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

Presentation prepared for National Treasury Carbon Tax Modelling Workshop

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Presentation Overview

- Background
- Methodology
- Impacts I – South African Economy
- Impacts II – South African Agriculture
- Impacts III - Other (Extensions)
- Conclusions
Background
Project Objectives

The NDP: “Chapter 5 - Transition to a Low-Carbon Economy”

- Page 182: “While the Long Term Mitigation Scenarios provided a useful starting point, more detailed analysis is needed to determine the optimal mix of mitigation actions to achieve the desired emission reduction outcomes for each sector and sub-sector of the economy. This work is needed to ensure that actions support job creation and take account of other relevant conditions related to the specific sector, sub-sector or organization concerned.”
- Page 187: “Planning for the transition requires a foundation of trustworthy data and analysis, neither of which is reliably and transparently available in South Africa.”

Project Objectives:

- Assess the economic impact of South Africa’s 2015 Carbon Tax
- Analyse how the impact will affect the Western Cape’s Agricultural Sector
- Identify the key potential sources of strain coming as a result of the carbon tax
Project Outputs


Partridge, A. 2015. The Impact of South Africa’s Carbon Tax on Agri Processing. Elsenburg: Western Cape Department of Agriculture
Methodology
The Project Model

Model Details

Static Computable General Equilibrium (CGE) Model

Model: International Food Policy Research Institute (IFPRI)


Social Accounting Matrix (SAM): United Nations University

  - 49 Activities (sectors)
  - 85 Commodities (goods and services)
  - 31 Other Accounts
CGE Models

Flow of Goods

- Households
- Activities (sectors)
- Commodities (goods)
- Rest of the World
- Other Institutions

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Flow of Income

- Households
- Commodities (goods)
- Activities (sectors)
- Other Institutions
- Rest of the World

CGE Models
The Project Model

Model Details

Static Computable General Equilibrium Model

- Behavioural changes need to be factored in exogenously
- Allows for analysis of direct and indirect impacts

Tax modelled as an activity tax

- Tax on activity output
- Tax calculated to be equivalent to a R200 tax per ton CO₂-eq emissions
- Tax rate for each activity determined by:
  - Fossil fuel use intensity
    - Taken from Model SAM
  - Emissions attributable to each fuel
    - Taken from South Africa's 2009 Energy Balances provided by the Department of Energy
Modelling a Carbon Tax

A Simplified Hypothetical Example

Assume a tax rate of R200 per ton CO2-eq emissions…

\[ \Sigma(C4-7) = \text{Aggregate Output} = Y_A \]
Assume a tax rate of R200 per ton CO2-eq emissions…

Fossil Fuel C3: δ tons CO₂-eq emitted per unit used (attributable emissions)

α units of C3 used to produce output $Y^A$
(fossil fuel use intensity)

Activity A producing $Y^A$ results in emissions of: $\alpha \delta$
Modelling a Carbon Tax

A Simplified Hypothetical Example

Assume a tax rate of R200 per ton CO2-eq emissions...

Fossil Fuel C3: \( \delta \) tons CO\(_2\)-eq emitted per unit used (attributable emissions)

\( \alpha \) units of C3 used to produce output \( Y^A \)
(fossil fuel use intensity)

Activity A producing \( Y^A \) results in emissions of: \( \alpha \delta \)

Therefore the total tax on Activity A will equal: \( 200 \cdot \alpha \delta \)
Modelling a Carbon Tax

A Simplified Hypothetical Example

Assume a tax rate of R200 per ton CO2-eq emissions…

Fossil Fuel C3: δ tons CO₂-eq emitted per unit used (attributable emissions)

α units of C3 used to produce output Y^A (fossil fuel use intensity)

Activity A producing Y^A results in emissions of: \( \alpha \delta \)

Therefore the total tax on Activity A will equal: \( 200 \alpha \delta \)

➢ Therefore the tax per unit activity: \( \frac{200 \alpha \delta}{Y^A} \)
**Project Scenarios**

