Border Tax Adjustments to Negate the Economic Impact of an Electricity Generation Tax

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Abstract

In the 2008 Budget Review, the South African government announced its intention to levy a 2c/kWh tax on the sale of electricity generated from non-renewable sources. This measure is intended to serve a dual purpose of helping to manage the current electricity supply shortages and to protect the environment (National Treasury 2008). An electricity generation tax is set to have an impact on the South African economy. However, several instruments have been proposed in the literature to protect the competitiveness and economy of a country when it imposes a green tax, one of these remedies being border tax adjustments.This paper evaluates the effectiveness for the South African case, of border tax adjustments (BTAs) in counteracting the negative impact of an electricity generation tax on competitiveness. The remedial effects of the BTAs are assessed in the light of their ability to maintain the environmental benefits of the electricity generation tax. Additionally, the the Global Trade Analysis Project (GTAP) model is used to evaluate the impact of an electricity generation tax on the South African, SACU and SADC economies and to explore the possibility of reducing the economic impact of the electricity generation tax through BTAs. The results show that an electricity generation tax will lead to a contraction in South African gross domestic product (GDP). Traditional BTAs are unable to address these negative impacts. We propose a reversedBTA approach where gains from trade are utilised to counteract the negative effects of an electricity generation tax, while retaining the environmental benefits associated with the electricity generation tax. This is achieved through a lowering of import tariffs, as this will reduce production costs and thereby restore the competitiveness of the South African economy. The reduction in import tariffs not only negates the negative GDP impact of the electricity generation tax, but the bulk of CO_2 abatement from the electricity generation tax is retained.

1 Introduction

In the 2008 Budget Review, the South African government announced its intention to levy a 2c/kWh tax on the sale of electricity generated from non-renewable sources. This tax is to be collected at the source, from the producers/generators of electricity. This measure is intended to serve a dual purpose of helping to manage the current electricity supply shortages and to protect the environment (National Treasury 2008).

Since the electricity generation tax is set to have an impact on the economy, in particular its competitiveness, measures to counter the negative effects while retaining pollution abatement benefits ought to be investigated. Several instruments have been proposed in the literature, one of which is border tax adjustments (BTAs).

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remedial effects of the BTAs are assessed in the light of their ability to maintain the environmental benefits of the electricity generation tax. If traditional BTAs are unable to achieve this, we will propose a new approach, which we refer to as "reversed BTAs". With this approach, gains from trade could be used to negate the negative effects of an electricity generation tax, while the environmental benefits associated with the electricity generation tax are retained

The next section provides an economic rationale for an electricity generation tax and examines the instruments available to reduce or eliminate the negative economic effects of such a tax. Section 3 provides an overview of the South African industries with regards to electricity needs, domestic production and export shares. Also, the average weighted tariffs as applied to the different products and regions are discussed. In the fourth section, the model and data are discussed. This is followed by an analysis of the results in section five. Section six concludes.

2 Literature Review [1]

2.1 Electricity generation tax: an economic rationale

Fossil fuel use creates negative externalities, such as CO_2 emissions. These externalities can be internalised through the price mechanism with the use of certain economic measures. This has the potential to achieve, at the least cost to the economy, environmental targets. The goal is equalised marginal abatement costs across all agents, ensuring that action is taken where it is the cheapest and most efficient (UP 2007). The two most prevalent economic measures in this context are taxes on emissions (or proxies of emissions) and tradable emission permits schemes (UP 2007).

According to McKibben and Wilcoxen (2002), a tax on emissions is more efficient than a permit system, especially under uncertainty. Furthermore, Rosen (1999) noted that the relevant issue is whether the measure employed is better than other alternatives, rather than whether or not it is a perfect measure to deal with externalities.

Environmental improvements are realised through price increases in environmentally harmful products. These price increases will result in a reduced demand for the products, reducing the quantity supplied and the associated emissions. However, existing exemptions and other special provisions aimed at protecting economies against the negative impacts of environmental taxes, restrict the environmental effectiveness and economic efficiency of environmental taxes. Removing these restrictions could create conflict with two main political concerns that currently impede the wider use of environmentally related taxes, namely the potential negative distributional effects and the potential loss of competitiveness (OECD 2001).

Regarding the competitiveness impacts, the authorities are responsible for stating clearly the objectives of the environmentally related taxes from the outset (OECD 2001). Due to vested interests within industry, energy taxes cannot be implemented without significant measures to reduce the impact on, at least, the worsthit sectors (OECD 2001). This applies in particular if the tax is implemented in a unilateral fashion. Where non-global environmental taxes increase prices of internationally traded goods, imports will become more attractive and exports less attractive in the taxing country. Therefore, domestic production is expected to decline, at least in the short run, leading to adjustments in the national economy as well as job losses (De Kam 2002).

The competitiveness impact is likely to be significant if the products or factors of production affected by the environmentally related taxes are traded widely, without significant import protection or other BTAs. It is therefore also likely that the competitiveness concerns are strongest if an environmentally related tax affects these products or factors of production. Another critical factor is substitution possibilities, since limited scope to identify and finance cleaner production technologies implies limitations on the ability to substitute away from environmental taxes (De Kam 2002). On

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the other hand, if an environmentally related tax is levied on products or factors of production that are not widely traded, with limited import and export possibilities and that are easily substituted with cleaner technologies, competitiveness concerns are likely to be less pressing.

