Greening the South Africa's economy could benefit the food sector: evidence from a carbon tax policy assessment

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Abstract:

South Africa has a competitive and viable food production sector which enables the country to be a consistent net exporter of agricultural products. Lately, the business and labour organisations have raised concerns that the government's intention to implement the carbon tax policy will affect the food supply, subsequently exacerbating the unemployment and food insecurity in the country. Carbon tax is one of the policy tools to be implemented in order to reduce the growing greenhouse gas (GHG) emissions thus helping the government meets its Paris Agreement commitments. South Africa's National Treasury released a second draft of the carbon tax bill in 2017, which takes into account the concerns raised by different organisations. In this paper, we evaluate the potential impact of the carbon tax policy on the food sector using a computable general equilibrium (CGE) model. The results show that the carbon tax is an effective policy tool to mitigate emissions, as they decline by 33 percent relative to the baseline by 2035. This also leads to a welfare loss of R98.326 billion as the country transform into a green economy. While sectors such as transport, steel and coal-generated electricity experiences significant output decline, the food sector shows improvements in terms of production and employment when the carbon tax is implemented. The positive effects on the food sector suggests that the policy makers have designed a plausible environmental protection policy that cushion the food supply against any expected negative effects.

Key words: CGE, carbon tax, food

JEL classification:C68, H23, Q18

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1. Introduction

According to the Department of Environmental Affairs (DAE 2017); and the World Resources Institute (WRI 2015), South Africa's GHG emissions were calculated to 524 metric ton carbon dioxide equivalent ($MtCO_2$-eq) in 2014, which is approximately 1.2 percent of the world's GHG emissions. This is equivalent to 8.86 tCO_2-eq per capita, making South Africa a thirteen largest

producer of emissions per capita in the world. The country's emissions are dominated by the energy sector, that accounts for 84 percent whereas the food sector contributes seven percent. The country has committed to reduce its emissions through a *peak, plateau and decline (PPD)* strategy. The strategy anticipates the emissions to reach a peak in 2025, stagnate between 2025 and 2035, and then decline post 2035. According to DAE (2017), the strategy forms part of the Nationally Determined Contribution submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2016, when South Africa ratified the Paris Agreement[1]. In the Paris Agreement, the country targets to reduce emissions by 42 percent below business as usual levels.

From a South African government perspective, the preferred policy instrument to reduce emissions is the carbon tax which is a market-based policy like the emission trading. The main difference between the carbon tax and emissions trading is that carbon tax fixes the price while the emission trading fix the quantity of emission, as such carbon tax policy provides a better signal to investors and is considered more effective in reducing emissions (DAE 2017; Jarke and Perino 2017; and Beck, Rivers, Wigle and Yonezawa 2015). In December 2017, the National Treasury (NT 2017), released a second draft of the carbon tax bill pronouncing a carbon charge of one hundred and twenty rand per ton carbon dioxide equivalent (R120/tCO$_2$-eq) in the country. According to NT (2017), introducing a carbon tax would act as an incentive to investors to make future investment decisions that promote a green economy. It also reduces market access risk that can arise if South Africa's trading partners decide to unilaterally impose a carbon consumption tax on products originating from South Africa. This market access risk was also noted by Arndt, Davies, Markelow and Thurlow. (2013) whom measured the emission intensity of different products in the country.

In the past eight years, a number of researchers have assessed the implications of introducing the carbon tax on the country's economy including Van Heerden, Blignaut, Bohlmann, Cartwright, Diederich, and Mander (2016); Alton, Arndt, Davies, Hartley, Mekrelov, Thurlow, and Ubogu (2014); and Deverajan, Robinson, and Thierfelder (2011). The study by Deverajan et al. (2011),

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[1] Paris Agreement is a legally-binding framework for an internationally coordinated effort to tackle climate change. It was adopted on 12 December 2015 by 196 Parties of UNFCC. The agreement entered into force on 4 November 2016

showed that the carbon tax is an effective tool to mitigate emissions but it can also lead to significant welfare loss. In their analysis, they did not distinguish between different energy technologies which partly explain the high welfare loss they found on the economy. Alton et al. (2014), assessed the policy effects on a detailed energy sector that distinguish five electricity technologies and three petroleum liquids. They found a minimal impact on the economy which is equivalent to a 1.2 percent decline in gross domestic product (GDP) relative to the baseline.

The low welfare loss found by Alton et al. (2014), can be attributed to a relatively low tax rate of R25/tCO_2-eq that they assumed since their study was conducted prior to the NT pronouncing the R120/tCO_2-eq tax rate. Van Heerdern et al. (2016), examined the policy impacts using the policy designs prescribed in the first draft bill released by NT in 2015. They obtain the results that indicated significant decline in emissions and GDP, falling by 38.3 and 13.7 percent respectively relative to the baseline by 2035. Although they applied a correct carbon charge of R120/tCO_2-eq and distinguished between various energy technologies, they did not account for the expected technology improvements in the non-coal electricity sector which partly explains the high welfare loss they obtained in their study. All the existing studies in the country have assessed the potential impact of the carbon tax policy focusing on the energy, industrial and manufacturing sectors but less so on the food sector which raises a need for a detailed assessment on the food sector.

2. Need for carbon tax policy assessment on the food sector

The existing local studies such as Van Heerden et al. (2016) and Alton et al. (2014), shared insight of the expected policy impacts only on the aggregate food sector, leaving policy makers, industry captains and labour formations to not fully understand the effects on individual food industries. At an aggregate food sector, existing studies found that the carbon tax will have negative but minimal impact on the food sector. This has propelled the different organisations to raised concerns over the potential impact of the carbon tax on food production. They argue that minimal policy impact on aggregate food sector will not necessarily equate to low impact on individual food industries because different industries are heterogenous with different input and output structures thus emitting varying quantities of emissions. Knowing the implications of the policy on individual

food products will inform the policy makers to design better support mechanisms for farmers and poor households. Horowitz and Just (2013) found that in developed countries like the United States of America, policies that provide payments to farmers to take actions that mitigate emissions helps minimise the risk exposure of farmers to mitigation policies. While mitigating the growing GHG emissions in South Africa is critical but maintain a viable food supply is equally important thus raising a need to understand the potential impact of the carbon tax on different food industries.

