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THE COMPETITIVENESS IMPACT
OF A MULTILATERAL ELECTRICITY GENERATION TAX

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ABSTRACT

The South African Government announced, in the 2008 Budget Review, the intention to tax the generation of electricity from non-renewable sources with 2c/kWh. This tax is to be collected by the producers/generators of electricity at the source. The intention of the tax is to serve a dual purpose of managing the potential electricity shortages in South Africa and to protect the environment. The primary objective of this paper is to evaluate the impact of an electricity generation tax on the international competitiveness of South Africa. Specifically, different scenarios are assessed to establish whether the loss of competitiveness can be negated through an international, multilateral electricity generation tax.

The paper firstly considers the beneficial impact of environmental taxation on the competitiveness of a country. We subsequently apply the Global Trade Analysis Project (GTAP) model to evaluate the impact of an electricity generation tax on the competitiveness of South Africa, given multilateral taxes on SACU, SADC and European Union economies.

We simulate the proposed tax as a 10 percent increase in the output price of electricity. We assume a closure rule that allows unskilled labour to migrate between sectors and a limited skilled workforce. As expected, a unilateral electricity generation tax in South Africa will adversely affect the competitiveness of the South African economy and slightly improve the competitiveness of the other SACU and SADC economies.

However, if a multilateral tax is imposed throughout the SACU and SADC countries, South Africa will experience a marginally greater loss of competitiveness compared to a unilateral tax. At the same time the rest of the SACU and SADC countries will experience a loss of competitiveness. The benefit of emission reduction in South Africa will also be lower under these multilateral tax scenarios. The competitiveness effect on the South African economy as well as emission reduction will be more moderate under a multilateral South Africa/EU electricity generation tax than under a unilateral South African tax.

1. INTRODUCTION

1.1 The electricity sector in South Africa

The South African Government announced, in the 2008 Budget Review, the intention to tax the generation of electricity from non-renewable sources with 2c/kWh. This tax is to be collected by the producers/generators of electricity at the source. The intention of the tax is to serve the dual purpose of managing the potential electricity shortages in South Africa and to protect the environment (Republic of South Africa 2008).

In 2004 South Africa contributed about 1 percent or 440 metric ton (Mt) of the global equivalent carbon dioxide (CO_2-eq) produced in the world (49,000Mt). The CO_2-eq production per capita averaged 5.0t for developing countries, 6.8t for the world and 9.5t for South Africa. Whereas African and developing countries emitted less CO_2 for a unit of GDP than the world average, South Africa emitted not only more per capita than the world average, but also more than OECD countries. South Africa's emissions against GDP was 0.75kg/$, whereas the world average was 0.56kg/$ (Winkler 2007).

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The electricity sector in South Africa produces 50.6 percent of the national CO_2-eq (Blignaut, Chitiga-Mabugu and Mabugu 2005).

Table 1: South Africa's electricity capacity – 2004 [2]

ENERGY SOURCE	CAPACITY (MW)	PERCENT OF TOTAL
Coal	38 209	88.8
Nuclear	1 800	4.2
Bagasse	105	0.2
Hydro	668	1.6
Gas turbines	660	1.5
Pumped storage	1 580	3.7
Total	43 022	100

Source: Republic of South Africa 2006

Table 1 illustrates the electricity generation capacity of South Africa. The South African electricity generation is dominated by coal-fired stations (88.8 percent).

South Africa is a member of the Southern African Power Pool (SAPP) which facilitates electricity distribution within SADC. As shown in Table 2, South Africa was an exporter of electricity from 2003 onwards.

Table 2: South African international trade in electricity

	ELECTRICITY GENERATED	IMPORTS GWH	EXPORTS GWH	NET EXPORTS
2000	210670	4719	4007	-712
2001	211744	7247	6519	-728
2002	211546	7873	6950	-923
2003	211120	6739	10136	3397
2004	210726	8026	12453	4427
2005	210160	9199	12884	3685
2006	209505	9782	13766	3984
2007	210091	11348	14496	3148
2008[3]	191574	9492	12968	3476

Source: Republic of South Africa 2009

1.2 South Africa's relative trade position

A tax on electricity generation in South Africa will affect not only the South African economy, but also SACU, SADC, EU and the rest of the world, via changes in South Africa's export and import volumes. This section provides a brief summary of South Africa's relative trade position.

Bilateral import shares for the regions under consideration are shown in Table 3. South Africa, despite bordering the rest of the SACU countries, only imports 7.1 percent of total imports from the rest of SACU countries and 6.3 percent from the rest of SADC countries. On the other hand, South Africa imports 35.7 percent of total imports from the European Union, South Africa's largest trading partner.

[2] The latest available breakdown as provided by the Department of Minerals and Energy.
[3] The data for 2008 is only for the first 11 months.