A world-wide characteristic of existing environmental taxes is the presence of tax relief and exemptions for certain sectors, specifically in the manufacturing sector (Ekins and Speck 1999). However, preserving competitiveness goes beyond the implementation of proper compensation measures; indeed, competitiveness concerns ought to be incorporated during the design phase of the environmental tax. Although it is common practice in energy taxation to offer tax relief or exemptions to internationally exposed, energyintensive sectors, this practice could be criticised. The tax relief and exemptions are counterintuitive as they distort the goal of environmental taxes, which is to equalise marginal abatement costs across the economy. It should be noted that this goal is one of the main reasons why economic measures are seen to be more efficient than commandandcontrol measures (UP 2007).

2.2 Instruments to limit the impact of environmental taxes on competitiveness

If an environmentally related tax is imposed unilaterally, instead of multilaterally, significantly larger decreases may realise in production of the country and sectors concerned. The larger the group of countries that impose the environmental tax, the more limited the impacts on sectoral and individual country competitiveness (OECD 2001).

The OECD (2001) proposes several options to protect the competitiveness of a country when implementing environmentally related taxes:

- Environmentally motivated reforms should be integrated with broader fiscal reforms.
- The introduction of new taxes or rate increases should be announced well in advance.
- If exemptions and rebates are given for competitiveness reasons in certain industries, impose the full tax rate, but channel part of the tax revenue back to the industry in such a way that marginal abatement incentives are maintained.
- Ensure that firms, who benefit from exemptions and reductions, sign up to stringent mitigation measures. This should limit the negative environmental effects of the exemptions and reductions.
- A two-tier rate structure, with lower rates for internationally exposed sectors is a more effective and efficient option than full exemptions for some sectors.

According to Stern (2006), the dynamic impacts of the transformation to a low-GHG economy should be relatively small. Relative prices will change as the social cost of carbon is incorporated into production activities. However, these changes are well within the normal range of variation in prices as experienced in an open economy. The short-run primary cost increases from an environmental tax that reflects the damage from emissions are likely to be far smaller than inputcost variations from fluctuations in, for example, the world oil price or the exchange rate.

Barde and Braathen (2002) suggest that countries can adopt two strategies in addressing competitiveness concerns. The first strategy is to wait for other countries to take the initiative. However, if no country is willing to take the lead, no action will be taken, even if all countries are convinced that environmental taxes are the best method to reduce emissions. The second strategy is to introduce environmental taxes unilaterally, but with special provisions to protect internationally exposed sectors and thereby protecting the country's competitiveness. Without exception, OECD countries, when introducing environmentally related taxes, have used one or more of the following instruments to soften the impact on sectors most affected (De Kam 2002):

- revenue recycling,
- exemptions for specific activities, sectors or products,
- reduced tax rates for certain sectors, products or inputs, or
- border tax adjustments.

These instruments will now be discussed in more detail.

2.2.1 *Revenue recycling*

The OECD (2001) looks at different approaches that could maintain abatement benefits of environmental taxes, while at the same time limiting the burden on affected firms and industries. The first option is to recycle a part of the tax revenue back to the affected firms. This approach is illustrated in Figure 1.

A number of governments have implemented environmental taxes in such a way that revenues are recycled fully back to the taxpayer. The environmental effectiveness of tax reform will be greater if the revenue recycling is based on factors that are independent from environmental damage, rather than exemptions and reduced rates for affected sectors. This independent recycling will maintain the abatement incentives, since the price signal to polluters is not diluted. In other words, the tax burden increases with the environmental damage done (De Kam 2002). For example, revenue recycling through a reduction in labour taxes might lead to an overall efficiency in the tax system, as long as labour is over-taxed compared to other factors of production (UP 2007). However, earmarking the tax revenue fixes the use of the revenue, which creates an obstacle for the re-evaluation and modification of the tax and spending programmes. In the case of earmarking, policymakers should evaluate the economic and environmental rationale regularly to avoid inefficient spending (OECD 2001).

2.2.2 *Exemptions and reduced tax rates*

Exemptions and reduced tax rates (Figure 2), the second and third options mentioned by De Kam (2002), are present in every environmental tax ever implemented. Normally firms qualify for an exemption if they meet certain criteria, where the first criterion usually relates to some measure of energy intensity (UP 2007).

Current tax systems tend to "favour" certain energy products, especially coal. The coal sector has gained either complete or partial exemption in many countries due to strong political influence (UP 2007). For instance, the political influence of the coal sector prevented the United Kingdom Climate Change Levy (UK CCL) from becoming a real carbon tax, which would have meant a higher tax rate on coal. Although the energy tax directive set a minimum tax rate for coal, the use of coal for electricity generation and non-fuel inputs in industrial processes are exempted in the directive (UP 2007).

2.2.3 *Border tax adjustments*

The final option mentioned by De Kam (2002) to protect industries against the negative competitiveness impact of an environmental tax is BTAs, which are illustrated in Figure 3.