According to NT (2017), the latest carbon tax bill contains policy designs that will cushion the food sector against any future severe impacts. Such claim has not been empirically evaluated. This paper seeks to examine the expected impacts of the latest carbon tax policy bill on the food sector in particular, and the entire economy. We apply a modified version of the University of Pretoria General Equilibrium (UPGEM) model, which is a dynamic CGE model solved in GEMPACK solution software. We make three important changes as an improvement from the previous studies conducted by Van Heerden et al. (2016); and Alton et al. (2014). Firstly, we construct a new CGE database that contains a detail treatment of the primary agriculture, electricity and food sectors distinguishing between 5 primary agriculture (i.e. grains, horticulture, livestock, fisheries and forestry); five foods (i.e. meat, dairy, beverages, cereals, and sugar); and two electricity (i.e. coal and non-coal generation) industries. We then account for the expected technological improvements in the non-coal generated electricity which allow for less emissions emitted by the non-coal electricity industry. The International Energy Agency (IEA 2017), reported that the renewable energy prices will decline by 40 percent over the next decade largely because of technology improvements in the non-coal generation.

Secondly, we apply the new policy features prescribed in the latest carbon tax bill of 2017, that includes full tax-free allowances in the primary agriculture, waste and land-use activities; trade-exposed allowance for trade-oriented sectors; and revenue recycling schemes. Thirdly, we modify the standard UPGEM model to allow for environmental enhancements analysis. This include equations that allow for inter-fuel substitution in different electricity generation technologies. Moreover, we develop a mechanism that allow for the endogenous take-up of various abatement

measures in response to carbon tax policy measures. Lastly, we estimate the new trade elasticities for the individual agriculture and food products for use in the modified UPGEM model in order to enhance the functionality and predictive power of the model.

3. Methodology

We applied the modified version of the UPGEM model which has a similar theoretical structure to the MONASH CGE model developed by the Centre of Policy Studies (CoPS) and described by Dixon, Koopman, and Rimmer (2013). The standard UPGEM is made up of a linearized system of equations describing the theory underlying the behaviour of agents in the economy. The core UPGEM model and database is discussed in Bohlmann, Van Heerden, Dixon, and Rimmer (2015). As mentioned earlier, three critical modifications in this study are made in the standard UPGEM model to enable an environmental policy assessment as well as the detailed treatment of the agriculture, food and electricity sectors in the analysis.

Firstly, changes to accommodate for environmental analysis include creating a mechanism that allows for the endogenous take-up of various abatement measures in response to emission policy measures. The mechanism tracks emissions at a detailed level thus breaking down emissions according to emitting agents and emitting activity. As an addition to modelling specifications done by Van Heerden et al. (2016), we made allowances for technology improvement in the non-coal electricity based on forecast data from the IEA (2017). Technology changes increase the efficiency and cost competitiveness of the non-coal electricity relative to coal-based electricity. According to the IEA (2017), the global average price for non-fossil energy, measured in US dollars per megawatts (US\$/MW), will decline by 29 percent between 2014 and 2020 and further 11 percent between 2020 and 2025. The capital cost, measured in US dollars per kilowatts (US\$/KW), will decline by 12 percent between 2014 and 2020 and a further eight percent between 2020 and 2025. These forecasted technology improvements will lower the cost of establishing a non-coal electricity plant relative to the coal electricity plant thus attracting investments into the non-coal generation.

The second modification is a detailed treatment of agriculture, food and electricity sectors in the model database which allows the evaluation of both direct and indirect effects of carbon tax on different sectors. The disaggregation and mapping process is informed by emission intensity of different sectors. The emissions and energy data used to inform the disaggregation process is based on emissions calculated by DAE (2017); and Seymore, Inglesi-Lotz and Blignaut (2014). The complete mapping of sectors in this study is presented in Figure 1. Following the splitting of agriculture, food and electricity, other sectors in the UPGEM database were kept unchanged.
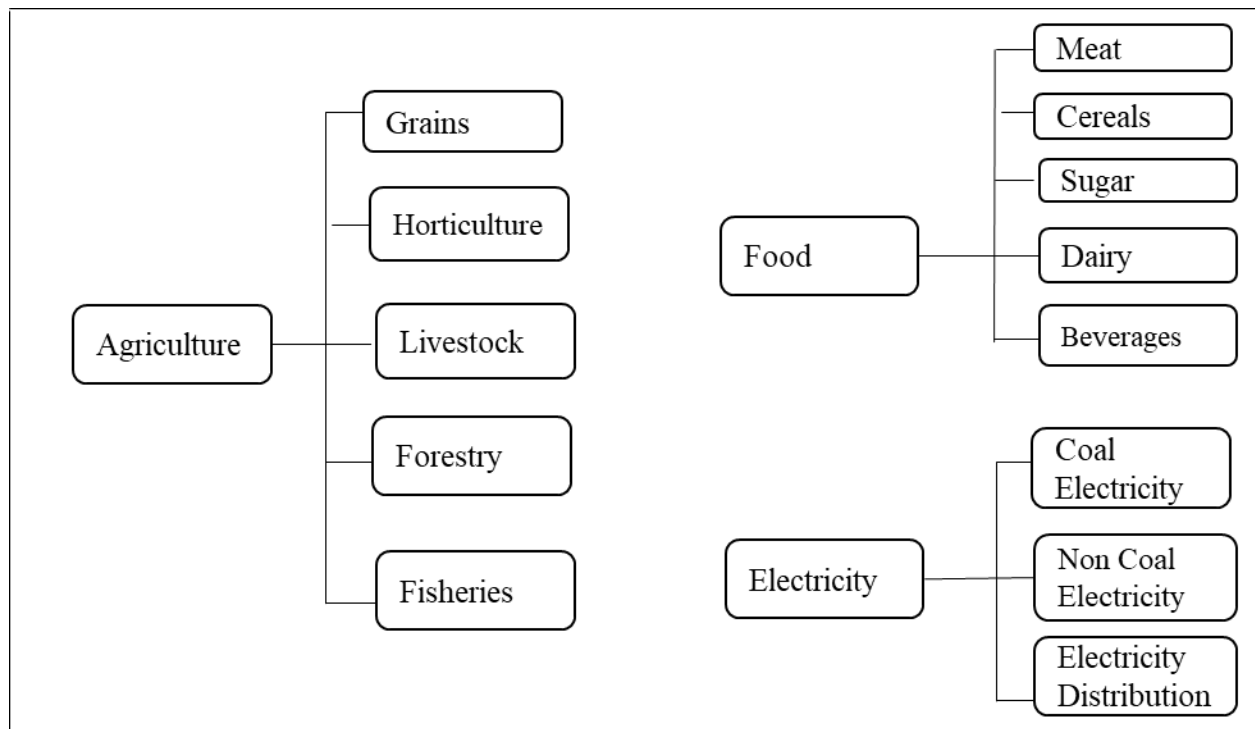

