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The Real Cost of a Carbon Tax

Estimating the Impact of South Africa's 2015 Carbon Tax with an Application to the Agricultural Sector of the Western Cape

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Abstract:

Carbon taxes are used by policy makers to influence behaviour towards cleaner production. This is achieved through reductions in the emissions of greenhouse gases which are disrupting the earth's environment and causing climate change. The impact of a carbon tax is complex and often difficult to accurately identify. This study utilises a static Computable General Equilibrium (CGE) model to identify what the potential impact will be of South Africa's carbon tax which is to be implemented at the beginning of 2015. The analysis begins at the level of the national economy, revealing the potential for significant economic strain resulting from the tax. The results also reveal the generation of substantial government savings which, if used correctly, could provide a vital means of ensuring the transition to a cleaner economy progresses as desired and in a way which does not hinder long-term economic development. The analysis is applied to the Western Cape Agricultural sector which reveals a negligible direct impact of the carbon tax. However, there were substantial indirect impacts. The main indirect impact comes in the sharp rise in the price of electricity, but there were a number of other inputs which are also shown to significantly impact the Sector, although the Western Cape's agricultural products were more strongly influenced by the electricity price that the country's Agricultural Sector as a whole. The conclusions drawn provide warning to the Sector and also briefly touches on the potential for opportunities to be created following from the implementation of the tax.

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1. Introduction

On February 27th 2013, South Africa's then Minister of Finance, Pravin Gordhan, gave the country's annual budget speech. One of the things called for in the speech was the need to move towards a low carbon economy. In order to achieve this goal a number of mechanisms are to be put into place, including the implementation of a carbon tax effective from the 1st January 2015 (National Treasury, 2013a). The carbon tax will aim to influence the behaviour of individuals and firms to pursue methods of production which are less harmful to the earth's environment.

Whilst the tax will be applied to the whole economy, the impact will disproportionately be felt by certain sectors and by certain regions. In order to fully understand what the impact will be on a particular sector requires modelling the impact at the level of the national economy and to then assess how this affects a particular sector and/or region.

The next section of this paper gives a background for the analysis, looking at climate change as a global problem and then looking at South Africa's position in terms of the problem, before discussing the proposed carbon tax. Section 3 then describes a static Computable General Equilibrium (CGE) model which is to be used in the study to assess the impacts of the carbon tax in South Africa. Following this, Section 4 looks at some of the potential economy-wide impacts and discusses the implications of these impacts. Going deeper, Section 5 then applies the impacts of the carbon tax to a specific sector within a specific region, namely the Agricultural Sector of the Western Cape. The paper then ends off with some concluding comments.

2. Background

Before looking at what the potential impact of the carbon tax will be, this section gives some background to the tax in order to better understand the reasoning for implementation and to provide the setting for the analysis.

The International Climate Change Agenda

> *"An overwhelming body of scientific evidence now clearly indicates that climate change is a serious and urgent issue. The Earth's climate is rapidly changing, mainly as a result of increases in greenhouse gases caused by human activities"* (Stern, 2007, p. 2)

The main greenhouse gas (GHG) emitted through human activities is carbon dioxide (CO_2). Others include nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), methane (CH_4) and sulphur hexafluoride (SF_6). The main source of GHG emissions is fossil fuel combustion, although significant emissions also come from other activities such as agriculture, deforestation, fossil fuel production, industrial processes and waste (IPCC, 2014).

In response to climate change and the threat it poses to the environment, the United Nations Framework Convention on Climate Change (UNFCC) was established in 1992 with the objective of achieving the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (United Nations, 1992, p. 9).

Combatting climate change is complicated as it is effectively a collective action problem (IPCC, 2014). This type of problem is referred to in Garrett Hardin's *The Tragedy of the Commons*, arising due to the fact that the benefits of the use of a particular resource accrue to individuals or groups but the costs of overuse are borne by all who use the resource (Harding, 1968). The problem is in essence a social dilemma resulting from a misalignment between individual rationality and optimal outcomes for a group as a whole (Ostrom, 2009). In the case of climate change, firms benefit from not adhering to environmentally friendly standards where they can produce goods or offer services at lower costs. The negative impact of these actions, the degradation of the earth's environment, is shared amongst the whole world.

The Kyoto Protocol is the most notable attempt at resolving the global climate change collective action problem. It is an international agreement committing countries to stabilize their greenhouse gas emissions using the principals of the UNFCCC. The protocol set binding emission reduction targets, to be achieved between 2008 and 2012, for 37 industrialized countries and the European community. The target set was to decrease greenhouse gas emissions to 5% less than the level that each country had in 1990 (United Nations, 1998). This marked the first commitment period. In December 2012 the Doha Amendment to the protocol was adopted signalling a second commitment period of the protocol which will span from 2013 to 2020 (United Nations, 2012).

South Africa's Emissions

South Africa does not fall under the list of annex 1 or annex 2 countries to which the mandatory emission reductions of the Kyoto Protocol apply (United Nations, 1998). Despite this, the country has a long standing commitment to reduce greenhouse gases, enshrined in the country's constitution and outlined in the governments *National Climate Change Response White Paper* (RSA, 2011).

South Africa's commitment to reducing greenhouse gas emissions is evident in numerous national and provincial policy documents. Of particular notice, in the country's 2013 National Development Plan which outlines the country's vision going forward to 2030, a whole chapter is devoted to a transition to a low carbon economy. The plan calls for "clear long-term-strategies for both adapting to the effects of climate change through adaptation policies and reducing its carbon emissions to a sustainable level through mitigation policies" (NPC, 2013, p. 180)

In light of the above some apprehensions exist for South Africa. These include ranking amongst the top global CO_2 emitters and the continuous rise in CO_2 emissions per capita. Figure 2.1 shows a cross-country comparison for 2009[2], plotting each country's per capita CO_2 emissions on the y-axis and the GDP per capita on the x-axis. Figure 2.2 shows the same but with the outliers[3] removed to get a better picture of South Africa's position. The figures clearly show that South Africa has a high level of CO_2 emissions given the country's level of development.

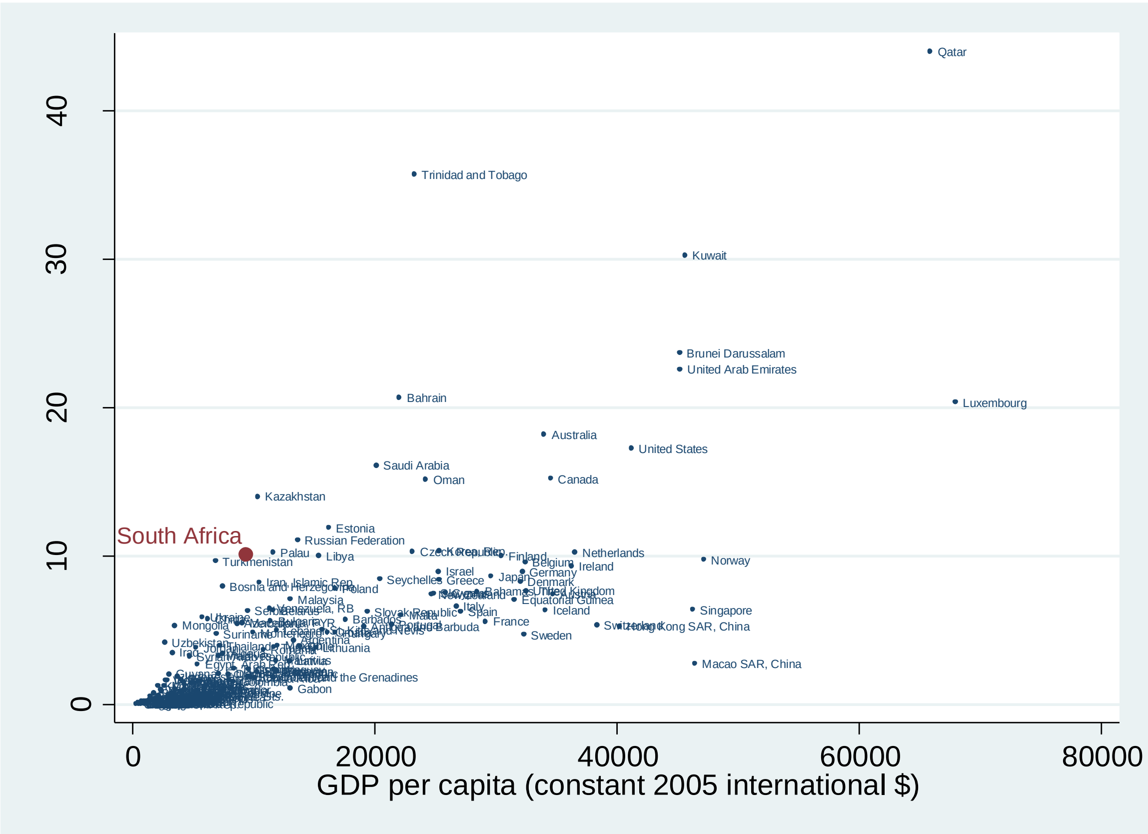
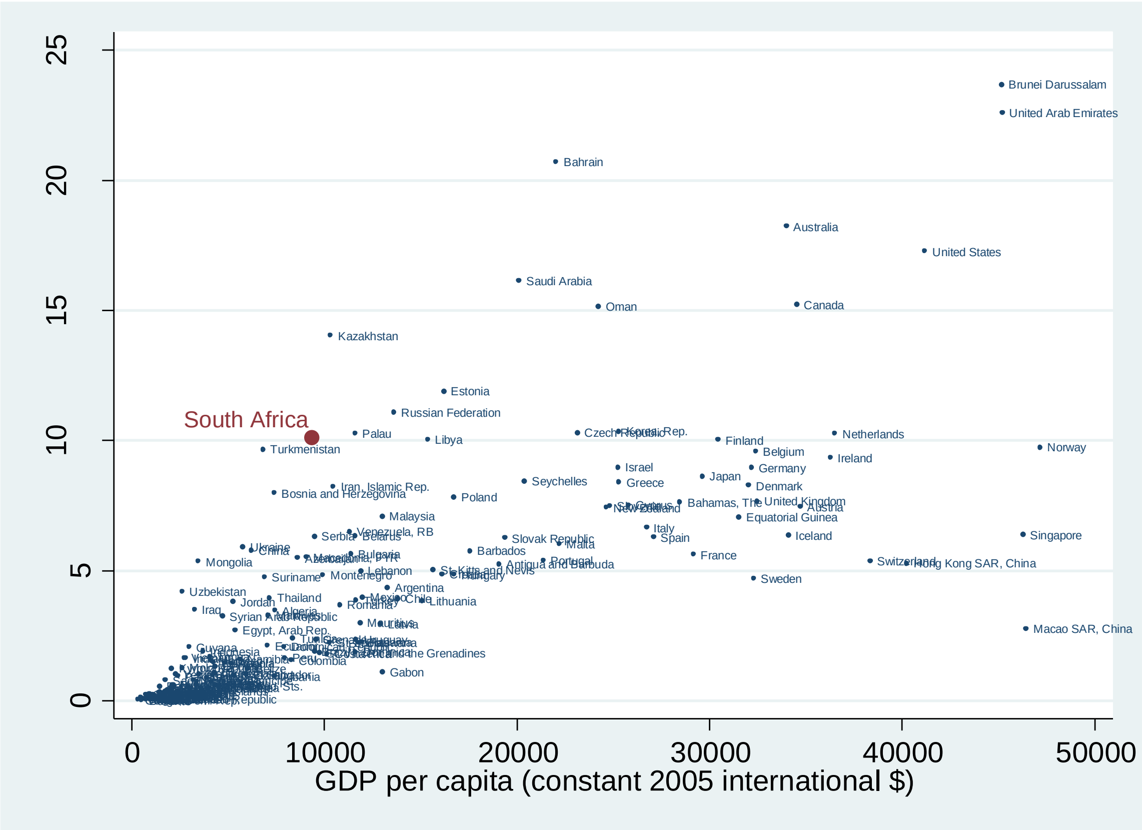