Governments can attempt to restrict the tax burden of an environmental tax on domestic consumption through the implementation of BTAs. Exporters are refunded for the environmental tax paid on exported products, while imported products are taxed. These taxes could be based on the characteristics of the technology used in the production of the concerned products. However, BTAs tend to be imprecise and the administrative and compliance costs could be high. There is also the potential that countries might use BTAs to favour domestic producers. BTAs might even be judged by the World Trade Organisation (WTO) to be undue protection of national interest (UP 2007).

Ismer and Neuhoff (2004) address the issue of information constraints in the implementation of BTAs and propose an indirect approach to induce participants to reveal information. They conclude, in the case of electricity, that adjustments should follow Carbon Emission Certificate price increases, relative to a situation without these Certificates. Alexecva-Talebi, Löschel and Mennel (2008) compare the effectiveness of BTAs and Integrated Emission Trading (IET). They find BTAs to be more effective in protecting domestic competitiveness, and IET more effective in reducing foreign emissions.

Debate regarding BTAs dates back to the adoption of Value Added Tax (VAT) in the European Union in the early 1960s. Following the 1958 Neumark Committee, it was agreed that the European VAT system would be administered on a destination basis, involving taxes on imports and rebates on exports (Lockwood and Whalley 2008). Initially this was viewed by US business as conferring a trade advantage on the EU, and the US pushed for a negotiation on BTAs as part of the Tokyo Round in the General Agreement on Tariffs and Trade (GATT) (Lockwood and Whalley 2008). The issue of BTAs was later examined by a GATT working party in 1970 (Goh 2004).

BTAs reappeared in national policy debates on the use of economic instruments to counter global warming. For example, in 1996 a Research Panel Report of the Japanese Environment Agency (Goh 2004), suggested the use of BTAs to address carbon leakage. However, the debate centred mostly on WTO compatibility of BTAs (Ismer and Neuhoff 2007). Although there are currently no BTA measures in place to offset the competitiveness impact of environmental taxes, two different bills relating to BTAs are currently under discussion in the US Senate (Lockwood and Whalley 2008). Furthermore, the harmonising of EU energy taxes between member states is likely to provide momentum to the BTA debate (Goh 2004).

Although BTAs involve both import tariffs and export rebates, if both import tariffs and export rebates were implemented simultaneously, the principle of neutrality might come into play and render BTAs ineffective (Meade 1974). However, the WTO has a clear set of stringent rules for export rebates as a result of the agreements reached in the Uruguay Round and Tokyo Round of trade negotiations (Pugel 2007). Since import tariffs are more likely to be implemented than export rebates, and to avoid the neutrality principle, this paper will consider only import tariffs.

There seems to be no literature which explores the possibility of reversing BTAs, where gains from trade can be used to counter the competitiveness effects of an environmental tax.

3 South African Electricity Consumption and Tariff Protection Profile

3.1 South African industries: Production, export and electricity needs

South African electricity usage is characterised by a few energy-intensive industries as shown in Table 1. The mining and extraction industry contributes only 3 percent to domestic production at market prices and 14.58 percent to exports at market prices, but consumes more than 50 percent of electricity. Also, the "Electricity" and "Utility and construction" industries consume 25 percent of electricity, but only contribute 6.17 percent to domestic production and 0.58 percent to exports at market prices[2]. On the other hand, "Grains and Crops", "Livestock and Meat products", ""Processed food" as well as "Textiles and Clothing" together consume 0.29 percent of electricity, but contribute 11.17 percent of domestic production and 11.45 percent of exports at market prices.

[2] However, it should be noted that these sectors are important providers of raw materials, to manufacturing in particular.

3.2 Industrial tariff protection by region

South Africa pursued an import substitution policy, through high trade tariffs and physical import controls, during the 1960s and 1970s (Gunnar and Subramanian, 2000).An import surcharge was introduced during 1985, but this system was replaced by the Generalised Export Incentive Scheme (GEIS) in 1990 (Ssekabira Ntege and Harmse 2003). At that time South Africa had a highly complex trade regime, with more than 13 000 tariff lines (Roberts 2000). Since the 1990s, South Africa liberalised its trade regime. Various tariffs were phased out over a five-year period starting in 1995 (Gunnar and Subramanian, 2000). The liberalisation also included the termination of GEIS by 1997, liberalisation of sensitive industries over an eight-year period, reduction in tariff lines, and the replacement of quantitative restrictions imposed on agricultural imports (Gunnar and Subramanian, 2000).

The number of eight-digit tariff lines was reduced to 6 618 in 2009. Furthermore, the number of tariff lines in the South African Tariff Book compared favourably with international standards, with 53 percent of these tariff lines at zero in 2009 (ITAC 2009). Formula duties comprised only 1.8 percent of the tariff lines in 2009, compared to 25 percent in the early 1990s, and are mainly applicable to agricultural products.

In an attempt to negate the negative economic impact of an electricity generation tax through BTAs, industry protection through the implementation of import tariffs ought to be considered. The average weighted *ad valorem* tariffs by industry per region are shown in Table 2.