**Elementary Tax**
- R200 per tCO$_2$-eq emissions

**Carbon Efficiency**
- R200 per tCO$_2$-eq emissions
- 20% decline in fossil fuel usage (across the board)

**Alternative Electricity**
- R200 per tCO$_2$-eq emissions
- 50% decline in coal use for electricity production

**Agriculture Tax Free**
- R200 per tCO$_2$-eq emissions
- Agriculture excluded from tax base
Impacts I – South African Economy
Economy Impacts

Percentage Change in GDP (Market Prices) Resulting from Carbon Tax

![Bar chart showing percentage change in GDP for Elementary Tax, Carbon Efficiency, and Alternative Electricity.]
Economy Impacts

Percentage Change in Household Income by Income Decile

Households by Income Deciles

- Elementary Tax
- Carbon Efficiency
- Alternative Electricity
Economy Impacts

Percentage Change in the Price of Electricity as a Result of the Carbon Tax
Impacts II – South African Agriculture
Agricultural Production

Percentage Change in Domestic Agricultural Activity Output

- Elementary Tax
- Carbon Efficiency
- Alternative Electricity
- Agriculture Tax-Free

0.32%
Agricultural Production

Indirect vs Direct Impacts of Carbon Tax on Agricultural Production

- Indirect Impact: 93%
- Direct Impact: 7%
Which intermediate input price change is causing the biggest impact on activity?

Degree of price change

\[ \alpha = \text{percentage price change following shock} \]

Intensity used in production

\[ \beta = \text{units used to produce one unit output from agricultural activity} \]

\[ AC = (\alpha \times \beta) \]

Ordinal Measure of the degree to which a shock influences activity
## Inputs With Biggest Impact

**Commodity Price Increases Most Influencing Agricultural Activity Decline**

<table>
<thead>
<tr>
<th>#</th>
<th>Commodity</th>
<th>% Price Change After Shock ($\alpha$)</th>
<th>Intermediate Units Per Unit Activity Output ($\beta$)</th>
<th>AC ($\alpha.\beta$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electricity &amp; gas distribution</td>
<td>47.70</td>
<td>0.02</td>
<td>0.99</td>
</tr>
<tr>
<td>2</td>
<td>Fertilizers &amp; pesticides</td>
<td>3.93</td>
<td>0.20</td>
<td>0.78</td>
</tr>
<tr>
<td>3</td>
<td>Petroleum products</td>
<td>6.14</td>
<td>0.06</td>
<td>0.34</td>
</tr>
<tr>
<td>4</td>
<td>Metal products</td>
<td>3.63</td>
<td>0.04</td>
<td>0.13</td>
</tr>
<tr>
<td>5</td>
<td>Animal feeds</td>
<td>0.80</td>
<td>0.15</td>
<td>0.12</td>
</tr>
<tr>
<td>6</td>
<td>Water distribution</td>
<td>11.63</td>
<td>0.01</td>
<td>0.06</td>
</tr>
<tr>
<td>7</td>
<td>Pharmaceuticals</td>
<td>1.36</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>8</td>
<td>Made-up textiles</td>
<td>1.62</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>9</td>
<td>Special purpose machinery</td>
<td>3.96</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>10</td>
<td>Vehicles &amp; parts</td>
<td>1.92</td>
<td>0.01</td>
<td>0.03</td>
</tr>
</tbody>
</table>
Commodity Impacts

Changes in Agricultural Commodity Outputs Resulting from Carbon Tax

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starches</td>
<td>-10</td>
</tr>
<tr>
<td>Dairy</td>
<td>-9</td>
</tr>
<tr>
<td>Sugar</td>
<td>-8</td>
</tr>
<tr>
<td>Fish</td>
<td>-7</td>
</tr>
<tr>
<td>Fruit &amp; Vegetables</td>
<td>-6</td>
</tr>
<tr>
<td>Meat</td>
<td>-5</td>
</tr>
<tr>
<td>Forestry</td>
<td>-4</td>
</tr>
</tbody>
</table>

