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Proposed carbon tax policy in South Africa: learning from the experience of other countries and effect on consumer price index

Abstract

The use of a carbon tax as an economic instrument to reduce carbon emissions by industries has been widely accepted by countries around the world as appropriate. This paper reviews the effect of a carbon tax on carbon dioxide (CO_2) emissions reduction in countries that have implemented the tax policy with a view to use their experiences as a cautionary note to policy makers and to analyze the likely effect of the proposed carbon tax on consumer price index (CPI) in South Africa. Using relevant literature, this paper highlights the experiences of countries currently implementing a carbon tax policy; and through a multivariate regression analysis method, an analysis of the likely effect of introducing a carbon tax on CPI is performed. A significant implication of the review of literature shows that a carbon tax has little or no effect on CO_2 emissions in those countries. Predictably, the multivariate regression analysis give credence to the fact that a further increase in the prices of energy-related products through a carbon tax is regressive on the poor and low income households, especially in South Africa where 15.2 million of a population of about 52 million are dependent on government social grants for basic household needs. The paper recommends that policy makers should consider other voluntary options that would encourage industries subscribe to targeted carbon emissions reduction.

Keywords: carbon tax, carbon emission reduction, energy-related products, South Africa, poor and low income households, consumer price index.
JEL Classification: H23, Q48, Q49.

Introduction

Excessive carbon emissions have been identified as an important cause of global warming (Meinshausen et al., 2009). The problem of greenhouse gas (GHG) effects has attracted wide attention. Global warming and climate change are a long-term issue that requires substantial mitigation effort involving complex interactions between environmental, economic, social, technological and political processes (Sathre & Gustavsson, 2007). In order to limit national emissions of GHGs, the South African authorities have proposed the introduction of a carbon tax as early as January 1, 2015. This policy, which is in accordance with the Kyoto Protocol to which South Africa is a signatory, aims to limit the emission of GHG and halt the trend of global warming.

South Africa is ranked poor at 37th position among 61 countries according to the Climate Change and Performance Index (CCPI) in 2013 (Burck et al., 2013); an indication that requires more aggressiveness to reduce its GHG emission. To revise this position, the South African government is committed to a policy for climate change mitigation with a target of reducing national emissions of GHG by at least 34% in 2020 and by 42% in 2025 in a statement made in Copenhagen in 2009 (DEA, 2013). While there are numerous potential options for reducing carbon emissions; national policies to encourage climate change mitigation can comprise a portfolio of market-based instruments, regulatory instruments, and voluntary instruments (Sathre & Gustavsson, 2007). Among the variety of instruments of controlling carbon emissions, a growing number of governments worldwide have opted for carbon tax as the most effective economic measure because of its relatively straightforward implementation and low transaction cost; its dynamic efficiency of giving a permanent incentive to reduce emissions; and the ability to recycle tax revenues back into the economy (Sathre & Gustavsson, 2007; and Fang et al., 2013).

The policy design of a carbon tax is to reduce carbon dioxide emissions from the use of fossil fuels, especially on electricity and transport fuel consumption. This policy is intended to provide incentives for consumers and organizations to find substitutes for those products with high carbon intensities towards products with low carbon intensities (Creedy & Sleeman, 2006). Consequently, the prices of the more intensive goods will increase proportionately more than those with lower intensities. Since government carbon tax policy will necessarily increase the price of energy and because energy is a necessary good in production and household consumption, a carbon tax can be considered as regressive because it can cause disproportional harm to low income earners and poorer households (Callan et al., 2009). This means that a carbon tax induced price changes will give rise to excess burdens on the poorer and low income earning households, as well as impose adverse impacts on the distribution of government welfare programmes. A higher price increase for carbon-intensity goods, which form a

larger proportion of these households budget, can lead to increased inequality among the groups within the economy.

In order to deal with the post-Kyoto pressure, South Africa, which is the largest emitter of GHG in Africa, needs to reduce its emissions level, thereby making the introduction of a carbon tax an ideal economic tool in achieving the reduction policy. The design and implementation of a carbon tax policy in South Africa is a complicated process because of the dependency by the majority of the population on government unemployment grants for basic livelihood. It is important to consider how to deal with the backlash of the intended carbon tax policy on the vulnerable members of the society; especially the low income and poorer households at the design stage, especially its political acceptability.