The absence of tariffs reflects the free movement of goods and services within the Southern African Customs Union (SACU). "Processed Food" and "Textiles and Clothing" are the most protected industries in trade between South Africa and the rest of SADC. In addition to these two industries, "Light Manufacturing" is also protected by relatively high tariffs in trade between South Africa and the European Union as well as the rest of the world. Overall, import tariffs from the EU to South Africa are lower than the import tariffs from the rest of the world to South Africa, due to the Trade Development Cooperation Agreement (TDCA) between South Africa and the EU.

In the next section, the model and data are discussed. This is followed by an analysis of the results.

4 Model and Data

4.1 Introduction

This paper applies the Global Trade Analysis Project (GTAP) model, which is coordinated by the Centre for Global Trade Analysis at Purdue University. The GTAP model is the pre-eminent modelling framework for the analysis of trade and environmental issues across countries,

(www.gtap.agecon.purdue.edu). Nearly all analyses of Free Trade Agreements by governments and individual academics have utilised aspects of the GTAP model and/or database.

4.2 The GTAP model

GTAP, a multi-region computable general equilibrium (CGE) model, is designed for comparative static analysis of trade-related issues. GTAP databases are defined in terms of three primary sets, namely the set of countries and regions, the set of primary factors and the set of sectors and produced commodities (Rutherford and Paltsev 2000). The aggregation of GTAP used for this model distinguishes four regions as shown in Table 3, namely South Africa, SACU countries excluding South Africa, SADC countries excluding SACU and the rest of the world. Table A1 in the Appendix shows the aggregation of the 57 GTAP sectors into 11 sectors. Furthermore, there are three other agents in each region, namely the government, a capital creator and a representative household.

International transport margins are explicitly modelled in the GTAP model, while a consumer demand system is designed to capture differential price and income responsiveness across countries. Also, a global bank is designed to mediate between world savings and investment (Hertel and Will 1999). The GTAP uses macroeconomic data to update the regional input-output tables to a common base year – 2004 for the GTAP database used in this paper. All the coefficients in the regional input-output models are initially in national currency units and then scaled-up to external GDP data in 2004 US dollars. Then, gross capital formation, government consumption and private consumption are used to update the values for these aggregates in the regional input-output tables (Hertel 1997).

The behaviour of agents is optimised in competitive markets and this determines the regional demand and supply of goods and services in GTAP. This optimising behaviour also determines the sector demand for primary factors (land, capital, labour and natural resources). The labour market is disaggregated into a skilled labour market and an unskilled labour market while there is a single, homogenous capital good. Standard comparative static applications of the model fix the total supplies of all endowment factors (capital, labour, land and natural resources) for each region. For the applications reported here, we adopt a different convention, with skilled labour fixed for each region, but unskilled labour allowed to move across regions to eliminate any initial disturbances to real wage rates. This provides a more accurate description of the South African economy, which is characterised by a limited supply of skilled labour in the skilled labour market and high structural unemployment in the unskilled labour market.

Other key assumptions:

- It is assumed that the rates of commodity taxes are not affected by the exogenously imposed shocks, other than the effects used to impose the shocks.
- National investment is responsive to changes in the rates of return on capital, but global investment is assumed to be fixed. Also, public as well as private consumption expenditure and nominal saving in each region are assumed to move with regional income. Therefore, the region benefiting the most from the exogenous shocks imposed will increase its share of global investment at the expense of other regions.
- GTAP contains different types of technicalchange variables. However, in these simulations we assume constant technological variables. For example, an electricity generation tax has no impact on the technological processes used in the production of electricity-intensive products.
- It is assumed that capital stocks are fixed, with rates of return varying to accommodate the unchanged capital.

4.3 The GTAP database

The simulations reported in this research study are based on a preliminary release of Version 7 of the database. The GTAP database comprises: input/output data for each region; bilateral trade data derived from United Nations trade statistics; and support and protection data derived from a number of sources. Documentation for the Version 6 data set is given in Dimaranan (2006). The Version 7 database contains estimates of production costs, final demand values, bilateral trade values and various tax levels for 2005.

4.4 Scenarios

The version described in the previous section is used to model two scenarios. In the first scenario, South Africa imposes a unilateral 2c/kWh tax on electricity generation. Changes in trade volumes are those linked to a 2c/kWh increase in the tariff, which is equivalent to a sector-wide weighted average 10 percent increase in the price of electricity (Blignaut, Chitiga-Mabugu and Mabugu 2005). The second scenario models the effects of a 10 percent electricity generation tax in South Africa, as well as import tax adjustments to eliminate the effect of the electricity tax on the real GDP and employment of South Africa. The import tax adjustments are simulated through a proportional reduction in import tariffs across all industries. Import tariffs are reduced to counter the reduction in imports resulting from the electricity generation tax. We modelled different trade-weighted import tariff percentage reductions to establish an average percentage reduction that would reverse the negative effect of the electricity tax on the real GDP. Therefore, we reverse the traditional BTA approach, and negate the competitiveness impact of an environmental tax, through realised gains from trade.

The shocks for the electricity generation tax were imposed via changes to output taxes in the production of electricity. An output tax drives a wedge between the price received by producers and the price paid in the market.

