Discretionary	70%	69%	36%	69%	152%	37%	18%	108%	100%	100%
Consumer Staples	57%	154%	37%	36%	32%	36%	40%	85%	100%	100%
Energy & Materials	79%	412%	60%	107%	59%	106%	121%	114%	100%	100%
Financials	97%	39%	55%	52%	156%	75%	122%	195%	100%	100%
Health Care	67%	197%	578%	100%	120%	113%	70%	30%	100%	100%
Industrials	61%	61%	82%	58%	41%	47%	102%	74%	100%	100%
IT & Telecoms	76%	230%	84%	46%	80%	74%	80%	77%	100%	100%
Average for JSE 100	**78%**	**158%**	**83%**	**67%**	**101%**	**71%**	**92%**	**125%**	**100%**	**100%**

Table 12. Aggregated Average Carbon Exposure of the JSE 100 companies (Long & Short Term Loans)

	2014 LTL	2014 STL	2013 LTL	2013 STL	2012 LTL	2012 STL	2011 LTL	2011 STL	2010 LTL	2010 STL
Consumer Discretionary	0.0295	0.0934	0.0188	0.0661	0.1570	0.0598	0.0216	0.0798	0.1045	0.0413
Consumer Staples	0.0323	0.1181	0.0211	0.0365	0.0222	0.0767	0.0567	0.1010	0.0663	0.4222
Energy & Materials	0.4143	1.4198	0.2157	0.6282	0.4896	2.8230	0.4500	1.9281	0.3946	2.4085
Financials	0.0084	0.0029	0.0041	0.0117	0.0363	0.0959	0.0279	0.4517	0.0223	0.0558
Health Care	0.0048	0.0148	0.2444	0.0159	0.0146	0.0090	0.0062	0.0098	0.0039	0.0292
Industrials	0.0217	0.0216	0.0591	0.0403	0.0614	0.0382	1.9389	0.2580	0.3352	0.5448
IT & Telecoms	0.0080	0.0556	0.0088	0.0135	0.0077	0.0294	0.0076	0.1147	0.0028	0.0071
Average for JSE 100	**0.1041**	**0.3435**	**0.0734**	**0.1600**	**0.1494**	**0.6717**	**0.3400**	**0.6251**	**0.1536**	**0.6671**

Since Carbon dependency indicates the performance of a company on the physical units of carbon emissions, carbon exposure indicates the performance of the monetary units of the carbon emissions of a company. In this case however the more the carbon they use in their production process the more costs they have and therefore greater their carbon exposure. In this case Energy & Materials and the Industrial sectors have a higher carbon exposure when it comes to short term loans compared to their long term loans. In other words, it is more risky to give more short term loans to these two sectors because you will be increasing their exposure to carbon costs. As an example for each one rand of short term and long term loan used by companies in the Energy & Materials sector in 2014 the carbon costs

would be R 0.4143for long term loans and R 1.4198 for short term loans. The carbon exposure is low in 2013 for the same sector with R 0.2157 for each one rand long term utilized and R 0.6282 for each short term loan utilized. Companies in the Health Care sector have the lowest carbon exposure in both short term and long term loans.

Table 13. Aggregated Average Carbon Risk of the JSE 100 companies (Long & Short Term Loans)

	2014 LTL	2014 STL	2013 LTL	2013 STL	2012 LTL	2012 STL	2011 LTL	2011 STL	2010 LTL	2010 STL
Consumer Discretionary	5%	5%	-9%	13%	113%	0.2%	-0.01%	73%	100%	100%
Consumer Staples	-7%	65%	-8%	-17%	-29%	-26%	-13%	10%	100%	100%
Energy & Materials	-14%	294%	-31%	12%	-27%	15%	29%	18%	100%	100%
Financials	37%	-16%	-2%	-4%	91%	16%	69%	132%	100%	100%
Health Care	-39%	79%	446%	10%	29%	23%	4%	-33%	100%	100%
Industrials	-26%	-26%	2%	-20%	-36%	-30%	29%	4%	100%	100%
IT & Telecoms	-6%	134%	2%	-33%	-2%	-8%	23%	20%	100%	100%
Average for JSE 100	**3%**	**75%**	**14%**	**-2%**	**31%**	**3%**	**32%**	**57%**	**100%**	**100%**