Figure 2.1: GDP per capita vs CO_2 Emissions per capita: All Countries with Available Data, 2009

Source: World Bank, World Development Indicators (Available: databank.worldbank.org)

[2] 2009 was chosen as it was the most recent year to obtain a sufficient number of observations

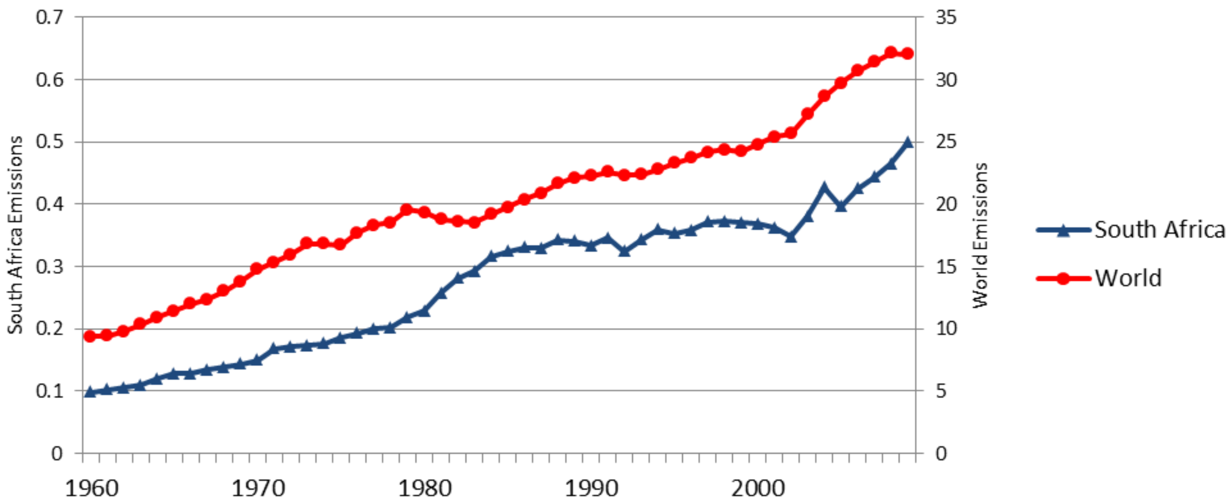
[3] Outliers were: Qatar, Trinidad and Tobago, Kuwait and Luxembourg



<u>Figure 2.2: GDP per capita vs CO_2 Emissions per capita: Outliers Removed, 2009</u>

Source: World Bank, World Development Indicators (Available: databank.worldbank.org)

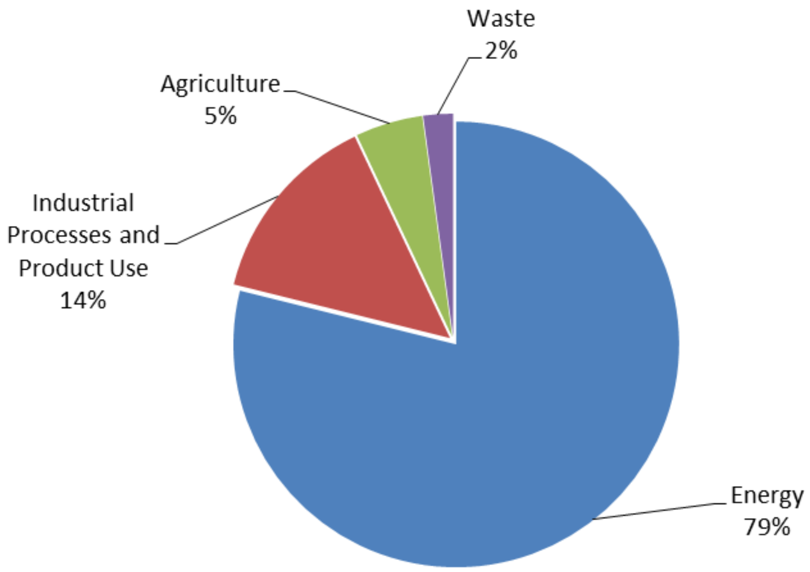
In general, South Africa's emissions have increased in line with the world trend. This is illustrated in Figure 2.3 which shows the annual CO_2 emissions per capita for South Africa and the World from 1960 to 2009. Over the entire 50 year period South Africa's share in world CO_2 emissions increased slightly from 1.04% in 1960 to 1.56% in 2009.



<u>Figure 2.3: Annual CO_2 Emissions, South Africa and the World, 1960-2009 (billion tons)</u>

Source: World Bank, World Development Indicators (Available: databank.worldbank.org)

In South Africa the major greenhouse gas polluters have historically been the Energy Sector, the Industrial Processes and Product use Sector, the Agricultural Sector and the Waste Sector. In 2000 these Sectors combined totalled 436 257 Gg CO_2-eq[4] emissions, of which 353 643 Gg CO_2-eq (81%) was carbon dioxide. The breakdown of these emissions by sector is shown in Figure 2.4 below. The Energy Sector is clearly the largest emitter of GHG's, with emissions in 2000 of 344 106 Gg CO_2-eq (79%). It should be noted that whilst the Agricultural Sector significantly contributed to GHG emissions, with 21 289 Gg CO_2-eq in 2000 (5%), this was mainly due to enteric fermentation, manure management (livestock), forest land, cropland, wetlands, GHG emissions from biomass burning and indirect N_2O emissions from managed soils (DEA, 2009).



<u>Figure 2.4: Breakdown of Greenhouse Gas Emissions by South Africa's Top Four Emitting Sector's</u>
Source: (DEA, 2009)

A Carbon Tax for South Africa

In order to reduce GHG emissions, South Africa can either engage in carbon trading and/or apply a carbon tax. Voluntary trading has been slow in South Africa; therefore the government has opted to implement a carbon tax. The tax will fall in line with South Africa's climate change response objectives which are guided by, amongst other things, the polluter pays principle. This principle simply states that the cost of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimizing further pollution, environmental damage or

[4] Carbon dioxide equivalent emissions

adverse health effects must be paid for by those parties responsible for harming the environment (National Treasury, 2013b).

Phase one of this tax will be implemented from 2015-2020 with phase two set to commence after 2020. To allow for a smoother transition to a low carbon economy, it has been proposed to initially introduce a modest carbon tax of R120 tCO2-eq. The tax rate will be expected to increase at 10 percent per annum until the end of 2019. This is expected to provide a significant long term price signal to influence behaviour (Andersen, 2008). After 2019 a new annual rate of increase will have to be determined and announced in the 2020 Budget (National Treasury, 2013b).

The carbon price (tax base) will be determined by means of a fossil fuel input tax on coal, crude oil and natural gases, based on their carbon content. All emission factors and procedures will be approved by the Department of Environmental Affairs (DEA) and will be in line with the International Panel on Climate Change (IPCC) (National Treasury, 2013b).

The Agricultural Sector contributes significantly to GHG emissions, mainly through enteric fermentation and manure management. As these emissions are difficult to measure and also require a complex baseline, it has been proposed that all agricultural related emissions should be excluded from the carbon tax for phase one, except for fuel related emissions in line with those already discussed. The same thinking applies for the waste sector and these sectors will be reviewed for phase two of the tax implementation (National Treasury, 2013b).

The carbon tax system will incorporate a tax free threshold for phase one, to be reviewed for phase two. The reason for the threshold is to provide some support to address concerns carbon-intensive sectors and businesses that are locally-based and trade-exposed might have surrounding their competitiveness as well as addressing some distributional concerns. The tax free percentage threshold is expected to be reduced for phase two and be replaced with absolute emission thresholds (National Treasury, 2013b).

The Treasury's Carbon Tax Policy paper does not give a clear indication on how the revenue generated from the carbon tax will be recycled except to suggest some possible avenues that they could explore. These avenues include tax shifting, rebates, free basic electricity, the supporting of energy efficiency and demand side management (EEDSM) programmes, supporting renewable energy programmes, the support of public transport and the shift of freight from road to rail (National Treasury, 2013b).

The successful adoption of the tax will rely heavily on the current structure of the economy, the recycling of all revenue collected from the tax, the incentives that will be provided for both technical and behavioural changes and how well environmental policy is coordinated with energy, industrial, trade and transport policies (National Treasury, 2013b).