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Impacts III - Other (Extensions)
Changes in Agri Processing Output Resulting from Carbon Tax

- Primary Agriculture
- Food processing
- Beverages & tobacco
- Leather products

%
# Agri Processing Inputs

## AC Index for Food Processing Activity

<table>
<thead>
<tr>
<th>#</th>
<th>Commodity</th>
<th>% Price Change After Shock (a)</th>
<th>Intermediate Units Per Unit Activity Output (β)</th>
<th>AC (a.β)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electricity &amp; gas distribution</td>
<td>47.70</td>
<td>0.02</td>
<td>1.068</td>
</tr>
<tr>
<td>2</td>
<td>Paper products</td>
<td>14.54</td>
<td>0.02</td>
<td>0.281</td>
</tr>
<tr>
<td>3</td>
<td>Plastics</td>
<td>1.13</td>
<td>0.04</td>
<td>0.041</td>
</tr>
<tr>
<td>4</td>
<td>Basic chemicals</td>
<td>4.46</td>
<td>0.01</td>
<td>0.030</td>
</tr>
<tr>
<td>5</td>
<td>Water distribution</td>
<td>11.63</td>
<td>&lt; 0.01</td>
<td>0.021</td>
</tr>
<tr>
<td>6</td>
<td>Construction</td>
<td>2.88</td>
<td>0.01</td>
<td>0.017</td>
</tr>
<tr>
<td>7</td>
<td>Miscellaneous business activities</td>
<td>0.26</td>
<td>0.06</td>
<td>0.017</td>
</tr>
<tr>
<td>8</td>
<td>Miscellaneous chemicals</td>
<td>2.31</td>
<td>0.01</td>
<td>0.012</td>
</tr>
<tr>
<td>9</td>
<td>Dairy</td>
<td>0.17</td>
<td>0.06</td>
<td>0.010</td>
</tr>
<tr>
<td>10</td>
<td>Grain milling</td>
<td>0.11</td>
<td>0.07</td>
<td>0.008</td>
</tr>
</tbody>
</table>
## Agri Processing Inputs

### AC Index for Beverages and Tobacco Activity

<table>
<thead>
<tr>
<th>#</th>
<th>Commodity</th>
<th>% Price Change After Shock (α)</th>
<th>Intermediate Units Per Unit Activity Output (β)</th>
<th>AC (αβ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Paper products</td>
<td>14.54</td>
<td>0.04</td>
<td>0.609</td>
</tr>
<tr>
<td>2</td>
<td>Electricity &amp; gas distribution</td>
<td>47.70</td>
<td>0.01</td>
<td>0.406</td>
</tr>
<tr>
<td>3</td>
<td>Water distribution</td>
<td>11.63</td>
<td>0.02</td>
<td>0.275</td>
</tr>
<tr>
<td>4</td>
<td>Glass products</td>
<td>3.79</td>
<td>0.04</td>
<td>0.167</td>
</tr>
<tr>
<td>5</td>
<td>Basic chemicals</td>
<td>4.46</td>
<td>0.02</td>
<td>0.084</td>
</tr>
<tr>
<td>6</td>
<td>Plastics</td>
<td>1.13</td>
<td>0.05</td>
<td>0.061</td>
</tr>
<tr>
<td>7</td>
<td>Construction</td>
<td>2.88</td>
<td>0.01</td>
<td>0.029</td>
</tr>
<tr>
<td>8</td>
<td>Weaving &amp; finishing of fabrics</td>
<td>4.72</td>
<td>0.01</td>
<td>0.025</td>
</tr>
<tr>
<td>9</td>
<td>Miscellaneous chemicals</td>
<td>2.31</td>
<td>0.01</td>
<td>0.015</td>
</tr>
<tr>
<td>10</td>
<td>Miscellaneous business activities</td>
<td>0.26</td>
<td>0.05</td>
<td>0.013</td>
</tr>
</tbody>
</table>
# Agri Processing Inputs