The question then is: What is the likely effect of the introduction of a carbon tax in South Africa on the economy? Since this is the first attempt by the South African government to introduce a carbon tax, this paper cautions that, despite the claim by the National Treasury that the primary objective of implementing a carbon tax is to change future behavior rather than to raise revenue, there is a need to draw from the experiences of other countries implementing the carbon tax policy. This is necessary considering that the majority of the population falls within the low income and poor household bracket. More importantly is that the direct economic variables most affected by such a tax are necessities for this economic group which include electricity price and transportation cost. Within the context of this study, the focus is on the economic impact of such a policy on the low income and poorer households in South Africa.

This paper is not the first to look at carbon tax issues in South Africa according to literature (Devarajan et al., 2009; Goldblatt, 2010; Devarajan, et al., 2011; and Winkler & Marquard, 2011), but the concern of this paper is that, although a carbon tax is a good economic instrument to mitigate carbon emissions, the question is: Is it appropriate at this point, particularly as it is being introduced as an additional tax? In South Africa, a carbon tax could spur investments in energy efficiency. However, this poses a serious challenge because South Africa's economic development has long been founded on mining and heavy manufacturing industry that is supported by cheap coal-fired energy (United Nations University, 2011). A further challenge is the effectiveness of the policy to strike a balance between development and environmental goals, especially because of concerns by various interest groups about the effects of introducing a carbon tax. South African businesses are concerned about losing competitiveness, especially in export markets for minerals and metals, while labor unions are worried about job losses that have driven the unemployment level to 25.6%, as in July 2013, with the civil society expressing grave concern about rising energy prices in the face of persistent and widespread poverty (United Nations University, 2011).

The study is organized as follows. An overview of the South African energy sector and the carbon tax theory as well as the proposed carbon tax in South Africa are discussed. A review of relevant literature to gain a better understanding of a carbon tax policy is presented; then follows a discussion on methodology; presentation of findings. Finally are the discussion section, the conclusion section, and implications for policy makers.

1. Overview of South Africa energy sector

South Africa's energy sector is critical to the economy because of its large-scale reliance on energy-intensive mining industry that contributes substantially to its Gross Domestic Product (GDP) (USEIA, 2013). While South Africa has only a small deposit of conventional oil and natural gas; the country uses its large coal deposits for most of its energy needs, particularly in the electricity sector (USEIA, 2013). Despite the rapid growth in its economy, some economic problems remain; particularly poverty and lack of economic participation among the disadvantaged groups, mainly the Blacks. This made the South African government to commit to ensuring that Black-owned companies have access to the energy sector under its Black Economic Empowerment (BEE) programme. Additionally, the 2000 Petroleum and Liquid Fuels Charter sets a target to place 25% of the oil sector in the hands of Black-controlled energy companies.

In 2010, about 70% of South Africa's total energy supply came from coal, followed by oil which accounts for 19%, and solid biomass and waste amounting to 10%, according to EIA estimates. South Africa's energy balance also includes relatively small shares of natural gas, nuclear, and hydroelectricity. South Africa's dependence on hydrocarbons, particularly coal, has led the country to become the leading carbon dioxide emitter in Africa and the 12th largest in the world, according to the latest 2010 EIA estimate. South Africa has the world's ninth largest recoverable coal reserves and holds 95% of Africa's total coal reserves. Additionally, it is the fifth largest coal exporter in the world. South Africa is the sole importer of natural gas from Mozambique, which is used to supply Sasol's operations at the Secunda coal-to-liquids (CTL) plant and power some natural gas-fired plants (USEIA, 2013).

The natural gas supplied to the Mossel Bay gas-to-liquids (GTL) plant is domestically produced off-shore. South Africa has the second largest crude oil refinery system in Africa and imports the majority of its crude oil from members of the Organization of the Petroleum Exporting Countries (OPEC).

South Africa's total electricity consumption has grown by about 20% over the last decade. The government has set out ambitious plans to expand the sector in an attempt to avoid another power crisis, which the country experienced in early 2008 by building additional power plants in Medupi and Kusile (DEA, 2013). In order to generate the required energy requirement for South Africa in the short term, considerable volume of coal, crude oil, and natural gas will have to be used and these resources are the reason for carbon emissions which the government is proposing to limit. The South African government recognizes that energy efficiency as one of the most cost-effective ways of meeting the demands of sustainable development and providing environmental benefits. A national voluntary target for improving energy efficiency by 12% by 2015 has therefore been set. This target is based on the projected national energy demand and economic growth as follows:

- Industry and mining sector: 15%.
- Power generation sector: 15%.
- Commercial and public building sector: 15%.
- Residential sector: 10%.
- Transport sector: 9% (National Treasury, 2013).