This paper is not concerned with the optimal design of a carbon tax for South Africa, nor whether or not this is the correct mechanism for achieving South Africa's climate change mitigation objectives. The carbon tax has already been designed after numerous studies aimed at informing policy makers with regards to these issues. The concern of this paper is to assess what the potential impact of the carbon tax will be given the proposed design and the current structure of the economy. The rest of the paper will proceed in this regard. The carbon tax is applied nationally and therefore the impact assessment will begin at the national level. However, as mentioned, the impact will be different for different regions and for different industries. With this in mind, the paper then assesses what the impacts mean for a specific sector in a specific region, namely the Agricultural Sector of the Western Cape.

3. Methodology

Computable General Equilibrium (CGE) models provide a representation of an economy, linking economic activities, commodity outputs, factors of production, intermediate inputs and institutions. These relationships are based on the present structure of the economy as well as equations derived from economic theory (Lofgren, Robinson, & Harris, 2001). It thus allows users to obtain an estimate of the economy-wide implications of a particular shock or intervention.

This study utilises a static CGE model developed at the International Food Policy Research Institute (IFPRI) by Lofgren, Robinson and Harris (A Standard Computable General Equilibrium (CGE) Model in GAMS, 2001). It has been adapted and applied to the 2009 Social Accounting Matrix (SAM) for South Africa (Davies & Thurlow, 2011). For a detailed description of the South African model see Thurlow and van Seventer (2002).

The South African SAM distinguishes economic activities from the commodities they produce and use intermediately in production. Thus one activity can produce a number of different commodities and one commodity can be produced by different activities (Thurlow & van Seventer, 2002).

Ideally a carbon tax would be applied directly to greenhouse gas emissions. This has been acknowledged as the first-best solution but there are administrative capacity constraints which make this currently an unfeasible option for South Africa. The second-best option is to use fossil fuel inputs as a proxy for the tax base. This could be either upstream, taxing fuels as they enter the economy based on their carbon content, or downstream, taxing fuels as they are used based on their carbon content. It has been decided to introduce the carbon tax as a tax on fuel usage based on their emission factors which are to be derived from either approved emissions factors or through measuring and monitoring which is transparent and can be verified (National Treasury, 2013b).

To apply a tax based on fuel usage requires emissions factors to be calculated to reveal emissions per unit of fuel used. Combining the amount of each fuel used domestically in the economy from South Africa's 2009 SAM (Davies & Thurlow, 2011) with the amount of emissions attributed to domestic use of that fuel obtained from South Africa's 2009 Energy Balances (DE, 2009a), allows for an estimation of the tons of CO_2-eq greenhouse gas emissions per monetary unit of each activity in the economy.

The emissions calculations are shown in Table 3.1. In the SAM, electricity and gas are lumped together as one activity; it is therefore difficult to estimate the amount of emissions per unit of activity. Because of this difficulty and given that natural gas emissions are very small and hence won't have a strong distortionary influence, the small amount of emissions from natural gas is attributed to petroleum, giving the amounts in the "Adjusted Emissions" column. This is the same methodology as was used in a 2009 World Bank study of the effect of the proposed carbon tax on emissions in South Africa (Devarajan, Go, Robinson, & Theirfelder, 2009).

Table 3.1: South Africa Fossil Fuels Emission Factors, 2009

	Emissions *(Million tCO_2-eq)*	**Adjusted Emissions** *(Million tCO_2-eq)*	**Domestic Use** *(Billion Rand)*	**Emissions Factor** *(tCO2-eq per Million Rand Output)*
Coal	409.65	409.65	44.17	9 274.86
Natural Gas	2.18	0.00	89.72	0.00
Petroleum	82.28	84.46	179.28	471.09
Data Source:	(DE, 2009a)	***Calculated***	(Davies & Thurlow, 2011)	***Calculated***[5]

The carbon tax is modelled as an activity tax on activities based on their usage of the fossil fuels in Table 3.1 as intermediate inputs. More formally, a carbon tax rate on unit activity is applied based on the following formula:

[5] Emissions factors are calculated by dividing emissions by output with the appropriate unit conversions.

$$c_a = \frac{r \cdot \sum_i (f_i \cdot q_i)}{a}$$

Where:

c_a = carbon tax rate for activity a (% tax per million Rand output)

r = carbon tax rate set as rand tax per tCO_2-eq emissions

i = set of fossil fuels {coal; natural gas; petroleum}

f_i = emissions factor for fuel i (see Table 3.1)

q_i = total annual quantity of fuel i used as intermediate input in activity a (million rand, taken from SAM)

a = total annual output from activity a (million rand, taken from SAM)

This way of modelling the tax rate requires the assumption that all fossil fuels acquired are used and also that households and firms have the same CO_2 coefficients for fossil fuel consumption.

The carbon tax rate proposed by the Treasury to be implemented in 2015 is R120 per tCO_2-eq emissions. This will then go up by 10% per annum until the end of 2019 when the tax rate will be reviewed (National Treasury, 2013b). Thus the proposed tax rate will increase from R120 per ton to approximately R200[6] per ton going into 2020. With this in mind, a tax rate of R200 per tCO_2-eq emissions is chosen for the static CGE model. This is the same rate used in a similar recent CGE analysis done by the World Institute for Development Economics Research looking at South Africa (Arndt, Davies, Makrelov, & Thurlow, 2011).

The proposed carbon tax has tax free thresholds which will be active during the initial stages (National Treasury, 2013b). Due to the nature of the CGE model, it is not possible to include these thresholds into the modelling. However, this analysis is interested in identifying the potential impacts rather than trying to precisely quantify them. For this reason, modelling the tax free thresholds is not necessary.

The modelling required the following assumptions be made:

- The Consumer Price Index (CPI) is fixed and the Domestic Producer Price Index is flexible.
- Investment is savings-driven (neo-classical). The economy's marginal propensity to save remains constant and investment adjusts to maintain equality between investment and savings.
- The exchange rate is fixed and foreign savings can adjust. This assumption is made under the pretense that South Africa's activities do not exert a strong influence on global prices.

[6] R193.26 after the 10% increase for 2020

- All other direct tax rates are held constant and government savings is allowed to adjust. This is important later when viewing government revenues generated through the carbon tax. We are unable to accurately model the revenue recycling due to no definitive plan for how the revenues are going to be utilised (National Treasury, 2013b). However, by allowing government savings to adjust we can get an idea of the extent to which revenues are created.
- Capital was assumed to be fully employed and activity specific.
- Land was assumed to be fully employed and mobile.
- Labour was assumed to be unemployed and mobile, except skilled labour (labour with a tertiary education) which was assumed to be fully employed and mobile. The reason for this is South Africa's high rate of unemployment among unskilled workers and shortage of skilled workers (DL, 2012).

The modelling uses three different scenarios to assess the main implications of the tax

i. **Elementary Carbon Tax**: This scenario is a straight forward application of the tax, the rate of which (c_a) is calculated to equate to R200 per tCO_2-eq emissions based on the 2009 SAM. The tax is then applied to the level of output from each activity based on this calculation. This scenario assumes that there are no behavioural changes resulting from the tax
ii. **Carbon Efficiency**: The elementary carbon tax is applied but it is assumed that the tax effectively incentivises firms to become less intensive in their use of GHG emitting inputs. This is modelled through a 20% decline in the use of both petroleum and coal across all activities. We assume this is observable, so the tax rate on activity adjusts accordingly with the change in the use of intermediate inputs
iii. **Alternative Electricity**: The elementary carbon tax is applied but it is assumed that there is a push for South Africa to produce alternative, cleaner energy. As shown in Section 2, the energy sector is the largest contributor to GHG emissions. This is largely due to the high reliance on coal in electricity production (Winkler, 2007; Dabrowski, Aston, Murray, & Leaner, 2008; SANEDI, 2011). As shown in Table 3.1, the use of coal results in very high GHG emissions. We model this push for cleaner energy as a 50% decline in the intermediate use of coal for electricity production.

The actual percentages used are not of great significance, the model is representing a system that is extremely complex and large. As such it should not be used as a forecasting tool but rather as a tool to reveal the impacts a shock may have on the economy given its current structure. With this in mind, the concern is more with the relative changes and the directions they occur in and less with the absolute magnitude of impacts.

4. Economic Impact Assessment

The nature of the carbon tax is such that it impacts the whole economy and has far reaching implications. For this reason, and given the nature of this study, the impact analysis begins in this section by assessing the effect of the tax on the economy in its entirety. This will allow a comprehensive assessment of what the implications of the tax are likely to be. These results can then be applied to specific sectors or regions. This is done in the proceeding section which looks at the implications of the tax for the Agricultural Sector of the Western Cape.

CGE Results

Figure 4.1 shows the change in Gross Domestic Product (GDP) which occurs as a result of the carbon tax under the four different scenarios, measured at market prices. The carbon tax places significant strain on the economy, with the elementary tax resulting in a decline in GDP of more than 4% from the base. Whilst there is still a slight decline from the base, almost the entire GDP decline gets offset in the “carbon efficiency” scenario. In the “alternative electricity” scenario there is a marked improvement from the “elementary carbon tax” scenario but it offsets a smaller portion of the GDP decline than that observed in the cross-the-board efficiency investment in the “carbon efficiency” scenario.