Carbon risk is calculated in the changes of a company's carbon exposure from one financial year to another. The highest carbon risk is observed in 2013 on long term loans for the Health Sector at 446% and this was mainly caused by an increase in long term loans. The ideal carbon risk will be a declining one from the base year which is 2014. Most sectors have achieved a decline in carbon risk on both long and short term loans since 2012 and this is evidenced by negative percentages registered in both short and long term carbon risk between 2012 and 2014. Most of the declines in the carbon risk are just below 40% across all sectors compared to the increases in carbon risk. From the results it can be observed that there is a volatile situation in which there is no continuous consistency in the decline of carbon risk across sectors.

5. Conclusion

The study embarked on a calculation of carbon risk embedded in long term and short loans of the JSE100 companies. The research used a carbon risk model proposed by Hoffman and Busch (2008) in calculating the carbon metrics. It can be observed that the carbon metrics reflect the monetary impact and physical impact of utilizing materials that emit carbon emissions, as well as processes and activities that involve emission with greenhouse gases. The first two carbon metrics of the physical carbon metrics - carbon intensity and carbon dependency – shows that the Energy & Materials sector and the Industrial sector have the highest carbon intensity and carbon dependency indicating their use for short term loans on energy sources and production processes that emit greenhouse gases and on long term terms loans there is a shift to clean energy sources and production processes. On the same carbon metrics the rest of the sector follow suit with longer term loans have lower carbon intensity and carbon dependency than the short term loans.

With regards to the monetary impact carbon metrics – carbon exposure and carbon risk – it can be observed that short term loans seem to give companies high carbon exposure more than long term loans. It can be observed as well that Energy & Materials sector have higher carbon exposure than all other sectors in both long term and short term loans. On the other hand the Financial and Health sector have the lowest carbon exposure in both long term and short loans compared to other sectors. The implication of the carbon metrics results which have monetary impacts is that banks will need to readjust their loan portfolios. There will be a need to readjust amounts and give a long term loan and reduce the short term loans, the logic being that companies cannot implement carbon emissions free production processes in short term periods of less than an hour. That is the why there is a higher carbon exposure on short term loans than on short term loans. With regards to carbon risk there is a general decrease in carbon risk in the period under study across all sectors although it can be observed the decrease is not a smooth one but a cascading one. It can also be noticed that the Energy & Materials sector registered a huge increase in carbon risk in short term loans in 2014.

This study overall managed to establish the implications of loans made by banks on a short term and long term basis to the JSE 100 companies in view of the carbon emissions they report. It is admitted that the results can be better if companies where to be reporting their carbon emissions and their loans consistently. More so, fair comparison amongst the sectors could have been done if each sector had an almost equal number of companies; however the aggregated averages of the carbon metrics within the sectors compensated this bias. The policy implications can be derived from the carbon costs that a tax based and it the study shows that a reconsideration of carbon tax incentives need to be considered in order to moderate the full impact of carbon costs on a company's revenue. Suggestions for future studies will be to do more focused carbon metric study on a sector by sector basis to see the impacts for companies within the sectors. On the other hand fully fledged study with other business metrics like sales, operating

costs, productions costs and so forth would help highlight the carbon risk performance.