For this reason, environmental groups continue to target the energy industry for air, land, and water pollution through all of the industry's stages from extraction to end use.

1.1. The carbon tax theory. A carbon tax is a tax on carbon dioxide (CO_2) emissions through the combustion of fossil fuels from electricity production in industrial, commercial and residential heating and lighting; and fuel and gas through transportation, cooking and residential heating. In South Africa, a carbon tax is a tax per ton of CO_2, since CO_2 is the substance of interest and not the carbon itself. In most countries where carbon tax has been introduced, the tax rate usually starts at a low rate and rises over time. While there are different options for applying carbon tax, each option has different impact on overall cost, effectiveness of raising revenue, and capability of reducing CO_2. This depends on how and where the tax is implemented and how the tax revenue is used.

1.2. The proposed Carbon tax in South Africa. In order to fulfil the pledge made by the South African government to the Conference of the Partiesat the United Nations Framework Convention on Climate Change (UNFCCC COP) 15 negotiations in 2009 to reduce its GHG emissions by 34% in 2020 and 42% in 2025, a carbon tax is considered an appropriate mitigation instrument to ensure the country achieves its GHG emissions target (National Treasury, 2013). A comprehensive carbon tax policy has been proposed based on the following tax bases:

- Tax applied directly to measured GHG emissions (this is considered administratively complex).
- Fossil fuel input tax on coal, crude oil, and natural gas which is based on their carbon content.
- Tax levied on energy outputs such as electricity and transport fuels (National Treasury, 2013).

South Africa adopted a carbon tax policy as against an emission trading system (ETS) because of its oligopolistic energy market nature. Policy makers are of the opinion that a carbon tax can propel changes in producers and consumers' behavior with a corresponding positive effect on climate change – hence the need for government intervention through market-based instruments such as a carbon tax to influence decision-making processes of producers and consumers. The aim of the proposed carbon tax in South Africa is to correct the existing prices of goods and services that generate excessive levels of anthropogenic GHG emissions, so that it reflects the social costs of such emissions (National Treasury, 2013).

2. Related literature

2.1. Carbon tax revenue, employment, and economic growth. Essentially, introducing a carbon tax is an avenue to generate revenue for the government. One might want to know how much revenue a carbon tax could raise for the government. The South African National Treasury (Central Bank) has proposed a carbon tax of R120 (equivalent to $12) per ton of CO_2 emitted beginning from January 1, 2015 with an annual increase rate of 10 per cent. It is expected that a carbon tax will generate additional revenue for the government between R15bn to R20bn (an equivalent of $1.5bn to $2bn) annually. The National Treasury explains that its main objective for introducing a carbon tax is to change future behavior rather than to raise revenue. For the introduction of a carbon tax to be achieved by the South African government, it has to be fully aware that the policy could threaten a host of businesses' bottom lines. There is a great concern that the proposed carbon tax could cripple industries that are currently struggling with competitive issues, thereby making the tax policy ineffective in changing behavior. The other concern suggests that alternative technologies that might facilitate a switch to cleaner energy are overlooked.

Another pertinent question is: How would a carbon tax affect the economy? While various perspectives have been offered about how a carbon tax could affect the economy, economic experts argue that the effect of a carbon tax policy is largely determined by the design and how tax revenue proceeds are used. Essentially, a carbon tax would increase the cost of fossil fuels and alternatively lead organizations to switch to cleaner fuels, which are currently expensive, thereby forcing businesses and households to reduce energy use (Kaygusuz, 2012). If the switch to more efficient and cleaner energy sources is successful, this will make the economy become less dependent on fossil fuels and, as such, prevent the economy from energy price shock effects.