5 Results

A unilateral 2c/kWh electricity generation tax in South Africa will affect not only the South African economy, but also the SACU, SADC, the EU and the rest of the world, via changes in South Africa's export and import volumes. Seymore *et al* (2009) discuss the results of such an electricity generation tax and these results are summarised in Table 2. It should be noted that revenue neutrality was also simulated and the results reflected no statistically significant differences from the results reported below.

As shown in Table 4, all the macroeconomic variables, with the exception of real export volume, decrease for South Africa. Contrary to the expected outcome, real import volume decreased by 0.69 percent and real export volume increased by 0.7 percent. Seymore *et al* (2009) explain that this is the result of the decline in domestic demand for domestic production outweighing the reduction in production, which leads to lower domestic prices and an increase in exports. Imports decreased due to lower domestic demand.

The higher production costs translate into job losses, with unskilled employment contracting by 0.77 percent. Skilled employment wages decrease by -1.05 percent due to the contraction in real GDP.

As discussed above, one method that could be utilised to counter the negative impact of the electricity tax is BTAs. However, as shown in Table 4, South Africa will experience an increase in exports. Therefore, export subsidies will not be an effective approach towards negating the effect of the electricity tax on the competitiveness of the country.

Imports, on the other hand, are set to decrease. Since production inputs are priced at import parity pricing, a reduction in import tariffs will reduce production costs and thereby restore South African competitiveness. Therefore, the appropriate action to counter the contraction in South African GDP as well as the increase in unemployment, is a reduction in import tariffs. Scenario 2 modelled different trade weighted import tariff reductions to establish an average reduction level that would reverse the negative effect of the electricity tax on the real GDP, and result in a constant real GDP[3]. The new revised tariffs are provided in Table 6. The average required reduction in import tariffs was calculated at 29 percent. The low baseline of the tariffs explains the relatively high result.

As shown in Table 6, the import tax adjustments could succeed in neutralising the effect of an electricity generation tax on real GDP, although this will be at the cost of weaker terms of trade. Nevertheless, international trade will be stimulated and exports are expected to increase by 2.75 percent and imports are expected to increase by 2.24 percent. This will result in a 0.46 percent improvement in the South African trade balance. Furthermore, it should be noted that under scenario 2, government spending decreases by 0.11 percent, as compared to 0.17 percent under scenario 1.

[3] This was done through a trail and error.

On an industry level, "Grains and Crops" and "Heavy Manufacturing" at 0.57 percent and 0.56 percent respectively, are set to record the highest increase in production, while "Textile, Clothing and Footwear" are set to decrease output by 2.91 percent. This is in line with expectations, as the "Grains and Crops" and "Heavy Manufacturing" industries are highly reliant on capital imports and fuel to increase production. On the other hand, the Textile, Clothing and Footwear industry will be even more exposed to a highly competitive international market. This will probably cause some relatively unproductive producers to exit the market.

We also tested for a neutral unskilled employment policy, where the negative impacts on employment and wages of an electricity generation tax was countered through tariff reductions. A 39.98 percent reduction in the overall level of baseline tariffs was found to be appropriate.

It is important to note that the proposed tariff reductions will be in line with the current trade liberalisation policy approach in South Africa. As discussed in Part 3, South Africa is not only simplifying the South African Tariff Book, but is also committed towards tariff reductions.

The CO_2 abatement before and after the reversed BTAs has been calculated. This was done using the greenhouse gas emissions inventory as developed by Blignaut, Chitiga-Mabugu and Mabugu (2005). Economic benefits accruing to CO_2 abatement was calculated at R100 per ton, based on a low estimate of approximately 8 euros for a Certifiable Emissions Reduction Certificate. As reflected in Table 7, reversed BTAs will reduce the CO_2 reduction benefit from R 970 million to R 824 million. This small forfeiture of CO_2 abatement benefits is due to the structural shift in the economy towards non-energy intensive sectors, as shown in Table 6.

The Stroud quadrature method was used to conduct a sensitivity analysis. The model was solved 22 times and the price elasticity for electricity demand? in the South African economy (0.47) has been found to be robust at a 10 percent variation.

6 Conclusion

The South African government, in the 2008 Budget Review, announced its intention to levy a 2c/kWh tax on the sale of electricity generated from non-renewable sources. This tax is to be collected at the source from the producers/generators of electricity. This measure is intended to serve a dual purpose of helping to manage the current electricity supply shortages and to protect the environment (National Treasury 2008).

An electricity generation tax is set to have an impact on the South African economy. However, several instruments have been proposed in the literature to protect the competitiveness and economy of a country when imposing a green tax, one of these being BTAs.

The primary objective of this paper was to evaluate the effectiveness of border tax adjustments to negate the competitiveness and economic impacts of such an electricity generation tax, without sacrificing the environmental benefits of the tax, in the case of South Africa. The paper firstly provided an economic rationale for an electricity generation tax and examined the instruments available to reduce or eliminate the negative economic effects of such a tax.

In the next section, the paper considered the South African industry structure in terms of electricity intensity of production as well as contribution to domestic production and exports.