References

1. BankTrack & Rainforest Action Network. 2012, "Bankrolling Climate Disruption: The Impacts of the Banking Sector's Financed Emissions", , pp. 13.
2. Barker , T., Bashmakov, I., Bernstein, L., Bogner, J.E., Bosch, P.R., Dave, R., Davidson, O.R., Fisher, B.S., Gupta, S., Halsnæs, K., Heij, G.J., Kahn Ribeiro, S., Kobayashi, S., Levine, M.D., Martino, D.L., Masera, O., Metz, B., Meyer, L.A., Nabuurs, G.-., Najam, A., Nakicenovic, N., Rogner, H.-., Roy, J., Sathaye, J., Schock, R., Shukla, P., Sims, R.E.H., Smith, P., Tirpak, D.A., Urge-Vorsatz, D. & Zhou, D. 2007, *Technical Summary. In: Climate Change 2007: Mitigation.* , Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
3. Button, J. 2008, "Carbon: Commodity or Currency-The Case for an International Carbon Market Based on the Currency Model", *Harv.Envtl.L.Rev.*, vol. 32, pp. 571.
4. Falconer, A., Stadelmann, M. & Brief, A. 2014, "What is Climate Finance? Definition to improve tracking and scale up climate finance", .
5. Gerardi, A., Grandjean, A. & Martinez, E. 2015, "La quantification des émissions de gaz à effet de serre des institutions financières", *Revue d'économie financière,* , no. 1, pp. 189-204.
6. Hoffmann, V.H. & Busch, T. 2008, "Corporate carbon performance indicators", *Journal of Industrial Ecology*, vol. 12, no. 4, pp. 505-520.
7. Labatt, S. & White, R.R. 2011, *Carbon finance: the financial implications of climate change*, John Wiley & Sons.
8. Le Quéré, C., Raupach, M., Canadell, J., Marland, G., Ciaia, P. & Woodward, F. 2009, *Trends in the sources and sinks of carbon dioxide.Nature Geoscience 2: 831-836,* .
9. Longroy, S.A. & Glaze, K. 2009, "Lending Goes Green – What Non-Energy-Sector Borrowers Can Expect in the Future", *Environmental Transactions and Brownfields Committee Newsletter*, vol. 11, no. 1, pp. 8-10.
10. Nielsen, J., Luttmer, M. & Hoek, Barbara,van,der. 2009, *Carbon Footprinting of Financed Emissions: Existing Methodlogies - A Review and Recommendation*, BECO Group, Rotterdam, Netherlands.
11. Rainforest Action Network, BankTrack & Sierra Club 2013, "*Extreme Investments: U.S. Banks and the Coal Industry"*, no. 4, pp. 24-30.
12. Remco, F., Coello, J., Burniston, N., Maier , S., Capurri , G., Manca, G., Gorte, J.F., Pitt-Watson, D., Greenwald, C., Robins, N., Lamb, N., Ruiz, S. & Loeffler, K. 2013, "Portfolio Carbon: Measuring, disclosing and managing the carbon intensity of investments and investment portfolios", *UNEP FI Investor Briefing,* .
13. Richardson, B.J. 2014, "The Evolving Marketscape of Climate Finance", *Climate Law*, vol. 4, no. 1-2, pp. 94-106.
14. Ritchie, J. & Dowlatabadi, H. 2014, "Understanding the shadow impacts of investment and divestment decisions: Adapting economic input–output models to calculate biophysical factors of financial returns", *Ecological Economics*, vol. 106, pp. 132-140.
15. Schucking, H. 2013, *Banking on Coal*, urgewald, BankTrack, CEE Bankwatch Network and Polska Zielona Sieć, Rainforest Action Network, World Development Movement, PowerShift. http://www.banktrack.org/download/banking_on_coal/banking_on_coal_4_67_6.pdf
16. Schücking, H., Kroll, L., Louvel, Y. & Richter, R. 2011, "Bankrolling climate change—a look into the portfolios of the world's largest banks", *Technical Reporturgewald, GroundWork, Earthlife Africa Johannesburg, BankTrack, Nijmegen, The Netherlands,* .
17. Serrano Marín, J.R. 2013, "Multi-factor models for carbon risk measurement in polish enterprises in the energy market", *Nauki o Finansach,* , no. 3 (16, pp. 89-100.
18. Stern, N. 2008, "The economics of climate change", *The American Economic Review,* , pp. 1-37.
19. Venugopal, S., Rigdon, C. & Daviet, F. 2009, "Accounting for Risk: Conceptualizing a Robust Greenhouse Gas Inventory for Financial Institutions", *World Resource Institute: Washington, DC,* .
20. Weidema, B.P., Thrane, M., Christensen, P., Schmidt, J. & Løkke, S. 2008, "Carbon footprint", *Journal of Industrial Ecology*, vol. 12, no. 1, pp. 3-6.
21. Wiedmann, T. & Minx, J. 2008, "A definition of 'carbon footprint'", *Ecological economics research trends*, vol. 1, pp. 1-11.