Figure 1: Industry disaggregation and mapping process

The third change is to apply the policy features prescribed in the latest carbon tax bill of 2017. The key features include the following (NT 2017:14-19):

(i) In the initial five-year window, the primary agriculture, forestry, waste handling, and land-use sectors are fully exempted but the food manufacturing activities are not fully exempted

(ii) The trade exposure allowance which is up to 10 percent will help protect the competitiveness of South African industries and to prevent carbon leakage problem. Trade exposed industries are those that have exports and imports combined value making up more than 40 percent of domestic output value;

(iii) The tax is effectively a fossil-fuel input tax levied on scope 1 emission, that is, emissions that result from fuel combustion, gasification, and non-energy industry process;

(iv) The tax is levied at R120/tCO$_2$-eq and set to increase by 10 percent per annum over the first five years (to R175.69/tCO$_2$-eq by 2020). Thereafter will increase in line with inflation. The revenue from the proposed tax will be recycled via the national fiscus;

To determine the implications of carbon tax on the food and other sectors, the economic data from 2011 Social Accounting Matrix (SAM) and the Supply-Use Tables (SUT) published by Statistics South Africa were entrenched with emission data from DAE (2017); and Seymore et al. (2014). The proposed carbon tax is effectively a fossil-fuel input tax, but one that is levied on industry specific emissions such as the coal, gas and petroleum. Since the emissions and energy content of fuels vary, the tax has to be applied to fuel use. As a result, the emission and energy data need to be converted into fuels terms using industry wide consumptions. To obtain the effective tax rate, a simple approach is adopted to transform the R/tCO$_2$-eq charge to rand per terajoule (R/TJ). This is necessary to standardise the unit of measurement because the tax is a tax on fossil-fuel consumption, yet the tax rate in the carbon tax bill is expressed in R/tCO$_2$-eq. The standardisation into TJ allows for the differences in the emission coefficients of each fuel input (Van Heerden et al. 2016). It is important to note that the use of an effective tax rate does not imply a change in the tax design, which is based on applying the full marginal tax rate of R120/tCO$_2$-eq, however, it just help address the issue of different fuel inputs.

Table 1 contains the coefficients required to make the convention in tax rate from R/tCO$_2$-eq to R/TJ. The CO$_2$/TJ coefficient for coal commodity is estimated at 95.60 tCO$_2$/TJ; for gas is estimated at 63.73 tCO$_2$/TJ; and for petroleum is estimated at 72.56 tCO$_2$/TJ (Van Heerden et al. 2016). Multiplying these input fuel specific coefficients with the carbon tax rate of R120/ tCO$_2$-eq which is proposed in the Bill of 2017, it gives the tax rate in R/TJ as provided in the last column of Table 1. These effective tax rates still need to take into account the tax-free allowances per sector as provided in the carbon tax bill of 2017(NT 2017:33).

Table 1: Conversion coefficients from carbon dioxide equivalent to terajoule

Fuel type	tCO$_2$-eq/TJ coefficient	R/tCO$_2$-eq	R/TJ
Coal	95.60	120	11 472
Gas	63.73	120	7 647
Petroleum	72.56	120	8 707

Source: adapted from Van Heerden et al. 2016

Once the tax rate is converted to R/TJ, the maximum allowances are applied and this is provided in Table 2 together with emissions as well as sector's energy consumption levels. As indicated in Table 2 the primary agriculture has 100 percent tax-free allowances which means it is fully exempted from the carbon tax in the first five-year window of implementation.

Table 2: Industry energy consumption, emissions, tax allowances and effective tax rate

Economic Sectors	Emissions (MtCO$_2$-eq)	Energy use (TJ)	Maximum Allowance (%)	Effective tax rate (R/TJ) after accounting for allowances		
				Coal	Gas	Petroleum
Primary agriculture	5.01	72 327	100	0	0	0
Food	0.10	4 115	95	574	382	435
Chemical, steel and plastic	58.57	729 574	95	574	382	435
Coal and lignite mining	2.36	49 671	95	574	382	435
Transport services	77.21	811 860	90	1 147	765	871
Petroleum refineries	83.51	687 019	90	1 147	765	871
Other economic sectors	36.51	625 174	90	1 147	765	871
Coal electricity	296.39	2 452 146	75	2 868	1 912	2 177
Non-coal electricity	2.82	23 298	75	2 868	1 912	2 177
Electricity distribution	1.51	12 492	75	2 868	1 912	2 177
Total	**564**	**5 467 676**				

Source: own calculations based on NT 2017; Van Heerden et al. 2016; and Seymore et al. 2014.

Table 2 also indicates that the majority of South Africa's emissions are from the energy sectors such as petroleum and electricity which relies on fossil fuels and coal. The leading sources of agriculture and food emissions are livestock manure and food waste. Oelofse and Nahman (2013), found that 30 percent of food is wasted per annum in South Africa which contributes to agricultural emissions. Looking at the international literature, WRI (2015) and Garnett (2011), also found that food waste contributes substantially to global agriculture and food sector's GHG emissions. The next step is to design baseline and policy scenarios that will help examine the expected impacts of the policy on the agriculture and food sectors within a broader economic context.

4. Simulation design

The proposed carbon tax has its theoretical underpinnings on the need to internalise the negative externality of emissions and thereby support a structural transition of the national economy towards a more climate-resilient and less carbon-intensive economy (NT 2017; and Van Heerden et al 2016). It is important to mention that the main difference between the 2017 carbon tax Bill and the 2015 tax Bill, is that the maximum tax-free allowances across sectors have increased from an average of 70 to 95 percent. Based on the policy features, four scenarios were formulated to assess the expected impacts on agriculture and food industries within a broader economic context.