In the fourth section, the model and data were discussed. This was followed by an analysis of the results. The results showed that, an electricity generation tax will lead to a contraction in South African GDP. However, traditional BTAs were unable to address these negative impacts. We proposed a reversedBTA approach where gains from trade were utilised to negate the negative impacts of an electricity generation tax, while retaining the environmental benefits associated with the electricity generation tax. This was achieved through a reduction in import tariffs, as this reduction will reduce production costs and thereby restore South African competitiveness. The reduction in import tariffs not only negated the negative GDP impact of the electricity generation tax, but the bulk of CO_2 abatement from the electricity generation tax was retained.

The multi-country GTAP model focuses on the interaction between countries arising from the flow of goods and services. The representation of investment and savings leakages is relatively weak and it does not record the possible inter-country shifts of physical and financial assets that may arise from the electricity generation tax. Also, the entire demand system is treated as the demand system of a representative household. There is effectively only one household, and it is not possible to analyse the welfare effects of the electricity tax on different households.

The GTAP version used in this paper is not dynamic, but rather a static model. Thus, there is no allowance for inter-temporal linkages between savings and consumption, and investment and capital. The model is able to project likely capital changes by region and industry associated with the tax, but there are no endogenous mechanisms that allow projections of the time-pattern of investment changes which lead to the projected capital changes. Also, short-term and long-term adjustment costs associated with the tax cannot be properly analysed in a static framework.

The emergence of new industries, such as nuclear or coal generation with carbon capture are not endogenously incorporated into the model. The model user must therefore exogenously introduce new industries, with the timing and size of the new industries specified by the modeller. In this paper, it is assumed that no new industries emerge as result of the 2c/kWh electricity tax. Thus, the impact analysis is a relatively short to mediumterm analysis.

No attempt is made in these simulations to include the possible effect of climate change in the base case. There are no assumptions made about the possible costs under "business as usual" resulting from climate change. For example, we do not assume an increase in the demand for electricity resulting from desertification leading to an increased need for irrigation. Not allowing for climate change implies that we also do not account for any of the possible economic benefits arising from abatement achieved by the electricity generation tax.

Although this paper attempted to evaluate the effectiveness of BTAs in negating the competitiveness and economic impacts of an electricity generation tax, given the limitations above, it might be useful to extend this analysis to a dynamic CGE model, or to allow the emergence of new industries due to the electricity generation tax.

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Table 1: Electricity consumption, contribution to GDP and international trade by industry in 2004 (in percent terms)

Industry	ELECTRICITY USED IN PRODUCTION	DOMESTIC PRODUCTION AT MARKET PRICES	EXPORTS AT MARKET PRICES	IMPORTS AT MARKET PRICES
Electricity	14.06	1.53	0.45	0.41
Grains and crops	0.00	1.59	4.13	4.92
Livestock and meat products	0.04	2.15	0.65	0.68
Mining and extraction	50.89	3.05	14.58	14.98
Processed food	0.05	5.21	4.77	5.38
Textiles and clothing	0.20	2.22	1.90	1.92
Light Manufacturing	1.95	11.15	16.38	16.38
Heavy Manufacturing	8.37	18.46	44.12	43.64
Utilities and construction	10.96	4.64	0.13	0.12
Transport and communication	3.57	17.99	6.75	6.06
Other services	9.90	32.01	6.12	5.50
Total	100.00	100.00	100.00	100.00

Source: GTAP database, Preliminary version 7

Table 2: Average weighted *ad valorem* tariffs by industry

	Rest of SACU	Rest of SADC	EU	Rest of the world
Electricity	0.00	0.00	0.00	0.00
Grains and crops	0.02	0.64	4.31	3.95
Livestock and meat products	0.00	0.23	5.78	10.46
Mining and extraction	0.00	0.01	0.05	0.02
Processed food	0.00	4.83	11.41	12.05
Textiles and clothing	0.00	6.42	11.68	27.07
Light Manufacturing	0.01	0.68	11.71	13.96
Heavy Manufacturing	0.00	0.00	1.60	2.96
Utilities and construction	0.00	0.00	0.00	0.00
Transport and communication	0.00	0.00	0.00	0.00
Other services	0.00	0.00	0.00	0.00

Source: GTAP database, Preliminary version 7

Table 3: Regional aggregation of GTAP

Identifier	Countries in Region
South Africa	South Africa
SACUexclSA	Lesotho, Swaziland, Namibia and Botswana
SADCexclSACU	Zambia, Malawi, Mozambique, Mauritius, Angola, Tanzania, Zimbabwe, the DRC and Madagascar
EU_25	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom
Restofworld	The rest of the world

Table 4: Results of a ten percent tax on the generation of electricity

10 PERCENT TAX	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Real GDP	-0.28	0.01	0.01	0.00	0.00
Real private consumption	-0.04	0.06	0.02	0.00	0.00
Real public consumption	-0.17	0.03	0.01	0.00	0.00
Real investment	-2.29	0.12	0.07	0.01	0.01
Real import volume	-0.69	0.13	0.04	0.00	0.00
Real export volume	0.70	0.02	0.00	0.00	-0.01
Terms of Trade	-0.15	0.06	0.02	0.00	0.00
Unskilled employment	-0.77	0.07	0.01	0.00	0.00
Skilled employment wage rate	-0.63	0.07	0.04	0.00	0.00
Industry production					
Electricity	-4.29	1.47	0.45	0.04	0.01
Grains and crops	0.31	-0.07	-0.02	-0.01	0.00
Livestock and meat products	-0.08	-0.05	0.00	0.00	0.00
Mining and extraction	-0.35	0.00	0.00	0.00	0.00
Processed food	0.01	-0.06	-0.02	0.00	0.00
Textiles and clothing	0.34	0.15	-0.02	0.00	-0.01
Light Manufacturing	0.12	-0.29	-0.14	0.00	0.00
Heavy Manufacturing	-0.18	0.01	-0.09	0.00	0.00
Utilities and construction	-1.84	0.10	0.06	0.01	0.01
Transport and communication	0.01	0.00	0.00	0.00	0.00
Other services	-0.19	0.04	0.01	0.00	0.00