## AC Index for Leather Products Activity

<table>
<thead>
<tr>
<th>#</th>
<th>Commodity</th>
<th>% Price Change After Shock (α)</th>
<th>Intermediate Units Per Unit Activity Output (β)</th>
<th>AC (α.β)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Electricity &amp; gas distribution</td>
<td>47.70</td>
<td>0.01</td>
<td>0.491</td>
</tr>
<tr>
<td>2</td>
<td>Basic chemicals</td>
<td>4.46</td>
<td>0.03</td>
<td>0.144</td>
</tr>
<tr>
<td>3</td>
<td>Metal products</td>
<td>3.63</td>
<td>0.03</td>
<td>0.093</td>
</tr>
<tr>
<td>4</td>
<td>Paper products</td>
<td>14.54</td>
<td>&lt; 0.01</td>
<td>0.049</td>
</tr>
<tr>
<td>5</td>
<td>Weaving &amp; finishing of fabrics</td>
<td>4.72</td>
<td>&lt; 0.01</td>
<td>0.017</td>
</tr>
<tr>
<td>6</td>
<td>Plastics</td>
<td>1.13</td>
<td>0.01</td>
<td>0.009</td>
</tr>
<tr>
<td>7</td>
<td>Miscellaneous textiles</td>
<td>6.49</td>
<td>&lt; 0.01</td>
<td>0.007</td>
</tr>
<tr>
<td>8</td>
<td>Construction</td>
<td>2.88</td>
<td>&lt; 0.01</td>
<td>0.006</td>
</tr>
<tr>
<td>9</td>
<td>Soap &amp; related products</td>
<td>0.56</td>
<td>0.01</td>
<td>0.006</td>
</tr>
<tr>
<td>10</td>
<td>Water distribution</td>
<td>11.63</td>
<td>&lt; 0.01</td>
<td>0.005</td>
</tr>
</tbody>
</table>
Conclusions
Conclusions… Difficulties / Short-comings

Modelling Difficulties

- Simplification of complex system
- Uncertain policy stances
  - Revenue recycling
  - Offsets
  - Reporting
- Changes in relative prices
  - Electricity: renewables vs fossil fuels
- Data relevance
  - Social Accounting Matrix (2009)
Conclusions… Presentation Summary

Economic impacts of carbon tax worrying
- Sharp drop in Gross Domestic Product
- Disproportionately felt by middle income households

The key factor in the carbon tax impact will be the behavioural reaction
- We have a good idea of how we want behaviour to react, uncertainty around how it will
- **Key factor:** recycling of tax revenues

Negative impact of carbon tax can be mostly offset through an across the board decline in fossil fuel use intensity
- Feasibility?

Negative impacts can also be set off by a targeted intervention at South Africa’s Energy Sector
- Reduced dependency on coal for electricity production
Conclusions… Presentation Summary

Carbon tax IS a serious threat to South Africa’s Agricultural Sector

Direct impact of tax negligible but it is still essential to look to reduce emissions in the sector

- Constitutional mandate
- What about post 2020?
  - Potential for a tax on agricultural emissions

Substantial indirect impacts

- Soaring electricity prices
  - Electricity infrastructure already under strain
- Strong impact also through rising prices of fertilizers and pesticides
- To a lesser extent, but still significant impact from rising prices of petroleum products

Impact on key Western Cape agricultural products greater than the sector’s aggregate impact
Conclusions… The Way Forward

Produce more with less

- Less electricity
  - Small-scale on-farm electricity production
- Less fertilizers and pesticides
  - Or look to fertilizers and pesticides utilising different production methods

**Agriculture could be a key player in transitioning to cleaner energy production**

- Biofuels
- Solar, wind, hydro etc.

**We don’t have much time to plan and the phase-in period has been shortened**

- Need to act NOW
- Need to ensure of efficient monitoring systems to collect data to be reviewed regularly
Thank you
Contact Us

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