4.1 Baseline scenario design

This is a business as usual scenario which reflects a plausible evolution of the economy without the introduction of the carbon tax shock, based on the currently available economic and emission forecast data. The main sources for macroeconomic forecast data include the Statistics South Africa (StatsSA); South African Reserve Bank (SARB); and the International Monetary Fund (IMF). The key improvements in the baseline is the allowance of technology improvements in the non-coal electricity sector. In addition, the baseline contains updated forecast of macroeconomic indicators which take into account the slow economic growth witnessed in South Africa over the past three years and expected to remain low until 2019. Beyond 2020 the GDP is forecasted to grow by 2.2 percent. This is still relatively low compared to the GDP growth rate required to realise

developmental goals of the country as stated in the National Development Plan (NDP). A complete forecast data used to create a baseline scenario is attached in Appendix A

4.2 Policy scenarios design

Three tax policy scenarios together with a revenue recycling scheme were developed as following:

(i) **Focus policy scenario**

This is the main policy scenario where the tax rate is modelled to accurately reflect the proposed carbon charge as described in the carbon tax bill. The tax rate is introduced at R120/tCO_2-eq then increases by 10 percent per annum in the first five years; thereafter increase at the inflation rate. The maximum tax-free allowances per sector are retained for the duration of the modelling period. The tax revenue recycling scheme is applied through an output-based rebate on production across all sectors.

(ii) **Allowances removed policy scenario**

In this policy scenario, the tax is applied as in the Focus scenario, but the tax-free allowances are gradually removed at a rate of 10 percent points per annum from 2021 onwards until all the industries are paying the full tax rate on their emissions. The tax revenue recycling scheme is kept the same as in the Focus scenario.

(iii) **No revenue recycling policy scenario**

The tax and allowances are applied as in the Focus scenario but there is no revenue recycling scheme. This scenario aims to analyse the sensitivity of the economy to a carbon tax impact if the tax revenue collected is not recycled back into the economy.

5. Simulation results
5.1 Macroeconomic results

The fist result to discuss is the impact of accounting for technology improvement in the non-coal electricity in the baseline scenario which is presented in Figure 2. By allowing for the technological improvements in the non-coal electricity, in line with the IEA (2017) forecasted changes, leads to a relatively higher investments and efficiencies in the non-coal relative to the coal electricity

sector. Subsequently, the output of the non-coal electricity sector grows by 126 percent relative to the base year by 2035, which is almost double the growth pace observed when there are no technology improvements. If no technology improvements are allowed, the non-coal electricity output increases by 79.2 percent which is inline with the GDP growth under the baseline scenario. The technology changes reduce the capital costs of establishing non-coal generation plants relative to coal generation plants, subsequently mitigating the quantity of GHG emissions emitted from the economy. This substantially growth is comparable with international expectations that forecast a significant growth in the output of the non-coal electricity in the next decades.
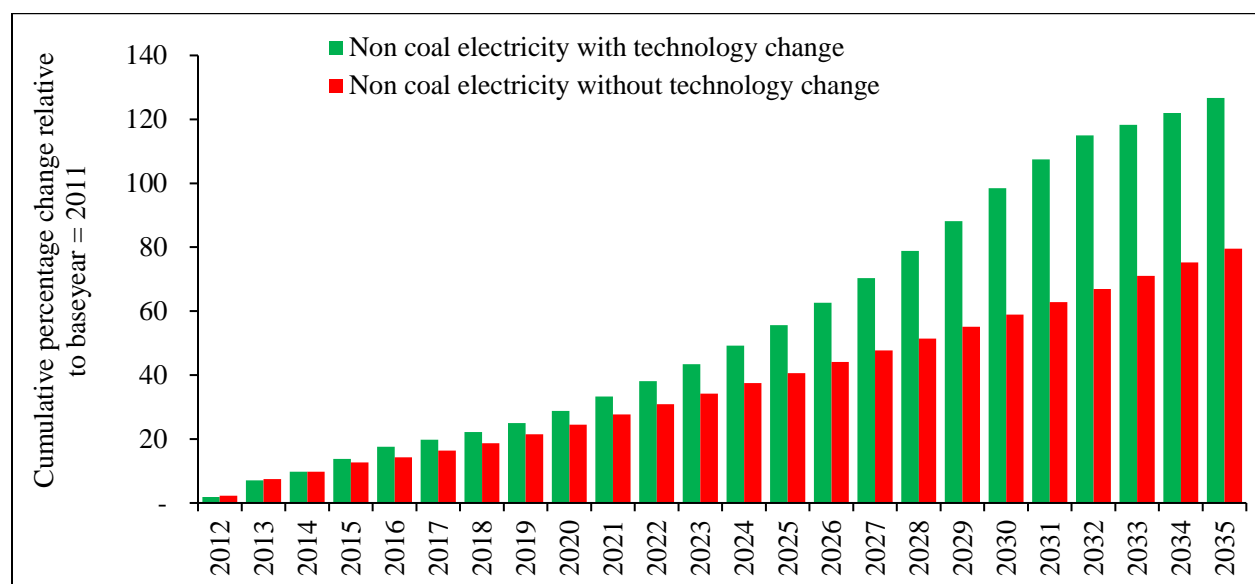

Figure 2: Expected impact of technology improvements on non-coal electricity output

The next step is to discuss the results on the macroeconomic indicators such as the GDP, aggregate employment and emissions. The implementation of a carbon charge of R120/tCO$_2$-eq on fuels use leads to a substantial reduction of emissions in the country. From Figure 3, the GHG emissions decline by 32.9 percent under the Focus policy scenario which mirrors the policy designs as prescribed in the carbon tax bill of 2017. The emissions decline is lower than the 38.3 percent found by Van Herdeen et al. (2016). The main reason for this deviation is the allowance made for technological changes in the non-coal electricity sector in the baseline scenario which reduces the amount of GHG emissions the country is producing prior to introducing the carbon tax. Moreover, are the additional tax-free allowances that have been added in the latest policy bill which ease the tax burden on industries. As a result, the reduction from the baseline after introducing the carbon tax is narrowed as compared to bigger deviations found by Van Heerdeen et al. (2016).