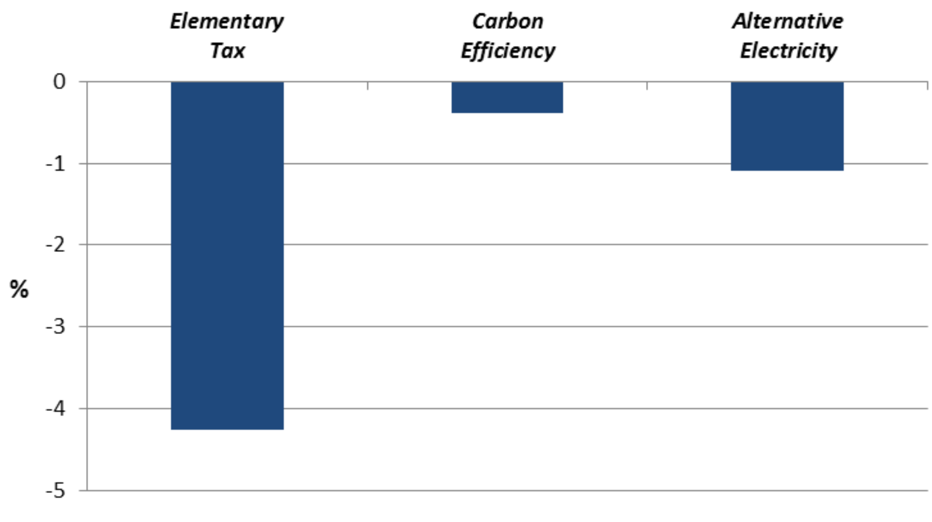


Figure 4.1: Percentage Change in GDP (Market Prices) Resulting from Carbon Tax
Source: Own Calculations using CGE analysis

Figure 4.2 shows the change to government savings occurring over the 3 scenarios. In the base, government savings is negative, with a budget deficit of approximately -R16 billion. The dashed horizontal line shows the amount of increase which would cover the deficit. In all scenarios the increase in government savings is more than the deficit, leading to a surplus. Despite the fact that the "carbon efficiency" scenario entails a decrease in the activity tax rate as firms use less greenhouse gas emitting fossil fuels per unit output, the increase in government savings is very similar to the elementary tax. This is due to the higher level of activity observed in Figure 4.1, so the decline in the tax rate is offset by an increase to the tax base.

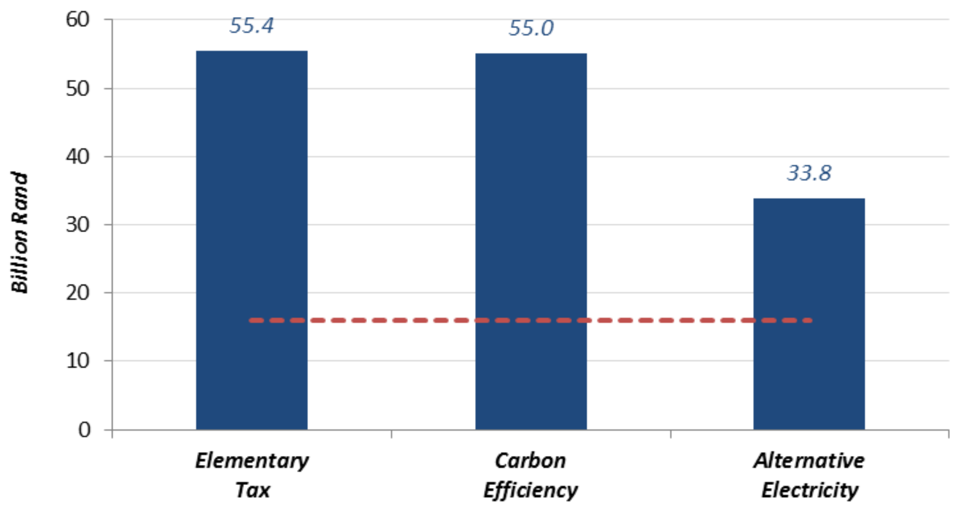


Figure 4.2: Net Increase in Government Savings Resulting from Carbon Tax
Source: Own Calculations using CGE analysis

In terms of the distribution of income effects, middle income households experience the biggest proportional drop in incomes, as shown in Figure 4.3 which shows the percentage drop in household income for each income decile. Decile 1 is the poorest 10% of households and decile 10 the richest 10%. With the elementary tax there are substantial drops in household income, even exceeding 10% for households in deciles 5 and 6. The improvement from the "elementary tax" is similar for both the "carbon efficiency" and "alternative electricity" scenarios. In both scenarios there is a much smaller decline in household incomes for all households. The fact that the curve becomes flatter indicates that the impact under these two scenarios is more equitable. Whilst the "carbon efficiency" and "alternative electricity" scenarios show a marked improvement on the "efficiency tax" scenario, there are still significant drops in household income in the range of 2%-4% depending on the decile.

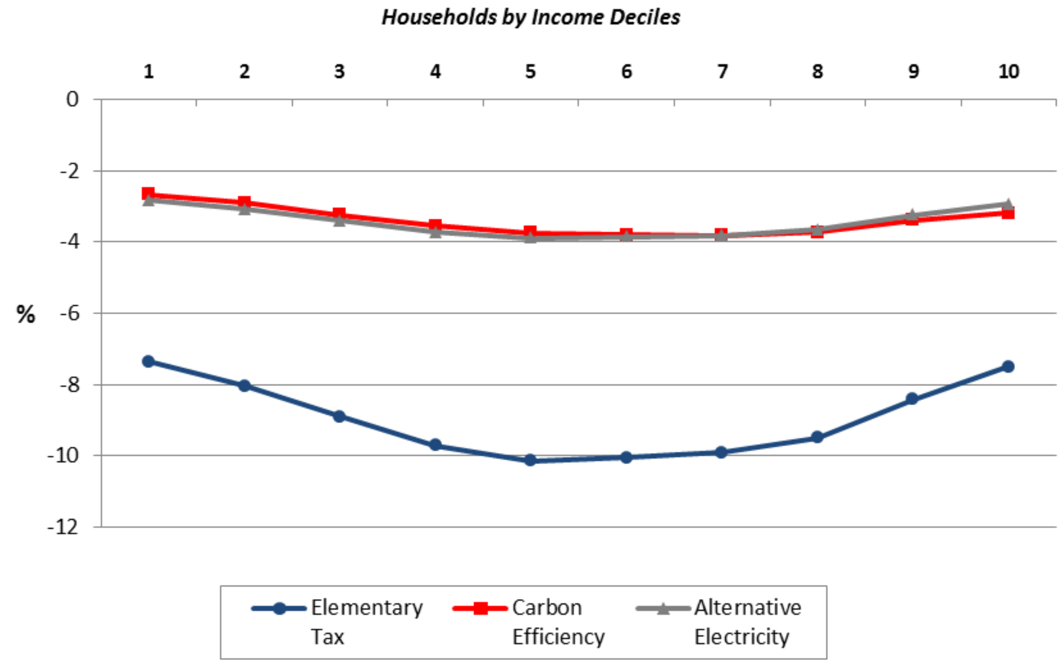


Figure 4.3: Percentage Change in Household Income by Income Decile

Source: Own Calculations using CGE analysis

Figure 4.4 shows the influence the carbon tax has on the price of electricity, The modelled tax of only R200 per tCO_2-eq emissions causes the electricity price to increase by almost 50% in the "elementary tax" scenario. This is mainly due to high usage of coal in electricity generation in South Africa, as illustrated by the high proportion of the price increase which is offset in the "alternative electricity" scenario.

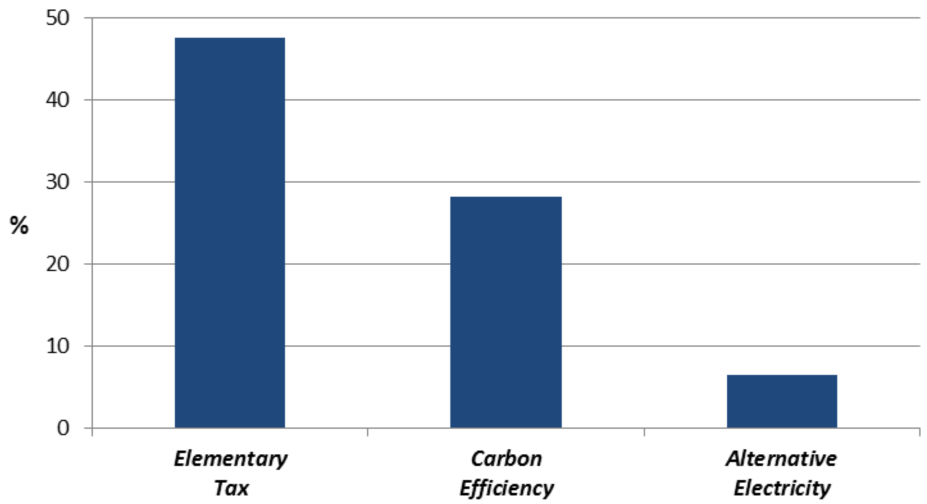


Figure 4.4: Percentage Change in the Price of Electricity as a Result of the Carbon Tax

Source: Own Calculations using CGE analysis

Economy-Wide Implications

The CGE results show the potential strain which the carbon tax could place on the South African economy. There is a significant drop in GDP as firms become less competitive. This drop will be felt disproportionately by middle income households.

The reality of the impact will depend on the reaction of the economy to the tax. If there is a move towards cleaner methods of production, the negative impact of the tax can largely be offset. The nature of the CGE model is such that it cannot gage how this may occur or what the cost of these alternative forms of production will be. It may well be the case that there are substantial initial costs for firms to switch and it is better for them to continue with the current methods of production to the long-term detriment of the economy.

The analysis highlights the important role that the State can play to ensure that there are the required changes in behaviour. The CGE results show the substantial revenues which stand to be generated from the carbon tax, these should be used to provide incentives or invest in research and development to assist in the transition to a cleaner economy. Currently, as discussed in Section 2, there are no specified channels for how the tax revenues are to be spent (National Treasury, 2013b).

It may seem unattractive for the government budget to spend the new revenues on pushing the economy away from the very production methods which are creating the revenues. However, it was shown that any loss in government revenue per unit produced resulting from the move towards cleaner production can be offset due to the significant increase in production levels.

It was observed that greater gains could be realised through a smaller move towards cleaner production throughout the economy than a targeted larger move towards cleaner electricity production. However, to get all industries to move, even a small amount would be far more difficult than a massive focused investment into cleaner electricity production. Considering this and the fact that the "alternative electricity" scenario still largely offset the negative impact of the tax, this would appear a more attractive option to focus the funds generated from the tax.

There are added welfare benefits to the "alternative electricity" scenario. From a household income point of view, the scenario is similar to the "carbon efficiency" scenario. However, the "alternative electricity" scenario exerts a much stronger influence on the electricity price. This is important given the huge spike in the electricity price under the "elementary tax" scenario and the fact that the country's National Development Plan makes specific reference to the goal of maintaining competitive electricity prices and to bring electricity to 95% of households within the next 20 years (NPC, 2013).