Source: Seymore, R., Adams, P.D., Mabugu, M., Van Heerden, J.H. and Blignaut, J. 2009

Table 5: Reversed Border tax adjustments:
South African import tariff changes (percentage points)

	SACUexclSA	SADCexclSACU	EU_25	restofworld
Electricity	0.00	0.00	0.00	0.00
Grains and crops	-0.01	-0.19	-1.23	-1.13
Livestock and meat products	0.00	-0.07	-1.63	-2.82
Mining and extraction	0.00	0.00	-0.02	-0.01
Processed food	0.00	-1.37	-3.05	-3.20
Textiles and clothing	0.00	-1.73	-3.12	-6.35
Light Manufacturing	0.00	-0.20	-3.12	-3.65
Heavy Manufacturing	0.00	-0.09	-0.47	-0.86
Utilities and construction	0.00	0.00	0.00	0.00
Transport and communication	0.00	0.00	0.00	0.00
Other services	0.00	0.00	0.00	0.00

Table 6: Results after border tax adjustments

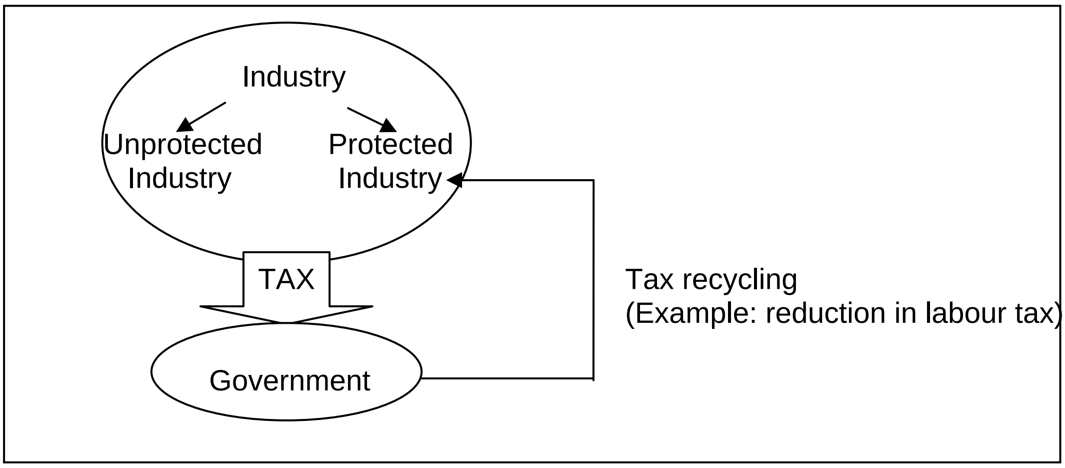
	SOUTH AFRICA (Percentage change)
Real GDP	0.00
Real private consumption	-0.15
Real public consumption	-0.11
Real investment	-0.28
Real import volume	2.24
Real export volume	2.75
Terms of Trade	-0.50
Unskilled employment	-0.20
Skilled employment wage rate	-0.12
Industry production	
Electricity	-3.97
Grains and crops	0.57
Livestock and meat products	-0.14
Mining and extraction	-0.06
Processed food	-0.02
Textiles and clothing	-2.91
Light Manufacturing	-0.70
Heavy Manufacturing	0.56
Utilities and construction	-0.28
Transport and communication	0.09
Other services	0.01

Table 7: CO_2 abatement benefit: with and without reversed border tax adjustments

		BEFORE reversed BTAs		AFTER reversed BTAs	
	CO_2 emissions (Mt)	Change in CO_2 emissions (Mt)	Benefit (million)	Change in CO_2 emissions (Mt)	Benefit (million)
Electricity	221.14	-9.49	948.68	-8.78	877.92
Grains and crops	7.87	0.02	-2.44	0.04	-4.48
Livestock and meat products	1.75	0.00	0.14	0.00	0.24
Mining and extraction	7.87	-0.03	2.75	0.00	0.47
Processed food	0.00	0.00	0.00	0.00	0.00
Textiles and clothing	0.00	0.00	0.00	0.00	0.00
Light Manufacturing	16.17	0.02	-1.94	-0.11	11.32
Heavy Manufacturing	102.27	-0.18	18.41	0.57	-57.27
Utilities and construction	2.62	-0.05	4.82	-0.01	0.73
Transport and communication	45.01	0.00	-0.45	0.04	-4.05
Other services	2.62	0.00	0.50	0.00	-0.03
	407.31	-9.70	970.48	-8.25	824.86