Moreover, Figure 3 shows that the emissions can reduce to 45.4 percent relative to the baseline if government gradually remove the allowances currently included in the policy Bill. However, under this scenario the welfare loss will be substantially high when allowances are removed. In essence, the results show that the manner in which tax-free allowances are removed will have significant effect on the reduction of emissions in the country. It is important to note that the carbon tax policy alone under the current design (i.e. Focus policy scenario) is not sufficient to meet the country's emission reduction targets made in the Paris Climate Agreement. However, the policy does make a meaningful contribution to the country's effort to reduce GHG emissions.
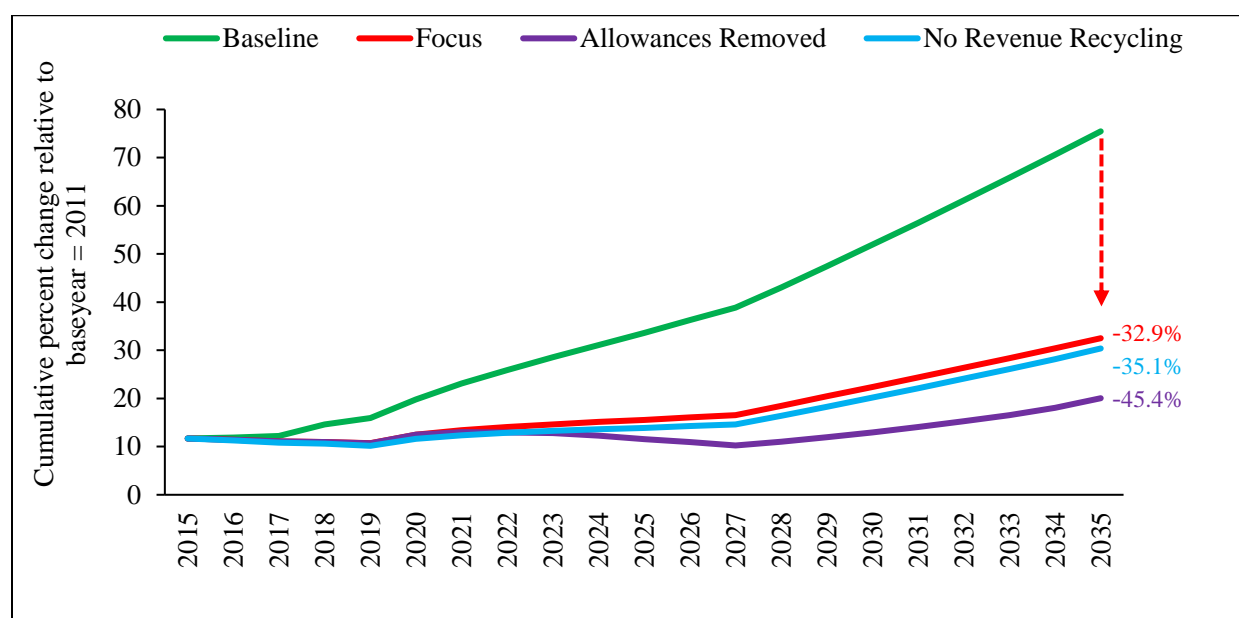

Figure 3: Expected impact of the carbon tax policy on the country's GHG emissions

The expected policy effects on the GDP growth are presented in Figure 4. The carbon tax will lead to a welfare loss, reducing the GDP by 0.91 percent (equivalent to R98.326 billion) under the Focus policy scenario relative to the baseline. When evaluating the sensitivity of different policy scenarios, it is clear that if tax-free allowances are removed at 10 percent rate from 2021 onwards, the GDP decline by 3.84 percent relative to the baseline. But if government withhold the recycling of the revenue back into the economy, the GDP reduce by 2.07 percent below the baseline. These results imply that the amount of the adjustment cost (i.e. welfare loss) the country will incur to transform into a low carbon economy largely depends in the manner in which government will treat the tax-free allowances as well as the recycling of the revenue back into the economy.
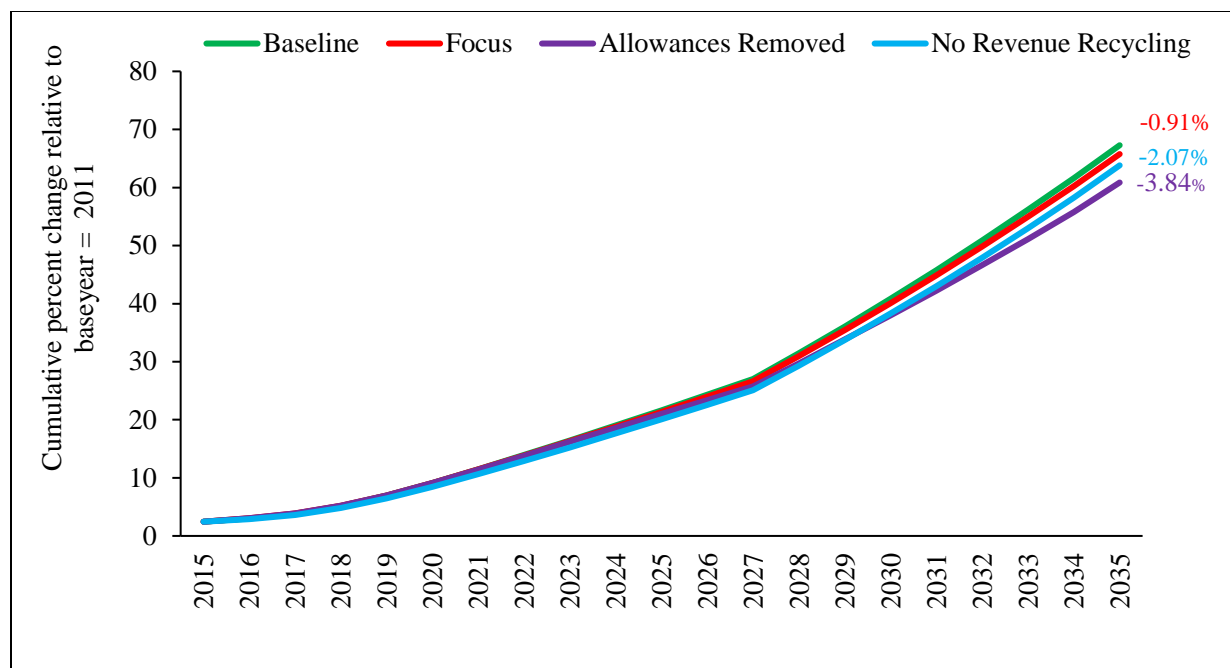
Figure 4: Expected impact of the carbon tax policy on economic (GDP) growth

The results presented in Figure 4, illustrates that the current carbon tax policy design as reflected in the Focus policy scenario will have a minimal impact on the economy whilst reducing the emissions by nearly 33 percent below the baseline by 2035. This adjustment costs to low carbon economy is lower than that found by previous studies like Van Heerden et al. (2016) and Alton et al. (2014), because of technological changes taken into account and additional tax-free allowances which were not accounted for by the previous studies. A 0.91 percentage decline in GDP relative to the baseline can be argued to be a marginal adjustment costs necessary to achieve a bigger goal of preserving the environment for both current and future generations.