A carbon tax could lead to slow growth in industries with high CO_2 emissions and an advantage to industries that uses alternative cleaner energy. What is the likely effect of a possible slow industrial growth for the country's employment rate? One of the likely effects is that a carbon tax will reduce national employment rate as result of a corresponding low demand for workers in carbon-intensive industries. This will weaken employers' incentives for their workforce since the tax would lead to higher prices thereby reducing workers' purchasing power. Consequently, workers will demand for higher wages with employers resulting to lay-off workers to meet increasing wage demand. The effect of a carbon tax on employment depends on factors such as the carbon-intensity of the producers, the degree to which they can pass the increased costs to consumers, the strength of import competitors, the producers' ability to substitute with less carbon-intensive energy sources, and the consumers' ability to switch to low carbon-intensive products.

In contrast, a carbon tax might result in overall economic growth if tax proceeds are used to promote variables of economic growth such as cutting other taxes or to reduce national deficits. Reducing personal and corporate income taxes for example, is associated with economic growth through increased disposable income, and largely because these taxes distort employment, savings, and investment. Indirectly, a carbon tax will affect everybody within the economy because the prices of electricity and fuel-related products will increase. In terms of electricity, prices could increase by an average of 8% or 4.80 cents per kW. Carbon tax revenue could be used to promote growth through promoting productive government spending, funding basic research, funding essential infrastructure, and investments in human capital. However, the failure to re-channel realized carbon tax revenue efficiently would render the objective of the policy and its output inconsistent and damaging to the overall economy.

What are the dangers of a higher energy prices on competitiveness among South African industries? For organizations that consume large amounts of energy or carbon-intensive, a carbon tax will raise their average production costs. Although some carbon-intensive organizations are better positioned to recover this cost increases than others; however, if such an organization's product prices are determined by international market forces (such as metals and chemicals), it could be disproportionately burdened if the carbon tax affects its operations but not that of its international competitors. If the foregoing is true, what can the government do about it? The government could adopt some policy options to offset the impact of a carbon tax on both local and international competitions on carbon-intensive industries by lowering capital taxes and increase depreciation allowances to reduce costs, or a general reduction of the carbon tax in such industries. On how other countries that had already implemented a carbon tax policy use the revenue, Table 4 presents the list of countries that had implemented a carbon tax policy and how they used the tax proceeds. The Quebec province in Canada and the district of Boulder in Colorado, the United States of America (USA) implemented a carbon tax policy in 2007, while Bay Area Air Quality Management District in California, the USA and British Columbia region in Canada implemented a carbon tax policy in 2008. Finland is the first country to implement a Carbon tax policy in 1990.

2.2. Carbon tax and emissions reduction. Energy-related CO_2 emissions produced through the combustion of liquid fuels, natural gas, and coal represents much of the world's anthropogenic GHG emissions (USEIA, 2013). World energy-related CO_2 emissions increase from 31.2 billion metric tons in 2010 to 36.4 billion metric tons in 2020 and 45.5 billion metric tons in 2040 (USEIA, 2013). According to International Energy Agency (IEA) (2009), transportation accounts for nearly one-quarter of global energy-related CO_2 emissions. The Agency attributed much of the growth in emissions to the developing non-OECD nations that continue to rely heavily on fossil fuels to meet fast-paced growth in energy demand. It reckons that non-OECD CO_2 emissions will reach 31.6 billion metric tons in 2040 or 69 percent of the world's total. As such, energy consumption is an important component of the global climate change debate.

The question about what is the environmental objective of a carbon tax is necessary to understand the reason for its introduction. Or how might a carbon tax affect the development of clean energy technologies is crucial in this context. Another question might be: how might a carbon tax in South Africa

affect global carbon emissions? As stated earlier, the primary objective of a carbon tax is to impose a price on emissions as a way to ensure that industries account for damages and effects expected from their actions on human health, food production, coastal inundation, and corporate induced climate change. A carbon tax is designed to discourage high carbon emissions in industrial and households activities so as to promote efficient carbon reductions throughout the economy. In South Africa, this is to be achieved by placing a uniform price of $12 per ton of CO_2 emissions (The Carbon Report, 2013) regardless of the emissions source, whether from electricity production or fuel consumption from transportation.