As Figure 4.4 shows, the move towards alternative forms of electricity can significantly help to mitigate the impact of the tax on the electricity price.

The carbon tax has economy-wide impacts. However the implications of these impacts are different for different sectors and for different regions within South Africa. The next section looks to provide some information on these implications for a specific sector within a specific region, the Agricultural Sector of the Western Cape.

5. Sector Focus: Agriculture in the Western Cape

Agriculture and climate change are very closely connected. As shown in the previous section, agriculture is a significant contributor to the GHG emissions which are responsible for climate change. Additionally, agriculture is one of the most vulnerable sectors to the negative impacts of climate change.

It is becoming increasingly difficult for farmers to harvest due to weather and climate changes including unexpected shifts in temperatures and unpredictable rain patterns. Conditions can become too wet to plant or harvest, or plants are too small due to lack of sunlight, or plants die because of too much sunlight and drought periods. With erratic hot and cool weather conditions, more pests and weeds tend to be attracted to areas where they do not normally exist or live. The “new” pests often become very resilient to pesticides and herbicides and can have a dramatic effect on crops and their export quality resulting in huge financial losses (Nelson, et al., 2009; Elbehri, Genest, & Bufisher, 2011; Terra Firma Academy, 2013).

Research has shown that the impacts of climate change tend to be particularly severe in the south-western corners of the three continents south of the equator (WCDEADP, 2008). This means that in South Africa, the Western Cape Province is particularly vulnerable. This province is also particularly important in terms of South Africa’s agricultural production. This can be seen in Figure 5.1 which shows the gross farming income for each province in 2007. The highest income is comfortably the Western Cape, responsible for approximately 21% of the total gross farming income of South Africa.

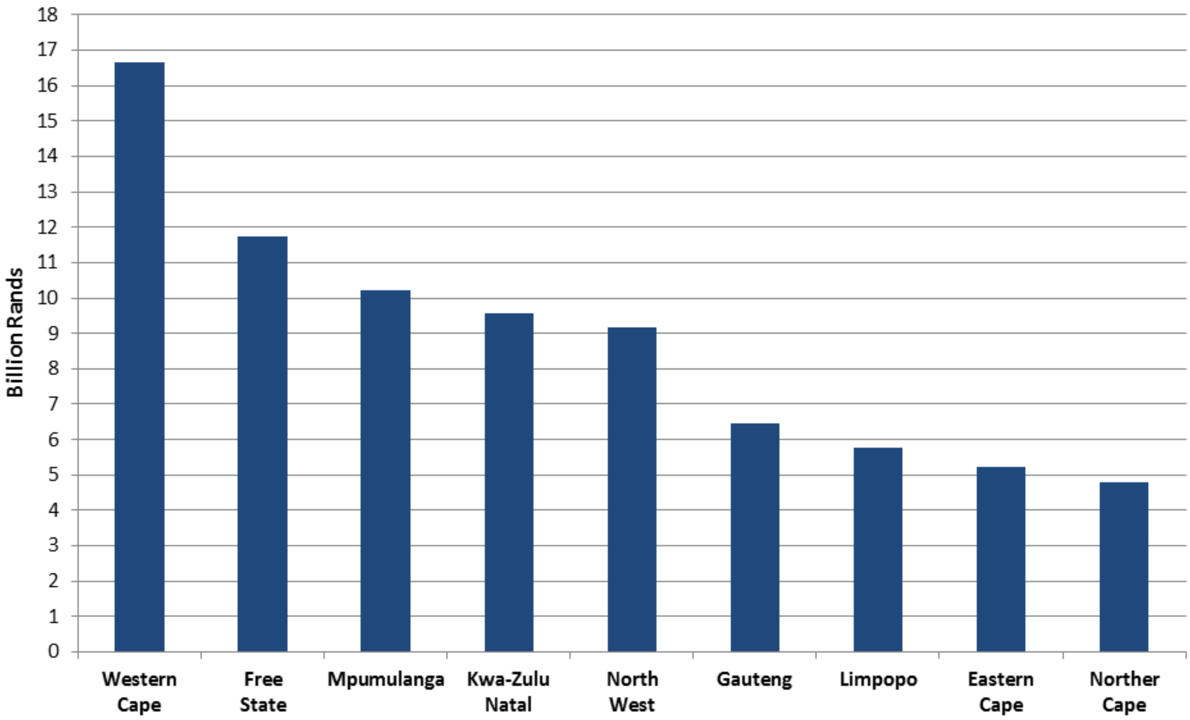


Figure 5.1: Total Gross Farming Income by Province in South Africa, 2007
Source: (Stats SA, 2007)

Whilst the carbon tax will be applied at the national level and the impact will be felt country-wide, the implications of the tax will vary amongst different Sectors and across the different regions of the country. This is particularly the case given the concentration of different agricultural products in different regions in South Africa. This can be seen in Figure 5.2 and Figure 5.3 below. Figure 5.2 shows the contributions to gross farming income of different agricultural product groups for South Africa and for each province. Figure 5.3 shows the breakdown of the area under crop production for South Africa and for each province. Both graphs show how regionally diverse South Africa is in terms of agricultural production, highlighting the need to tailor conclusions specifically for a particular province.

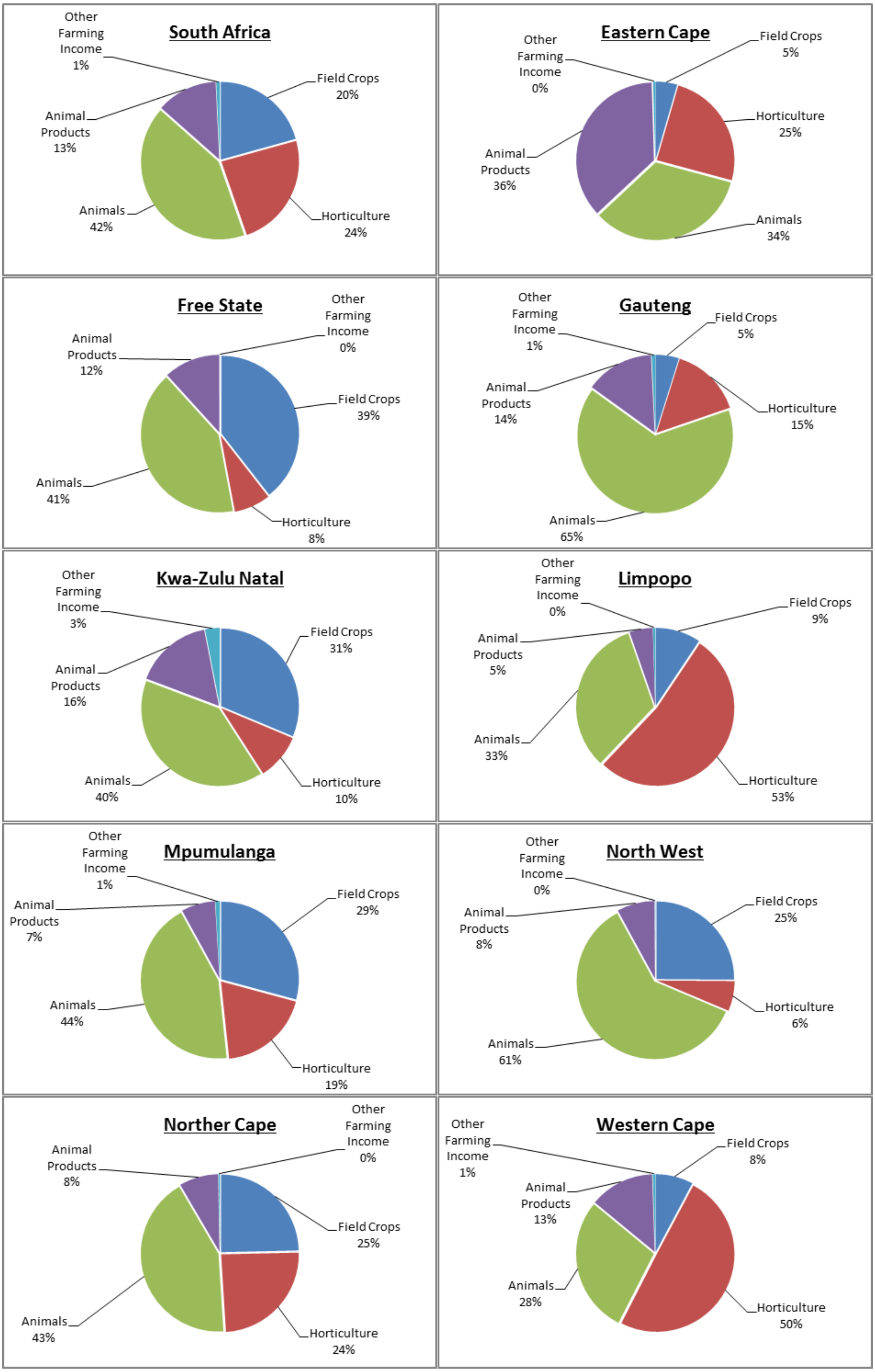


Figure 5.2: Breakdown of Farm Income in South Africa and by Province, 2007

Source: (Stats SA, 2007)