Arndt et al. (2013), found that green energy sectors such as the non-coal electricity in South Africa will creates jobs but not at the same intensity as the fossil related sectors like the mining and coal electricity. The expected policy impacts on aggregate employment is presented on Figure 5, and it confirms finding of Arndt et al. (2013) that greening the economy will likely lead to job losses at the national level. We found that the aggregate employment will decline by 0.62 percent relative to the baseline when carbon tax policy is implemented. This suggests that there will be employment losses when the economy transform towards a less carbon intensive industries because they create less job opportunities. Importantly to note is that the employment losses will be small indicating that the labour market will not be servery affected by the introduction of the carbon tax.
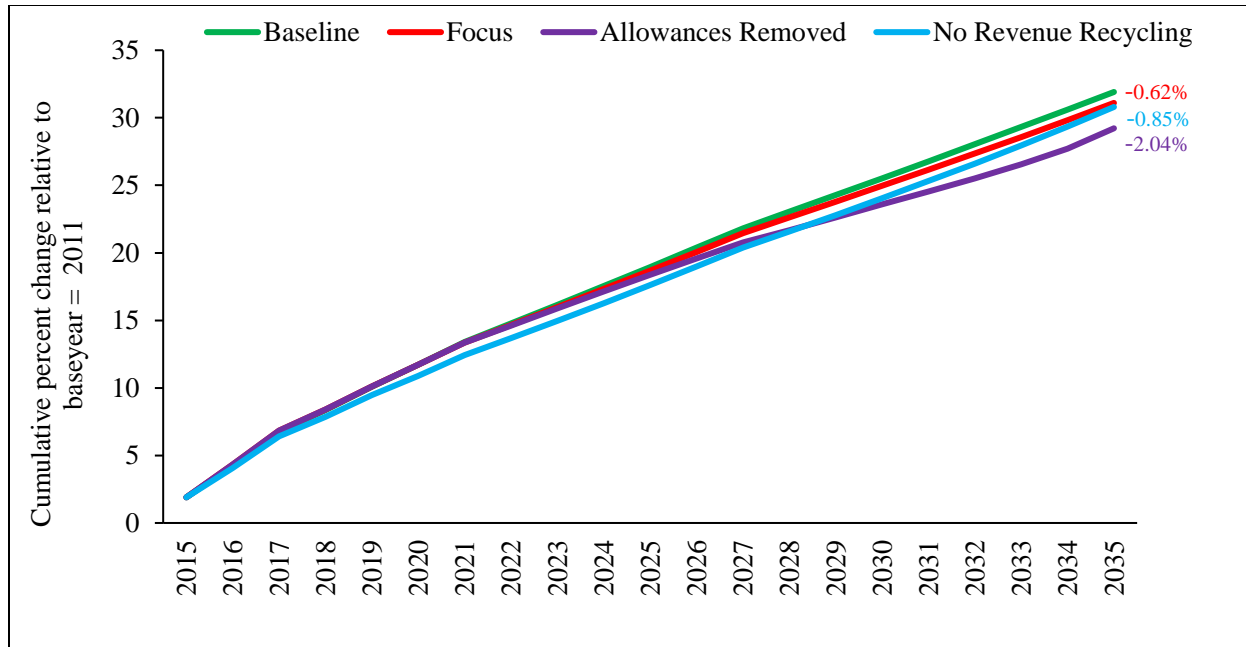
Figure 5: Expected impact of the carbon tax policy on aggregate employment

The macro results indicate that the carbon tax policy will assist in reducing the GHG emissions in the country. However, it will lead to a minimal welfare loss driven by a decline in aggregate investments, employment and other GDP components. Despite the expected decline on the GDP, the ability of the carbon tax to reduce GHG emissions by nearly 33 percent relative to the baseline is critical in helping the country achieve its commitments under the Paris Agreement. The next section discusses the disaggregated results focusing on the effects of the carbon tax on the food, agriculture and other economic sectors.

5.2 Sectoral results

The industrial results assist in examining both the direct and indirect impacts of the carbon tax on different industries, thereby identifying the winners and losers in the economy. At a broader level, the non-coal electricity sector is the biggest winner with output growing by 224 percent above the baseline by 2035. This is driven by technological changes in renewable energy which promotes investments in the country. South Africa has an operating Independent Power Producer (IPP) program that seek to promote investments in the renewable energy and help the country diverse its energy sector that is currently dominated by the coal electricity. The sectoral results also indicate

that the heavy emitting sectors such as the coal electricity, petroleum, metal and steel are negatively affected losing 34 percent of output on average under the Focus scenario.

Zooming into the food sector, the results on food production shows a minimal but positive growth in all food sub-sectors relative to the baseline when the carbon tax is implemented. On average, the food sector output experiences a cumulative growth of 1.76 percent above the baseline by 2035 (Figure 6). This is due to positives growth from sub-sectors such as the meat, cereals, sugar, and dairy which registers growth rates of 2.29; 1.34; 1.71; and 1.70 percent respectively relative to the baseline by 2025. The positive growth in the food sector can be attributed to the full tax-free allowances provided in the primary agriculture which reduces the indirect impact to the food sector under the Focus scenario. Since the food sector is heavily reliant on agricultural output, they subsequently benefit from the full-tax-free allowances granted in the primary agriculture.
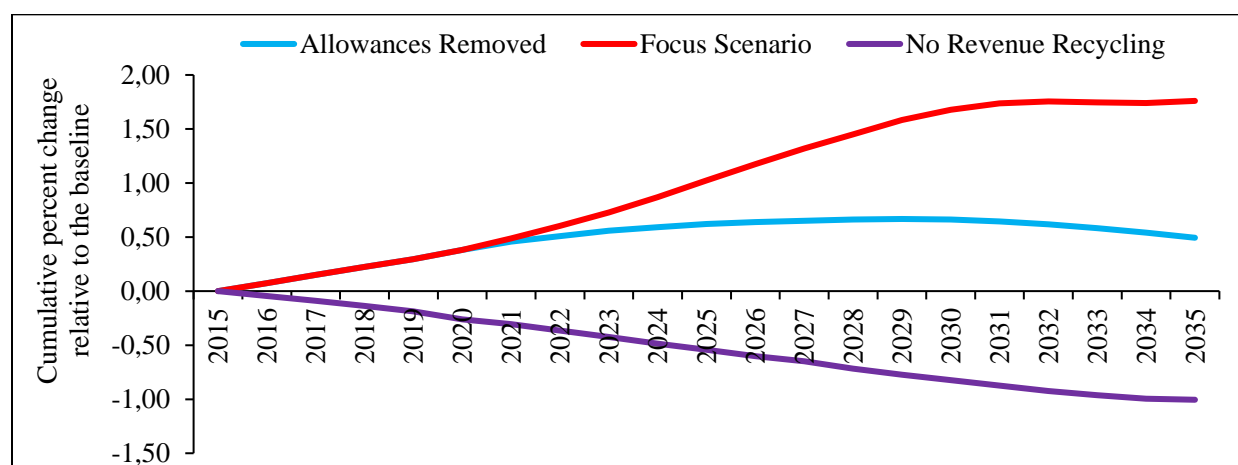