Figure 1

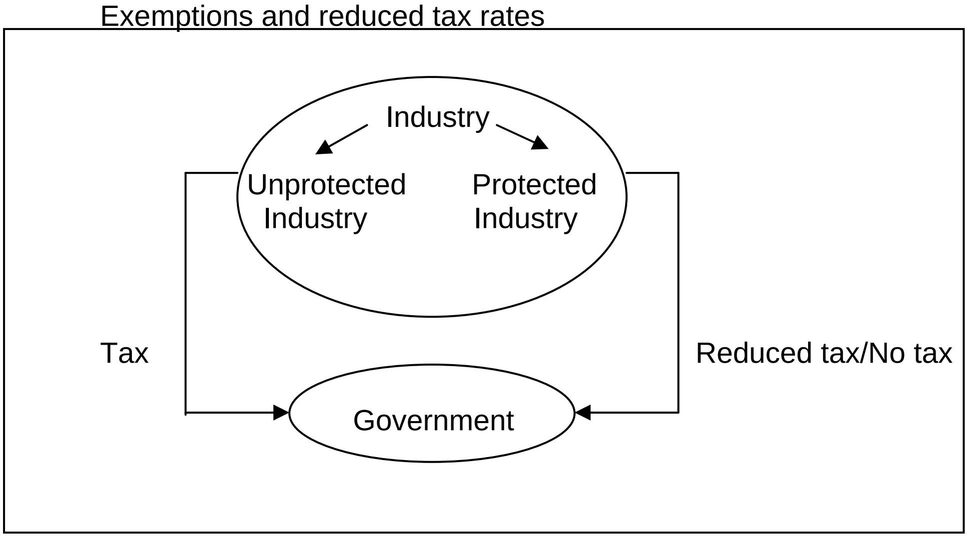
Revenue recycling



Source: Republic of South Africa 2008

Figure 2

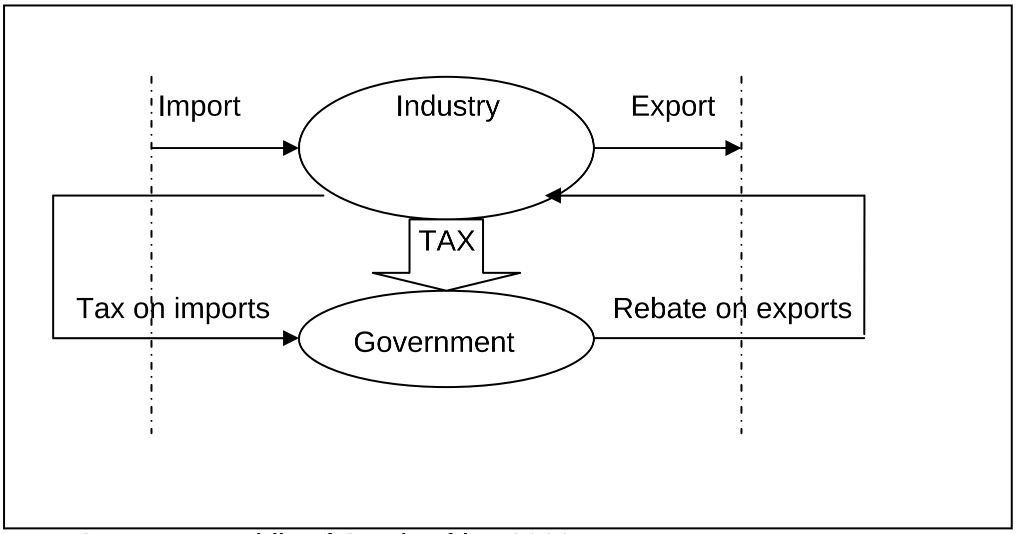
Exemptions and reduced tax rates



Source: Republic of South Africa 2008

Figure 3

Border Tax Adjustments



Source: Republic of South Africa 2008

APPENDIX

Table A1: Sectoral aggregation of GTAP

Identifier	Sectors in Region
1. Electricity	Electricity
2. GrainsCrops	Paddy rice Wheat Cereal grains nec Vegetables, fruit, nuts Oil seeds Sugar cane, sugar beet Processed rice
3. MeatLstk	Cattle, sheep, goats, horses Animal products nec Raw milk Wool, silk-worm cocoons Meat: cattle, sheep, goats, horse Meat products nec
4. Extraction	Forestry and fishing Coal Oil and gas Mineral nc
5. ProcFood	Vegetable oils and fats Dairy products Sugar Food products nec Beverages and tobacco products
6. TextWapp	Textiles Wearing apparel
7. LightMnfc	Leather products Wood products Paper products, publishing Metal products Motor vehicles and parts Transport equipment nec Manufactures nec
8. HeavyMnfc	Petroleum, coal products Chemical, rubber, plasticprods Mineral products nec Ferrous metals Metals nec Electronic equipment Machinery and equipment nec
9. Util_cons	Gas manufacture, distribution Water Construction
10. TransComm	Trade Transport nec Sea transport Air transport Communication
11. OthServices	Financial services nec Insurance Business services nec Recreation and other services Public Admin, defence, health, education Dwellings