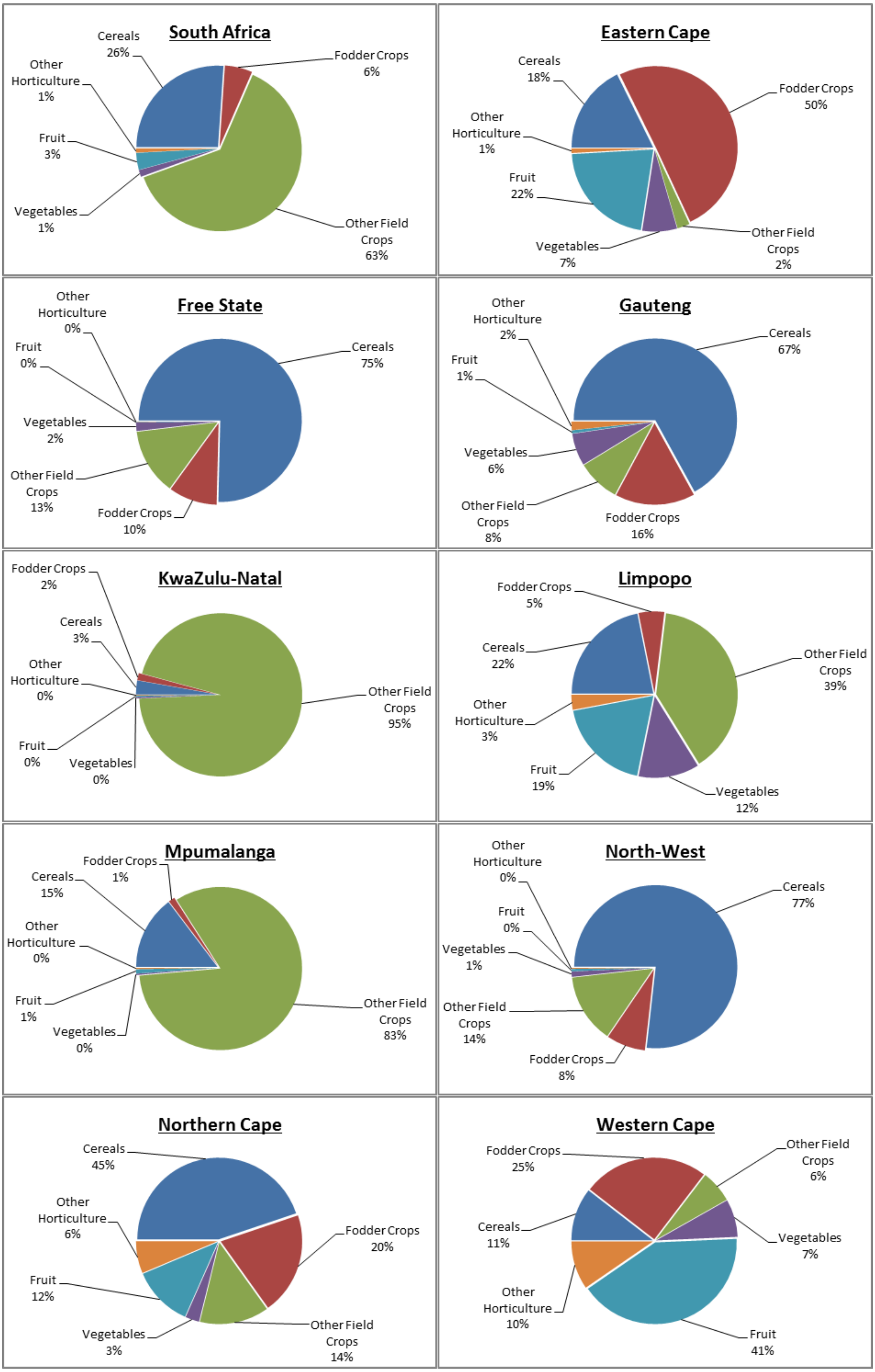


Figure 5.3: Agricultural Land Use for Crop Production in South Africa and by Province, 2007

Source: (Stats SA, 2007)

Direct vs Indirect Impacts

Using CGE analysis allows users to observe not only the direct impact of the carbon tax as firms have the financial cost of paying taxes, but also the indirect impact resulting from changing prices of intermediate inputs to production.

The main emissions from agriculture come through enteric fermentation, manure management, burning of agricultural residues, fire and deforestation (DME, 2008). As discussed in Section 2, these agricultural emissions will not be taxed. The direct impact of the carbon tax will therefore only be in relation to the use of fossil fuels in production (National Treasury, 2013b).

In order to distinguish between the direct and indirect impacts, a fourth scenario is introduced:

iv. **Agriculture Tax-Free**: This scenario is the same as the "elementary tax" scenario but agricultural activities are not taxed. This will remove the direct impact of the tax and highlight the degree to which the agricultural sector will be impacted indirectly.

Figure 5.4 shows the changes in agricultural activity resulting from the carbon tax under the three original scenarios plus the new "agriculture tax-free" scenario. The elementary tax results in a significant decline in agricultural output with activity falling by over 7%.

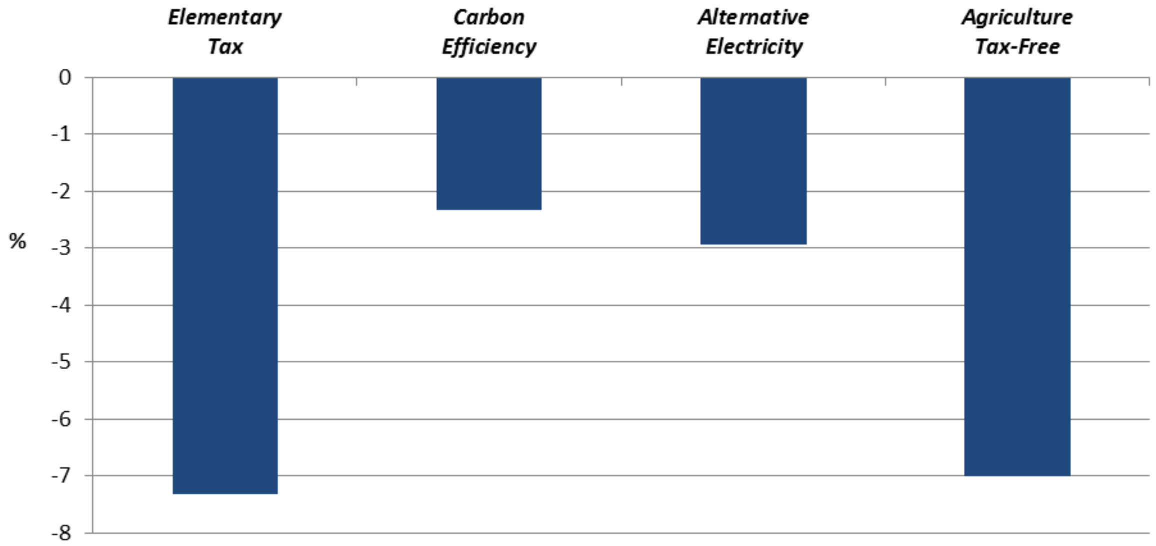


Figure 5.4: Percentage Change in Domestic Agricultural Activity Output Resulting from Carbon Tax
Source: Own Calculations using CGE analysis

Under the "agriculture-free" scenario, there is very little difference to the impact on agricultural activity when compared with the elementary tax. As discussed in Section 2, the tax is targeted at the intermediate use of fossil fuels, particularly carbon. The CGE results show that the agricultural sector only uses a minimal amount of these fuels and hence will not suffer too heavily in terms of the direct impact of having to pay the tax.

The main impact on the agricultural sector is going to come through the increase in the price of intermediate inputs. This is evident in both the similarity between the "elementary tax" and "agriculture tax-free" scenarios, and also through the fact that under the "carbon efficiency" and "alternative electricity" scenarios, the negative impact of the tax is largely offset.

As shown in Section 3, the main commodity affected is electricity. However, the fact that the "carbon efficiency" scenario shows a substantial improvement on the "alternative electricity" scenario shows that there are other intermediate inputs which are experiencing price increases which are significantly impacting on agricultural activity.

To gain an understanding of these different price pressures for the Agricultural Sector requires a measure to which each production input influences activity in the Sector. In general, for the type of CGE model used in the analysis[7], there are two factors which influence the impact that each intermediate good has on a particular activity following a particular shock:

- The magnitude of the increase in the price of the commodity following the shock (α)
- The amount of the commodity required to produce one unit of output from the activity (β)

To get an idea of the combined effect of these two factors, a new index is created, AC, calculated as the product of the two factors, α and β. Put formally:

$$AC = \alpha.\beta \qquad \text{(where } \alpha \text{ and } \beta \text{ are defined above)}$$

Using the product of the two factors means that the weighting of the two factors and the units used are not important which is good for the analysis which is only concerned with relative influences. The top ten factors in terms of their influence on agricultural activity, as determined by the AC index based on the "elementary tax" scenario, are shown in Table 5.1 below. The magnitude of the index is trivial; the purpose of the analysis is just to see which commodity prices are going to have the strongest negative influence on agricultural activity.

[7] This statement is reliant on the constant elasticities which govern how different intermediate inputs are used together in production. For a full description of the CGE model see: (Thurlow & van Seventer, 2002)

Electricity and gas distribution comes out top of the list due to the price increase being so large, as already shown in Figure 4.4. Fertilizers and pesticides are also shown to exert a strong impact on agricultural activity. With this input, the price change is relatively small, less than 4%, but it is an input used intensively in agricultural production and hence the small change will have put a large amount of pressure on the sector.

Table 5.1: Commodity Price Increases Most Influencing Agricultural Activity Decline

#	Commodity	Percentage Price Change After Shock (α)	Intermediate Units Per Unit Agricultural Activity Output (β)	AC (α.β)
1	Electricity & gas distribution	47.70	0.0207	0.9894
2	Fertilizers & pesticides	3.93	0.1979	0.7769
3	Petroleum products	6.14	0.0559	0.3435
4	Metal products	3.63	0.0369	0.1339
5	Animal feeds	0.80	0.1461	0.1165
6	Water distribution	11.63	0.0052	0.0604
7	Pharmaceuticals	1.36	0.0291	0.0395
8	Made-up textiles	1.62	0.0202	0.0326
9	Special purpose machinery	3.96	0.0074	0.0294
10	Vehicles & parts	1.92	0.0132	0.0254

Source: Own Calculations using CGE analysis

We have thus far been discussing agriculture very generally. In actual fact agricultural activities produce a number of different commodities and these different commodities have very different production technologies and are concentrated in different parts of the country depending on the required climate and geography (see Figure 5.2. and Figure 5.3). In the next subsection the analysis is taken a step deeper to look at the impact the carbon tax will have on the production of different agricultural commodity groups.

Commodity Outlook

Table 5.2 shows the percentage change in output for all the commodity groups as broken down in the CGE model, sorted ascending by the change under the "elementary tax" scenario. Under the "elementary tax" scenario, there is a decrease in the output of 70 of the 85 commodities, with 15 commodities increasing in supply. The same is true under the "agriculture tax-free" scenario. Under the "alternative electricity", an additional 5 commodities experience an increase in output which are also positive for the "carbon efficiency" scenario along with an additional 6 more commodities.