Figure 6: Expected impact of the carbon tax policy on food production in South Africa

Figure 6 also indicates that when the tax-free allowances are gradually removed they affect the sector's ability to produce. This effect becomes severe when there is no revenue recycling in the economy as food production declines by a cumulative of 1.05 percent relative to the baseline by 2035. The results from Figure 6, suggests that the policy designs as prescribed in the latest carbon tax bill of 2017 could have positive effects on the primary agriculture and food sectors, provided the full tax-free allowances and revenue recycling schemes are maintained post the first five-year window of the policy implementation. This is contrary to the perceptions of labour and business

organisations that have argued against the implementation of the carbon tax due to its likely negative effects on the food production and supply in the country.

Following the analysis of the implications on the food output, Figure 7 presents the expected effects on food sector's employment. It is evident that the employment in the food sector will likely increase relative to the baseline. Food, primary agriculture, business, and non-coal electricity are among the key economic sectors that are expected to experience positive growth in employment when the carbon tax is implemented. On the opposite side, transport, coal electricity, metal and steel sectors will experience the significant losses in employment when the carbon tax is introduced across all three policy scenarios. It is worth noting that the primary agriculture and food sectors employ nearly a million of people in the country. Moreover, they employ people from the rural areas thus playing a critical role in alleviating poverty in the rural areas.
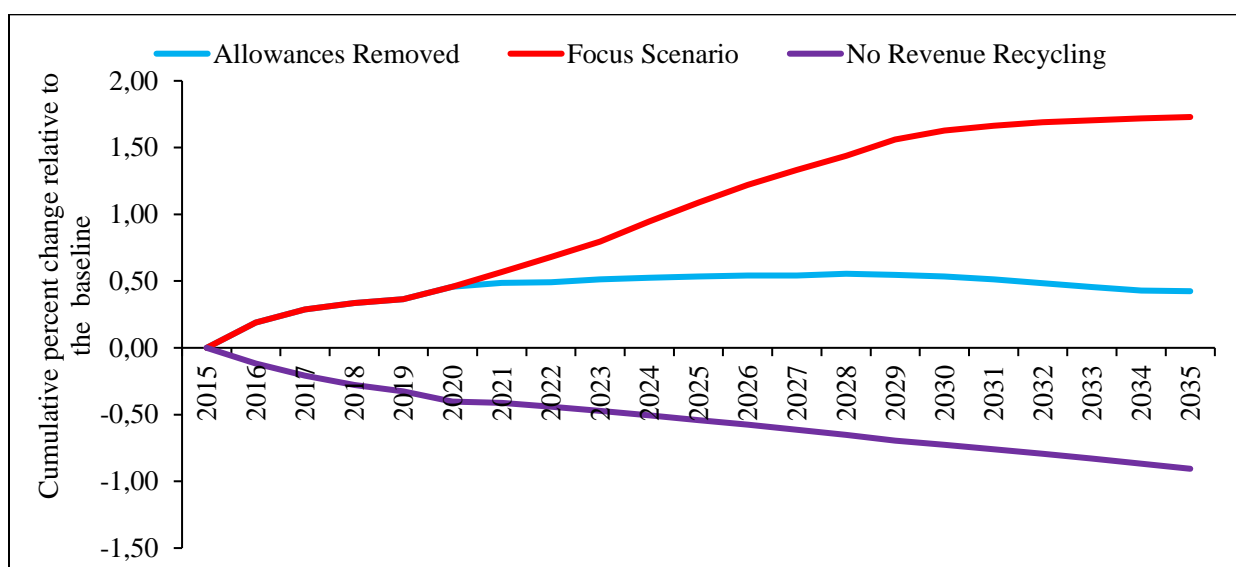

Figure 7: Expected impact of the carbon tax on food industry employment

Agriculture and food sectors are one of the key exporters in South Africa accounting nearly 10 percent to total exports. One of the key concern about the introduction of carbon tax policy was the implications on the sectors' competitiveness. To avoid affecting the competitiveness of the food sector, policy makers included a trade exposure allowance in the Bill which helps industries maintain their competitiveness in the international markets. Figure 8 indicates that the food sector will continue having a competitive edge in the global market as exports shows a positive growth