Since a carbon tax would lead to higher prices for a carbon-intensive organization's goods and services, development and investment in innovative and efficient renewable energy and carbon sequestration or other technologies will be a potentially rewarding venture. This means that organizations need to increase their spending on research and development costs for cleaner energy. The financing could be sourced from the carbon tax revenue fund. If investments in cleaner energy technologies is successful, and since the carbon emission level of South Africa is the highest in Africa as a leading emerging market and nation, such reduction can contribute significantly to reducing total global emissions. In contrast, the imposition of a carbon tax to reduce carbon emissions in South Africa can lead to increased emissions in another country – carbon leakage – where there is no imposition of a carbon tax. This situation happens for a variety of reasons, some of which include the following:

- The production of some carbon-intensive goods will likely move to another country where there is no carbon tax to avoid the tax.
- A reduction in South Africa and other carbon-taxed economies' demand for fossil fuel would result in lower prices for fossil fuels, thereby making them more attractive in unregulated or non-carbon taxed countries.

2.3. Carbon tax, energy prices and low-income households. Consequently, it is necessary to ask the question: How might a carbon tax affect energy prices? or How would the changes in energy prices, as a result of a carbon tax, affect low income households? Invariably, introducing a carbon tax in an economy like South Africa would increase energy prices. But the amount of increase is dependent on the size of the carbon tax and the extent to which it is passed on to consumers. While it can be affirmed that the total energy costs of low-income households are relatively lesser in comparison to high-income households; low-income households relatively spend a higher proportion of their household budget on energy (Emmel et al., 2010). One can conclude that a carbon tax is regressive because it would have a relatively higher impact on low-income households than on high-income households. As such, mitigating this regressive tax system depends on how the revenues from the carbon tax are used.

A significant implication of this study is the effect of a carbon tax on the income of poor and low-income households in South Africa and to alert policy makers on the danger of subsequent backlash in the form of protests against such a policy on the national economy for necessary adjustment or amendment before implementation. Backlash in the form of violent protests is a common occurrence among South Africa's poor and low-income communities against policies that are considered regressive. In their research analysis in the United States of America, Grainger and Kolstad (2010) noted that looking at the extremes of household income distribution, the regressive nature of a price on carbon is more pronounced. They found that the burden of a carbon tax, as a share of national income for the lowest income group, is almost four times higher than the burden-to-income ratio for the highest income group. Of importance to politicians is the use of revenue from a carbon tax policy, especially in a country like South Africa where the majority of the population relies on government grants to address the regressivity of such a policy.

3. Methodology

The main focus of this study is to review the effects of a carbon tax on carbon emissions reduction in countries that have implemented the tax policy with a view to use their experiences as a cautionary note-to policy makers and to analyze the likely effects of the proposed carbon tax on CPI in South Africa. A key consideration is the implications of the proposed carbon tax on energy-related goods on the poor and low income households. The paper hypothesizes the effect of introducing a Carbon tax on Consumer Price Index (CPI) for the years 2003-2009 in South Africa using a multivariate regression analysis method. This was to predict the effect and implications of a carbon tax on the economy, especially in relation to the poor and low income households. Poor and low income households are members of the population whose basic needs are mostly dependent on receipt of government social grants. This group is significant because it constitutes about 15 million of the total population of 50 million, amounting to a staggering 30% (NGO Pulse, 2013). Data on CPI were obtained from the Department of Energy (DoE), South Africa (DoE, 2011). Despite the many economic variables affecting the introduc-

tion of carbon tax, this study is limited to those economic variables directly related to carbon emissions from fossil fuel – petroleum, coal and natural gas as the independent variables. The experiences of other countries on the effects of carbon tax on carbon emissions reduction were sourced from the National Renewable Energy Laboratory of the United States of America's Department of Energy (Sumner et al., 2009). Economic variables used in this paper were those that directly relate to high carbon-intensity energy-related goods CPI as dependent variable.

3.1. Control variables. In analyzing the effect of carbon tax on these two economic variables, the following control variables were used:

The multiple regression model for consumer price index (CPI) is:

Dependent variable (γ_1) = CPI.

Independent variables (X) = (X_1, X_2, X_3, X_4).

X_1 (bituminous coal price/ton), X_2 (anthracite coal price/ton); X_3 (petroleum price/litre), X_4 (natural gas price/kilogram).