Table 5.2: Percentage Change in Commodity Output Resulting From Carbon Tax Scenarios

#	Commodity	Elementary Tax	Carbon Efficiency	Alternative Electricity	Agriculture Tax-Free
1	Electricity & gas distribution	-15.00	-8.76	-4.08	-14.97
2	Water distribution	-13.40	-7.65	-5.68	-13.37
3	Coal mining	-11.55	-24.65	-22.62	-11.53
4	Weaving & finishing of fabrics	-11.12	-4.73	-4.08	-11.05
5	Knitting & crocheted fabrics	-10.60	-4.73	-4.03	-10.54
6	Wearing apparel	-9.74	-4.04	-3.79	-9.68
7	Starches	-9.39	-3.76	-3.63	-9.26
8	Grain milling	-9.31	-3.62	-3.61	-9.18
9	Dairy	-9.05	-3.59	-3.52	-8.92
10	Oils & fats	-9.02	-3.54	-3.49	-8.91
11	Other foods	-8.99	-3.47	-3.52	-8.88
12	Sugar	-8.92	-3.48	-3.45	-8.79
13	Soap & related products	-8.91	-3.51	-3.37	-8.87
14	Bakery	-8.76	-3.41	-3.43	-8.65
15	Paper products	-8.71	-3.98	-3.35	-8.67
16	Pastas	-8.67	-3.49	-3.38	-8.56
17	Fish	-8.60	-3.46	-3.36	-8.50
18	Confectionary products	-8.60	-3.41	-3.38	-8.50
19	Footwear	-8.47	-3.20	-3.26	-8.41
20	Fruit & vegetables	-8.44	-3.36	-3.30	-8.33
21	Made-up textiles	-8.38	-3.20	-3.25	-8.30
22	Meat	-8.37	-3.30	-3.24	-8.26
23	Basic chemicals	-8.16	-4.00	-2.47	-8.12
24	Rubber tyres	-7.96	-3.18	-3.28	-7.93
25	Agriculture	-7.87	-2.74	-3.12	-7.62
26	Fertilizers & pesticides	-7.74	-3.15	-2.94	-7.56
27	Animal feeds	-7.60	-2.64	-3.02	-7.34
28	Petroleum products	-7.36	-13.71	-2.91	-7.32
29	Beverages & tobacco	-7.31	-2.94	-2.92	-7.25
30	Domestic appliances	-7.24	-1.93	-2.45	-7.19
31	Fisheries	-7.21	-2.76	-2.81	-7.11
32	Forestry	-7.01	-2.78	-2.69	-6.98
33	Other chemicals	-6.92	-3.80	-3.07	-6.90
34	Other mining	-6.78	-3.91	-2.37	-6.78
35	Other manufacturing	-6.59	-1.70	-2.25	-6.54
36	Pharmaceuticals	-6.45	-2.58	-2.46	-6.40
37	Education	-6.30	-2.59	-2.44	-6.27
38	Glass products	-6.09	-1.58	-1.72	-6.05
39	Jewellery	-6.07	-2.51	-2.43	-6.03
40	Transport	-5.89	-2.52	-2.68	-5.84
41	Printing & publishing	-5.84	-2.17	-2.13	-5.81
42	Other services	-5.84	-2.02	-2.14	-5.80
43	Hotels & catering	-5.71	-2.10	-2.19	-5.68
44	Health	-5.28	-2.06	-2.07	-5.25
45	Other transport equipment	-5.14	-1.76	-2.18	-5.11
46	Carpets, rugs & mats	-5.11	-0.87	-1.39	-5.08
47	Wholesale & retail trade	-4.94	-1.78	-1.57	-4.91
48	Other textiles	-4.80	-0.30	-1.07	-4.76
49	Leather products	-4.68	-0.30	-1.19	-4.62
50	Recycling & waste	-4.60	-0.67	-1.27	-4.61
51	Other rubber products	-4.57	-1.32	-1.85	-4.55
52	Research & development	-4.50	-1.65	-1.61	-4.48
53	Insurance & pensions	-4.39	-1.85	-1.74	-4.36
54	Wood products	-4.35	-0.79	-1.20	-4.31
55	Post & communications	-4.26	-0.59	-1.72	-4.23
56	Furniture	-4.20	0.39	-0.83	-4.17
57	Financial services	-4.00	-1.56	-1.52	-3.97
58	Rental services	-3.90	-0.45	-1.21	-3.87
59	Plastics	-3.86	0.02	-0.83	-3.81
60	Non-ferrous metal	-3.17	1.16	-0.14	-3.17
61	Paints & related products	-2.65	0.49	-0.42	-2.63
62	Radio & television equipment	-2.56	0.66	-0.36	-2.54
63	Real estate activities	-2.45	-0.67	-0.82	-2.43
64	Other business activities	-2.33	0.02	-0.56	-2.30
65	Lifting equipment	-1.96	1.41	0.09	-1.92
66	Legal & accounting activities	-1.64	1.29	0.14	-1.62
67	Metal products	-1.42	1.80	0.39	-1.40
68	Basic iron & steel	-1.29	2.60	0.81	-1.28
69	Bearings & gears	-0.65	2.49	0.80	-0.64
70	Public administration	-0.10	-0.04	-0.04	-0.10
71	Vehicles & parts	0.04	3.56	1.39	0.06
72	Pumps, compressors & valves	0.25	2.90	1.28	0.24
73	Other non-metallic minerals	2.44	5.32	2.61	2.44
74	Cement	2.73	5.74	2.86	2.74
75	Ceramicware	2.91	6.31	3.09	2.91
76	Electrical machinery	3.42	6.13	3.25	3.42
77	Medical equipment	5.57	8.21	4.46	5.58
78	Construction	7.03	9.19	5.19	7.03
79	Office machinery	7.85	10.20	5.77	7.85
80	Engines & turbines	8.22	10.53	6.05	8.22
81	Special purpose machinery	8.30	10.56	5.99	8.31
82	General purpose machinery	8.70	11.14	6.35	8.71
83	Railways & trams	9.06	11.24	6.50	9.06
84	Ships & boats	9.20	11.38	6.54	9.20
85	Aircraft	9.76	11.80	6.83	9.77

Source: Own Calculations using CGE analysis

As expected, the main commodity to suffer is "electricity and gas distribution" except under the "carbon efficiency" and "alternative electricity" scenarios where the coal mining industry is hardest hit. Output of "water distribution" is severely decreased as are the manufactured commodities "weaving & finishing of fabrics", "knitting & crocheted fabrics" and "wearing apparel". After this, most of the commodities worst affected are either agricultural products or agriculture-related products.

In the Western Cape, approximately half of agricultural income comes from horticulture (see Figure 5.2) and combined approximately 58% of the farmed cropland is used for vegetables, fruit and other horticultural products (see Figure 5.3). Figure 5.5 shows the percentage change in fruit and vegetable output resulting from the carbon tax under the four different scenarios. Production in this area is significantly affected, dropping by over 8% under both the "elementary tax" and "agriculture tax-free" scenarios. Interestingly, the drop in output is slightly greater under the "carbon efficiency" scenario than under the "alternative electricity" scenario, although both show a substantial improvement on the "elementary tax". This is in contrast to what was observed when viewing agricultural activity more generally, showing that whilst fruit and vegetables are strongly affected by the price of electricity, it is less affected by the other inputs discussed when analysing Table 5.1.

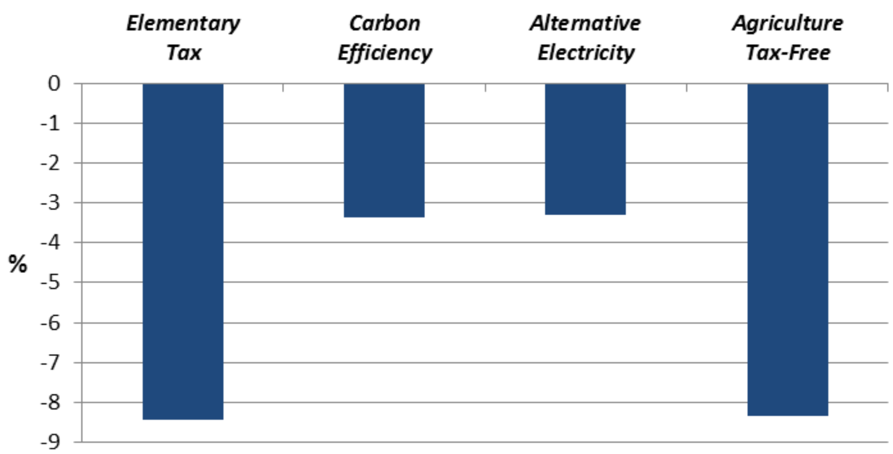


Figure 5.5: Percentage Change in Fruit and Vegetable Output Resulting From Carbon Tax
Source: Own Calculations using CGE analysis

In the breakdown of gross farming income in the Western Cape in Figure 5.2, animals made up approximately a third of farming income. Figure 5.6 shows the change in the output of meat products resulting from the carbon tax under the four scenarios. The outcome is remarkably similar to that of fruit and vegetables and hence the same conclusions can be drawn about the meat industry.

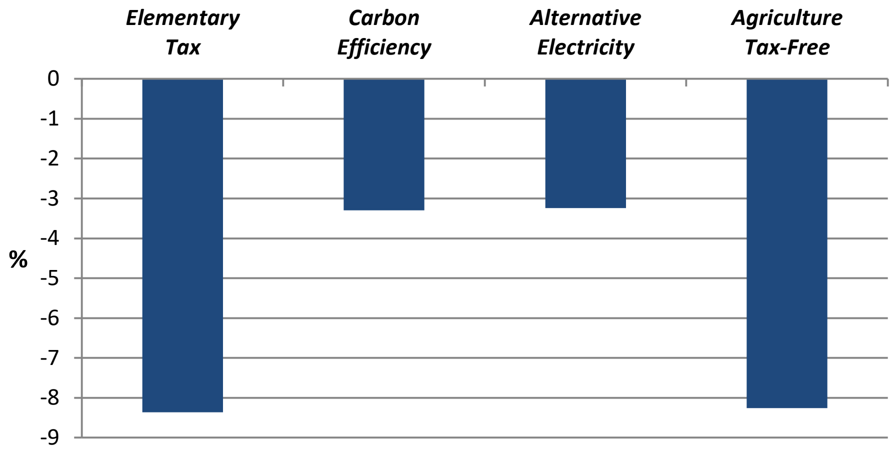


Figure 5.6: Percentage Change in Meat Output Resulting From Carbon Tax
Source: Own Calculations using CGE analysis

Implications for the Western Cape's Agricultural Sector

The preceding analysis has shown us that the impact of the carbon tax for each industry is more complex than simply the degree to which the industry uses GHG emitting fossil fuels in production. In fact it has been shown that the direct impact can often be trivial in comparison to the potential indirect impacts.