relative to the baseline under Focus policy scenario. At a disaggregated food sector level, the results indicate higher growth rates on food such as meat, cereals, dairy, sugar, and beverages as compared to primary agriculture. This significant growth in the food exports can be attributed to weakening consumer buying power, subsequently declining household consumption in the domestic market which avail large quantities of food for the export market. Under the Allowance Removed policy scenario, the household consumption significantly declines, hence a stronger export growth is observed under this scenario in Figure 8.
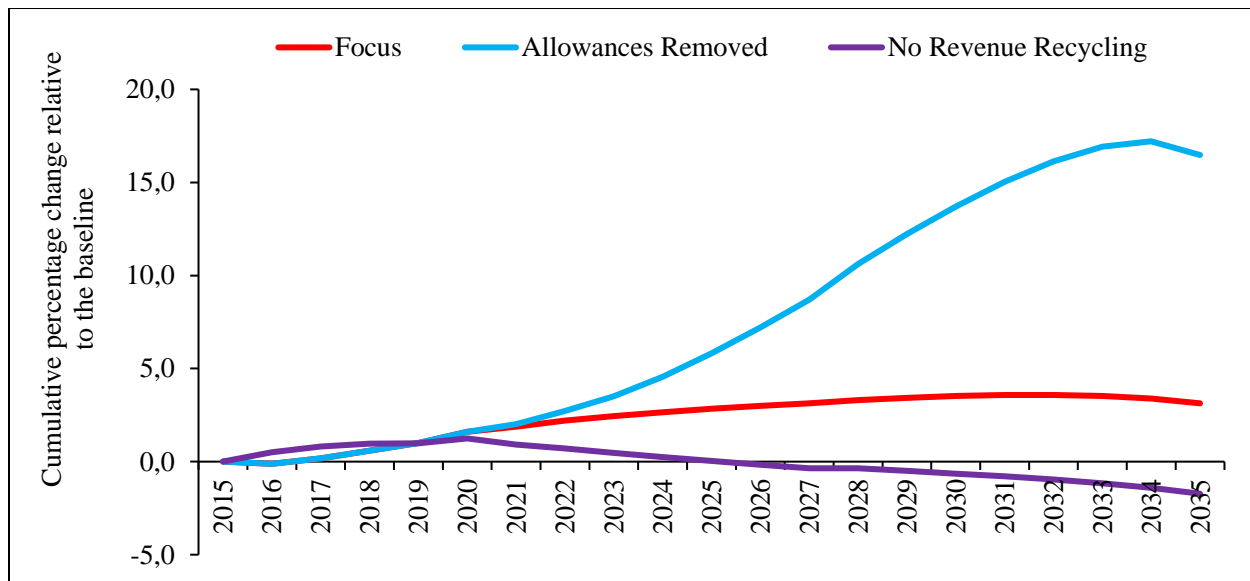

Figure 8: Expected impact of the carbon tax policy on industry exports

The sectoral results for the food sector provide an indication that the manner in which government removes the tax-free exemptions and treat the collected carbon tax revenue will determine the magnitude of the effects on the food supply in the country. For an example, the Focus policy scenario that assumes maximum tax-free exemptions and full recycling of the revenue results into output activity improvements as well as positive gains in employment. However, when exemptions are removed the negative impacts on food industries increase leading to higher output and employment losses. A similar negative implication is obtained when the revenue collected is not recycled.

6. Conclusion and policy recommendation

In this paper, we applied a CGE model to evaluate the expected impacts on food and agricultural sectors within a broader context of the economy. At a macro level, the results indicated that the carbon tax is an effective tool to reduce GHG emissions as it leads to large emissions reductions in the country. However, the implementation of the carbon tax also leads to a welfare loss as the country transforms into a low carbon economy. Notable, the results found in this paper appears to be much lower than the findings of the previous studies such as Van Heerden et al. (2016); and Alton et al. (2014). The deviation from previous studies can be attributed to the allowance made for technology improvement in the non-coal electricity which reduces the emissions and attracts investments in the non-coal electricity sector. Moreover, the higher tax-free exemptions provided in the 2017 carbon tax bill also eases the impact on the economy which partly explains the 0.91 percent decline in the GDP relative to the baseline.

The sectoral results showed that the heavy emitting industries like coal-generated electricity, steel; metal, and petroleum will be severely affected with output declining by an average of 34 percent over the next 25 years relative to the baseline. The results on agriculture and food sectors indicate a positive benefit as output, employment and exports improves relative to the baseline when carbon tax policy is implemented. From a policy perspective, the results provide empirical evidence that agriculture and food industries could benefit from greening the economy conditional that the policy makers retain the full exemption in agriculture as well as recycling the revenue back into the economy. The positive assessment of the current carbon tax bill suggests that the policy makers have designed the carbon tax policy well to an extent that it partially cushions the food production system against any significant negative effects associated with the introduction of the carbon tax. Noting that the carbon tax is relatively well designed as prescribed in the carbon tax bill of 2017, it is recommended that the policy makers should retain a full exemption to primary agriculture beyond the first-five-year window of implementation. In addition, it is recommended that the full tax exemptions are also extended to the food sector given its importance on ensuring food security in the country. Lastly, it is recommended that policy makers develop a mechanism to reduce food waste as it is one of the primary sources of emissions emitted from the food sector.

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Appendix A: Baseline forecast data

Variables (Percent Change)	Source	Actuals						Estimates				Long term average				
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026-2035
Renewable capital cost	IEA 2017	-1.7	-1.7	-1.7	-1.7	-1.7	-1.7	-1.7	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
Renewable price	IEA 2017	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Real GDP	NT 2017	2.20	2.30	1.60	1.30	0.10	0.80	1.30	1.70	2.00	2.20	2.20	2.20	2.20	2.20	2.20
Household	NT 2017	3.40	2.90	1.40	1.40	0.70	1.60	2.20	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
Government	NT 2017	3.40	3.30	1.90	0.40	1.20	-0.20	0.20	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
Investment	NT 2017	3.60	7.60	-0.40	1.40	0.30	1.40	2.70	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73
Exports	NT 2017	0.10	4.60	2.60	9.50	3.00	4.60	5.20	4.14	4.14	4.14	4.14	4.14	4.14	4.14	4.14
Imports	NT 2017	6.00	1.80	-0.50	5.30	3.70	4.50	4.90	3.74	3.74	3.74	3.74	3.74	3.74	3.74	3.74
CPI inflation	SARB 2017	5.70	5.80	6.10	4.60	6.40	6.00	5.80	5.70	5.60	5.50	5.50	5.50	5.50	5.50	5.50
Interest rates	SARB 2017	9.00	9.25	9.75	11.25	11.50	11.50	10.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
Current account	SARB 2017	-5.10	-5.90	-5.30	-4.30	-3.30	-3.20	-3.30	-3.40	-3.50	-3.60	-3.60	-3.60	-3.60	-3.60	-3.60
Exchange rate -Rand/US$	SARB 2016	0.18	0.12	0.18	0.17	-0.07	-0.10	-0.08	0.06	-0.03	0.03	0.03	0.03	0.03	0.03	0.03
Population growth	StatsSA 2017	1.64	1.66	0.70	0.36	0.72	0.72	0.71	0.72	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Unemployment rate	StatsSA 2017	24.50	24.10	24.30	25.70	26.90	28.40	29.90	30.90	31.50	27.36	27.36	27.36	27.36	27.36	27.36