Therefore, multiple regression models are represented by:

$$\gamma_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4,$$

where γ is CPI in the equation: β_0 is the regression estimate of the slope for X_1 to X_4 gradients; and X_1 is the price of bituminous coal per ton; X_2 is the price of anthracite coal per ton X_3 is the petroleum price per litre; X_4 is the price of natural gas per kilogram. To predict the effect of a carbon tax on Consumer Price Index (CPI), the research question is restated as: what is the likely effect of the introduction of a carbon tax in South Africa on CPI? Consequently, the study tested the hypothesis below at 5% significant level.

Hypothesis 1:

H_0: Introducing a carbon tax in South Africa will not have significant effect on the consumer price index (CPI).

H_1: Introducing a carbon tax in South Africa will have a significant effect on the consumer price index (CPI).

Data and multiple regression results on hypothesis 1 are presented in Table 1 and Table 2.

Table 1. Consumer Price Index (CPI), prices of coal, petroleum, and natural gas for 2003-2011 in South African rand

Year	γ_1 (Consumer price index (CPI))	X_1 (Price of bituminous coal in rand per ton)	X_2 (Price of anthracite coal in rand per ton)	X_3 (Crude oil price in rand per barrel)	X_4 (Natural gas price in rand per gigajoules)
2003	76.30	77.77	394.32	218.03	8718.50
2004	77.40	74.29	417.25	246.45	8318.08
2005	80.00	84.42	414.33	345.77	9906.58
2006	83.70	85.17	477.17	439.43	11924.83
2007	89.70	105.86	485.67	514.03	12082.42
2008	100.00	150.68	604.24	683.85	19742.58
2009	109.20	171.63	690.36	519.06	14305.75
2010	113.00	180.50	781.75	581.94	14764
2011	117.30	196.02	898.90	806.93	18218.42

Source: Data were compiled from South African Energy Price Report 2011 on the Department of Energy website. Available online at: http://www.energy.gov.za/files/media/explained/2011EnergyPrice%20Report_new.pdf.

Table 2. Multivariate regression result on the effect of energy-related product prices on CPI for the years 2003-2011 in South Africa

Summary output								
Regression statistics								
Multiple *R*	0.997444226							
R square	0.994894985							
Adjusted *R* square	0.989789969							
Standard error	1.629422124							
Observations	9							
ANOVA								
	df	*SS*	*MS*	*F*	Significance *F*			
Regression	4	2069.699934	517.4249835	194.8857914	7.79175E-05			
Residual	4	10.62006583	2.655016458					
Total	8	2080.32						
	Coefficients	Standard error	*t* stat	*P*-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	56.11783624	4.044684618	13.87446527	0.000156456	44.88799143	67.347681	44.88799143	67.34768105
X_1 (Bit. coal)	0.311527667	0.063324269	4.919562031	0.007931884	0.135711312	0.48734402	0.135711312	0.487344023

Table 2 (cont.). Multivariate regression result on the effect of energy-related product prices on CPI for the years 2003-2011 in South Africa

Summary output								
	Coefficients	Standard error	*t* stat	*P*-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
X_2 (Anth. coal)	0.001202489	0.017193707	0.06993776	0.947600063	-0.046534894	0.04893987	-0.046534894	0.048939873
X_3 (Crude oil)	0.021178204	0.012954087	1.634866599	0.177416445	-0.014788107	0.05714452	-0.014788107	0.057144516
X_4 (Nat. gas)	-0.000913686	0.000578485	-1.579445751	0.189381276	-0.002519818	0.00069245	-0.002519818	0.000692446

Table 3. Annual foreign currency exchange rates

Date	South African rand per US$
2003	7.56
2004	6.45
2005	6.35
2006	6.75
2007	7.09
2008	7.05
2009	8.44
2010	7.32
2011	7.25

Table 4. Countries implementing a carbon tax policy, use of proceeds, and the effect of a carbon tax on carbon emissions reduction