The aim of the carbon tax is to incentivise firms and individuals to become more carbon efficient in production. For the Agricultural Sector the impact most felt is not going to be the effective increased cost of GHG emitting fossil fuels but through the indirect impact due to the rise in the price of other inputs. In particular the price of electricity, if left to market forces, will increase substantially due to South Africa's reliance on coal for electricity production. This means that in order to weather the impact of the carbon tax, the key will be to target electricity efficiency more so than looking to cut the sector's emissions.

The change in the price of other inputs, such as fertilizers and pesticides were also shown to significantly influence agricultural activity. These inputs were less important influences for the main produce of the Western Cape, meaning electricity efficiency is of particular importance to agriculture in the Western Cape. Agricultural producers should nonetheless also look to other areas where they can improve efficiency, particularly in the use of fertilizer and pesticides.

The impact of the carbon tax presents serious challenges for the Agricultural Sector of the Western Cape, especially if there is no assistance from the government in developing new technologies and processes for electricity production. However, there is also the potential for opportunities to be created for the Sector.

One particular area of potential opportunity is in biofuel production. With the clear strain which is going to be placed upon the electricity sector as it currently is, there is going to be increased demand for alternative electricity sources. Biofuels present an opportunity to fill this demand and provide a cheaper and cleaner energy source (Mitchell, 2011). As it requires agricultural inputs, it can help to boost agricultural production in the economy. Here the key is going to be research into production processes, particularly as there is still uncertainty on the optimal crop to use and whether or not crops should be used to which the Western Cape is suited to producing.

It has been shown that it is not so much fossil fuel emissions which are going to be the key to surviving the impact of the carbon tax but rather the use of inputs which use these fuels intensively, particularly the electricity sector. It is, however, still important that the Sector still strives to be cleaner by reducing emissions. This is not just due to the fact that the transition to a low-carbon economy is a national priority (NPC, 2013), but also could prove critical for the development of the Sector. There is a plan for a review of the tax after 2020 and then there could be taxes applied to agricultural emissions (National Treasury, 2013b). If the Sector is still struggling to cope with the impact from the rise in other input costs at the time that taxes are applied to agricultural emissions, the Sector could find itself under serious strain if it hasn't already taken steps to reduce these emissions beforehand.

6. Concluding Remarks

This paper has, amongst other things, highlighted the complexities surrounding the potential impact of the upcoming carbon tax. It has also shown the importance of doing a thorough analysis when assessing the impact of a certain shock as there could be indirect impacts which far outweigh the direct impacts.

In the case of South Africa's carbon tax, the main strain on the economy is going to come through the rise in the price of electricity resulting from the high reliance on coal for production. With the case of the Agricultural Sector it was shown that the direct impact of the tax is actually negligible when compared with the indirect impacts.

The reality of the carbon tax impact on the economy will be determined by how the State spends the new tax revenues. Investing in cleaner production technologies, in particular cleaner sources of electricity, can help to significantly offset the potentially damaging impact of the tax. The rate at which these investments are made will also be important. Quick, robust investments will stand the country in good stead going forward but if it's a slow process then the economy will severely struggle.

In addition to trying to adopt cleaner production technologies, firms should look at how, where possible, they can contribute towards achieving cleaner energy. For the Agricultural Sector of the Western Cape this could involve research and investment into biofuel production or other forms of clean energy.

The carbon tax comes at a difficult time. The world economy is on the back of years of underperformance meaning exports have dried up, particularly to some of the key exports markets of the Western Cape Agricultural Sector (WCGPT, 2012). In addition global warming and the resulting climate change means that farmers face challenging conditions to produce under. At the same time recent years have seen a sharp rise in the number and stringency of standards to which agricultural exporters have to comply in order to gain access into foreign markets (Wilson & Otsuki, 2004). This means that there is very little room for error and it is important that actions are tailored to outcomes which are in line with reality.

The good news is that today the tools and technology exist to accurately anticipate what the impacts of a shock will be. If the necessary actors remain informed and act accordingly, the Agricultural Sector of the Western Cape, and in the same fashion the South African economy, can make it through this period adapting to the carbon tax and come out on the other side not only strong and growing but also developing in a way which assists in the preservation of the earth's precious environment.

References

Andersen, M. (2008). Environmental and Economic Implications of Taxing and Trading Carbon: Some European Experiences. In J. Milne, *The Reality of Carbon Taxes in the 21st Century* (pp. 61-87). Vermont, USA: Vermont Journal of Environmental Law.

Arndt, C., Davies, R., Makrelov, K., & Thurlow, J. (2011). *Measuring the Carbon Intensity of the South African Economy.* World Institute for Development Economics Research, Working Paper No. 2011/45.

Dabrowski, J., Aston, P., Murray, K., & Leaner, J. (2008). Anthropogenic Mercury Emissions in South Africa: Coal Combustion in Power Plants. *Atmospheric Environment, 42*(27), 6620-6626.

Davies, R., & Thurlow, J. (2011). *A 2009 Social Accounting Matrix for South Africa: Version 1.2.* Helsinki, Finland: World Institute for Development Economics Research, United Nations University.

DE. (2009a). *Commodity Flow and Energy Balances, Aggregated Balances 2009, Version 4.* Republic of South Africa: Department of Energy.

DE. (2009b). *Commodity Flow and Energy Balances, Native Units 2009, Version 1.* Republic of South Africa: Department of Energy.

DEA. (2009). *Greenhouse Gas Inventory South Africa: 1990 to 2000.* South Africa: Government Gazette (No 32490).

Devarajan, S., Go, D., Robinson, S., & Theirfelder, K. (2009). *Tax Policy to Reduce Carbon Emissions in South Africa.* The World Bank, Africa Region: The World Bank Policy Research Working Paper 4933.

DL. (2012). *Job Opportunities in the South African Labour Market. 2011-2012.* South Africa: Department of Labour.

DME. (2008). *CDM in Agricultural Sector, South Africa.* Republic of South Africa: Department of Minerals and Energy.

Elbehri, A., Genest, A., & Bufisher, M. (2011). *Global Actions on Climate Change in Agriculture: Linkages to Food Security, Markets and Trade Policies in Developing Countries.* Rome, Italy: Food and Agricultural Organization of the United Nations, Trade and Markets Division.

Harding, G. (1968). The Tragedy of the Commons. *Science, 162*(3859), 1243-1248.

IPCC. (2014). *Climate Change 2014, Mitigation of Climate Change.* Geneva, Switzerland: Intergovernmental Panel on Climate Change (IPCC).

Lofgren, H., Robinson, S., & Harris, R. (2001). *A Standard Computable General Equilibrium (CGE) Model in GAMS.* Washington D.C., New York: International Food Policy Research Institute.

Mitchell, D. (2011). *Biofuels in Africa: Opportunities, Prospects, and Challenges.* Washington DC, USA: The World Bank.

National Treasury. (2013a). *2013 Budget Speech.* Pretoria, South Africa: National Treasury.

National Treasury. (2013b). *Carbon Tax Policy Paper: Reducing Greenhouse Gas Emissions and Facilitating the Transition to a Green Economy.* Republic of South Africa: National Treasury.

Nelson, G., Rosegrant, M., Koo, J., Robertson, R., Sulser, T., Zhu, T., et al. (2009). *Climate Change: Impact on Agriculture and Costs of Adaptation.* Washington DC, USA.: International Food Policy Research Institute (IFPRI).

NPC. (2013). *National Developemnt Plan: Vision for 2030.* South Africa: National Planning Commission.

Ostrom, E. (2009). *A Polycentric Approach for Coping with Climate Change.* Washington DC, USA: The World Bank Policy Research Working Paper 5095.

RSA. (2011). *National Climate Change Response White Paper.* Pretori, South Africa: The Government of the Republic of South Africa.

SANEDI. (2011). *Overview of the South Africa Coal Value Chain.* Prepared as a basis for the development of the South African Coal Roadmap: South African National Energy Development Institute.

Stats SA. (2007). *.* Pretoria, South Africa: Statistics South Africa.

Stern, N. (2007). *Stern Review: The Economics of Climate Change.* Cambridge, United Kingdom: Cambridge University Press.

Terra Firma Academy. (2013). *Carbon Footprint Analyst.* South Africa: Terra Firma Academy.

Thurlow, J., & van Seventer, D. (2002). *A Standard Computable General Equilibrium Model for South Africa.* Washington D.C., USA: International Food Policy Reseacrh Institute, Trade and Macroeconomics Division Discussion Paper No. 100.

United Nations. (1992). *United Nations Framework Convention on Climate Change.* United Nations.

United Nations. (1998). *Kyoto Protocol of the United Nations Framework Convention on Climate Change.* New York, USA: United Nations.

United Nations. (2012). *Doha Ammendment to the Kyoto Protocol.* New York, USA: United Nations.

WCDEADP. (2008). *A Climate Change Strategy and Action Plan.* South Africa: Western Cape Department of Environemntal Affairs and Developemnt Planning.

WCGPT. (2012). *Provincial Economic Reviee and Outlook.* Cape Town, South Africa: Western Cape Government Provincial Treasury.

Wilson, J., & Otsuki, T. (2004). *Standards and Technical Regulations and Firms in Devleoping Countries: New Evidence from a World Bank Technical Barriers to Trade Survey.* Washington DC, USA: The World Bank.

Winkler, H. (2007). Energy Policies for Sustainable Development in South Africa. *Energy for Sustainable Development, 11*(1), 26-34.