Country	Year implemented	Carbon tax rate per ton of CO_2 in $	Annual carbon tax revenue	Uses of carbon tax revenue	Effect of a carbon tax on carbon emissions
Finland	1990	$30 per metric ton CO_2	$750 million	Government budget; accompanied by independent cuts income taxes	In 1990, emissions were 47 million tonnes, but had increased to 52.6 million tonnes by 2007
Netherlands	1990	~$20 per metric ton CO_2 in 1996	$4.819 billion	Reductions in other taxes; climate mitigation programs	At least 65% of used packaging recycled by 2012 through the company called Nedvang
Norway	1991	$15.93 to $61.76 per metric to CO_2	$900 million	Government budget	Norway's per capita carbon emission rose by 15% between 1991 and 2008
Sweden	1991	Standard rate: $104.83 per metric ton CO_2; Industry rate: ~423.04 per metric ton CO_2	$3.665 billion	Government budget	Emissions dropped from 57 million tonnes in 1992 to 54 million by 2007
Denmark	1992	$16.41 per metric ton CO_2	$905 million	Environmental subsidies and returned to industry	It reduce from 59 million tonnes in 1972 to 58 million tonnes in 2007
Costa Rica	1997	Set at 3.5 per cent of the market value of fossil fuels	Not available	A portion is used to finance programs that incentivizes sustainable development and forest conservation	CO_2 emissions increased by more than 60 per cent between 1997 and 2008
United Kingdom	2001	$0.0078 per kWh for electricity; $0.0027 per kWh for natural gas provided by gas utility; $0.0175 per kg for liquefied petroleum gas or other gaseous hydrocarbons supplied in a liquid state; and $0.0213 per kg for solid fuel	$1.191 billion	Reductions in other taxes	Not available
Switzerland	2008	$11.41 per metric ton CO_2 in 2008, increased to $34.20 per metric ton CO_2 in 2010	$209 million	One-third of revenues used to finance climate-friendly building innovations; the remainder is redistributed through benefit system	A number of 400 voluntary companies helped to reduce total permissible quantity of CO_2 emission of 3.1 million tonnes to 2.6 million tonnes in 2009
Ireland	2010	$19.60 per metric ton $C0_2$ in 2010 and increased to $26.17 per metric ton CO_2 in 2012	$523 million in 2012	Used to finance government budget	Not available

Table 4 (cont.). Countries implementing a carbon tax policy, use of proceeds, and the effect of a carbon tax on carbon emissions reduction

Country	Year implemented	Carbon tax rate per ton of CO_2 in $	Annual carbon tax revenue	Uses of carbon tax revenue	Effect of a carbon tax on carbon emissions
Australia	2012	$23.78 per metric ton CO_2 to increase annually at 2.5 per cent. The fixed price will transition to a cap-and-trade system in July 2015	$24 billion for the first three years (projections)	Over 50 per cent of the revenue will be used to assist households, reduction in other taxes, and energy intensive trade exposed industries will receive assistance	By July 2013, the tax had caused economic damage amounting to billions of dollars with thousands of job lost. This made the Gillard regime to lose control of political power. However, the new government immediately ditched the carbon tax

Source: http://www.nrel.gov/docs/fy10osti/47312.pdf.

4. Discussion of findings

Based on the multivariate regression output in Table 2, the *F*-statistic is 194.89 at a significant level of $P < 0.01$, which is less than 5%. This indicates that the regression model is statistically significant. Likewise, a closer look at the *P*-value coefficient of each independent variable suggests that the price of bituminous coal with a separate *P*-value of less than 0.01 has a strong positive relationship in the regression equations as shown by the positive coefficient of 0.31. This means that the gradual increase in the price of bituminous coal contributed to the increase in the CPI within the years 2003 to 2011. About 70% of South Africa's primary energy supply is generated from coal mostly from bituminous coal (DoE, 2011). Coal consumption increased significantly over the years 2003-2011 to meet South Africa's growing energy demand, especially now that two new power plants are being built in Medupi and Kusile. This growing demand is the reason for the gradual increase in the price of coal. Coal dominates South Africa's energy market because it is an abundant source of energy in the country and can be produced relatively cheaply locally, compared to importing other sources of energy (DoE, 2011). However, analysis of other control variables such as anthracite coal, petroleum, and natural gas indicates weaker relationship with CPI having *P*-values of 94%, 18%, and 19% respectively all of which are greater than 5% significant level. In essence, this result indicates that a gradual increase in bituminous coal price had a greater influence on CPI in the years 2003 to 2011.This contributes to the high correlation of 99.7%; *R* square of 99%; and adjusted *R* square of 99%. This confirms the alternate hypothesis that the introduction of a carbon tax in South Africa will have a significant impact on CPI. The null hypothesis is therefore rejected.

A significant implication of this finding is the confirmation that an increase in the price of energy-related product will significantly affect the prices of consumer goods. This extends to almost all consumer goods, either directly through production cost or indirectly through transportation cost. A closer look at the prices of energy-related goods in Table 1 shows a gradual increase in prices, which is assumed to continue into the future. Hence, this paper argues that the introduction of a carbon tax in South Africa will definitely lead to a higher CPI. Conversely, it is logically reasonable to assume that households' expenditure will rise. This increase will obviously affect the low-income percentile households in greater proportion in comparison to high-income households. Introducing a blanket carbon tax on all carbon dioxide emission activities or products in South Africa can, therefore, be labelled as regressive.

One argument proposed in this paper is that, with South Africa having a large proportion of its population dependent on government grants, about 15 million people across different age groups (NGO Pulse, 2013) will be unable to curtail or address any backlash that could result from the indirect impact of this policy on the majority poor population. Another significant implication of this policy is that the redistribution of revenue from the tax could be marred by corruption because the present grant distributionsystem has been tainted with corruption. Whilst the document on the proposed tax dealt with a number of implementation issues; details about this is not provided. This can lead to morality issues since companies could seize the opportunity to persuade officials or monitors and assessors to record low carbon emissions for them. Otherwise, South African manufacturers will probably choose to adapt to this new tax liability than innovate and invest in low carbon emission technologies. The poorer households will continue to bear the burden of cost-push prices under the proposed policy because the tax burden will definitely be passed on to consumers. For instance, Eskom, the sole provider of electricity, has submitted a response to parliament that it would not bear the burden of the tax but pass it on to consumers, the majority of who are poor.

While the policy document modestly acknowledged that a carbon tax would not immediately lead to low carbon developments, it hopes that its implementa-

tion will change future behavior. In analysing the effect of implementing a carbon tax in other countries, this paper discovers that a carbon tax has little or no effect on carbon emission reduction. The effect of a carbon tax on carbon dioxide emission is presented in Table 4. France, for instance, considered and rejected the introduction of a carbon tax because almost every case cited by the Treasury in support of a carbon tax indicates that it is not effective in reducing carbon dioxide emissions (Lloyd, 2013). This paper proposes that, in the period before the implementation of this tax policy in South Africa, the experiences of other countries in relation to mitigating the effects of carbon emissions should be considered. This is crucial because South Africa as a country has peculiar characteristics such as a high number of poor in comparison to those countries analysed in this paper.

Conclusion and policy implications

Given the growing concern about the level of carbon dioxide emissions around the world and especially in South Africa, supporting the policy that emitters should pay to reduce emitting is the appropriate thing to do.Before implementing a carbon tax policy, consideration should be given to the experiences of other countries that have implemented such a policy in order to predict the likelihood of it being successful in a country like South Africa with its differing economic variables. Policy makers need to consider whether it is beneficial to implement a carbon tax policy that would lead to job losses, further impoverish the poor through high CPI, provide producers opportunity to adapt to the new tax liability by shifting the burden to consumer rather than innovate and invest in low carbon technologies. Perhaps policy makers who are currently in control of the political power would like to be voted out just as it turned out in July 2013 in Australia where the government that introduced the carbon tax lost power to the opposition who immediately suspended the tax policy upon resuming office.

The multivariate regression analysis showed a significant relationship between increases in CPI and energy-related product prices. This result adds credence to confirm that a further imposition of a carbon tax on energy-related products is regressive and will impact negatively on the welfare of the poor and low-income households in South Africa. While the focus of this paper is not to suggest a new system of reducing carbon emissions but to draw the attention of policy makers to the experiences of other countries implementing this tax; policy makers might like to consider other options such as selective carbon tax on high carbon intensive industries, encourage-both high and low carbon intensive emitters to innovate by granting tax holidays during this period.

Implication for policy makers

While policy makers have a duty to ensure that the country complies with international agreements under the UNFCCC's COP 15 negotiations in 2009 to reduce its GHG emissions to mitigate carbon emissions, they also have a responsibility to ensure that those policies do not impact negatively on the well-being of its people. This paper demonstrates that, in proposing to implement a tax policy like a carbon tax, consideration should be given to the experiences of those countries that have implemented the tax and its effect on carbon emission reduction. In addition, policy makers should consider the economic variables peculiar to their economy, such as level of development, percentage of the poor and low-income households, as well as the available technology to develop renewable and other low carbon emission energy.

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