Table 3: Bilateral import shares

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25
to SouthAfrica	0.0	7.1	6.3	35.7
to SACUexclSA	6.9	0.1	1.9	55.4
to SADCexclSACU	6.1	0.7	5.1	42.4
to EU_25	0.6	0.0	0.1	59.9

Source: GTAP database

The rest of SACU countries import 6.9 percent of total imports from South Africa, but 55.4 percent from the European Union. Similarly, the rest of SADC countries import 6.1 percent of total imports from South Africa, but 42.4 percent from the European Union.

As shown in table 4, exports exhibit similar shares, with the European Union being the dominating trade partner for South Africa, the rest of SACU countries and the rest of SADC countries.

Table 4: Bilateral exports shares

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25
from SouthAfrica	0.0	7.5	5.5	36.2
from SACUexclSA	7.1	0.1	1.7	55.0
from SADCexclSACU	6.3	0.7	4.9	41.5
from EU_25	0.5	0.0	0.1	61.2

Source: GTAP database

The primary objective of this paper is to evaluate the impact of an electricity generation tax on the international competitiveness of South Africa. Also, different scenarios are assessed to establish whether the loss of competitiveness can be negated through an international, multilateral electricity generation tax.

The next section considers the relationship between environmental taxation and pollution, as well as the effect of environmental taxation on competitiveness. In the third section, the model, data and simulation design are discussed. This is followed by an analysis of the results. The fourth section presents a conclusion and discussion of the limitations of the model.

2. LITERATURE REVIEW[2]

2.1 Introduction

This section of the paper considers the impact of environmental taxation on the competitiveness of a country. The fear of loss of competitiveness and the fear of negative distributional impacts are currently the main obstacles to the implementation of environmental taxation (OECD 2001).

2.2 Defining environmental taxes

The idea behind environmental taxation is to internalise the externalities caused by polluting industries, which should then fully reflect the negative impact of production on the environment (OECD 2001).

"Putting an appropriate price on carbon, explicitly through a tax or trading, or implicitly through regulation, means that people are faced with the full social cost of their actions. This will lead individuals and businesses to switch away from high-carbon goods and services, and to invest in low-carbon alternatives."
(Stern & The Great Britain Treasury 2006 p xviii)

Environmental taxes were defined by De Kam (2002 p2) as "Any compulsory, unrequited payment to general government levied on a tax base deemed to be of particular environmental relevance". Environmental taxes are unrequited since the payments by taxpayers are normally not in proportion to the benefits they receive from government.

Given the definition above, environmental taxes can only be successfully implemented if the following two principles of taxation are considered (De Kam 2002):

- A tax will, as long as it affects the incentives of economic agents, creates distortions in the economy that will lead to a reduction of economic efficiency. However, these distortions might be introduced into the system to correct market failures and thereby enhance welfare. Also, where the price elasticity of demand is relatively inelastic, there will be substantial revenue gains; this might be used to offset distortions cause dby other taxes. In such a situation, a double dividend becomes possible.
- The direct effect of the tax should be assessed as it will impact on the distribution of income and create questions about fairness. According to De Kam (2002), this issue of redistribution should be awarded substantial weight even if it lowers economic efficiency.

The OECD (2001) found, over the past couple of decades, that environmental taxes could be effective and efficient instruments for environmental policy to reduce pollution. These measures, through their price signals to the economy, ensure that polluters take into account the detrimental impact of their production and consumption decisions on the environment (OECD 2001). Environmental improvements are achieved through price increases of environmentally harmful products. These price increases reduce the quantity demanded of the product. The idea is that the most efficient and cheapest abatement could be achieved if marginal abatement costs are equalised across all agents (University of Pretoria (UP) 2007).

However, most stakeholders will agree that the optimal environmental effectiveness and economic efficiency of environmentally related taxes have not been achieved due to existing exemptions and other special provisions. Two main political concerns hamper the scaling back of these obstacles, namely, the fear of loss of competitiveness and the fear of negative distributional impacts (OECD 2001). As a result, the negative environmental impacts caused by production and consumption are not fully reflected in the economy.

2.3 The effect of environmental taxes on competitiveness

International competitiveness

The definition of "international competitiveness" is not clear in the literature. Krugman (1994) claims that competitiveness is a dangerous obsession when applied to countries, as opposed to companies. International trade is not a zero-sum game, and countries do not compete directly in the same way as companies (Krugman 1994). Golub (2000 p8) defined competitiveness as a "favourable business climate, sometimes measured by a composite score of a series of indicators: structural and macroeconomic policies, basic infrastructure, education, labour market rigidities, etc.". This definition is in line with the approach of the competitiveness rankings of the World Economic Forum.

The concept of competitiveness has several different levels (UP 2007). It is therefore important to distinguish between the competitiveness of an entire country and the competitiveness of individual firms and sectors. As long as a company or sector is able to compete in international markets, and earn an adequate rate of return; the company or sector could be seen as competitive. On the other hand, competitiveness for an entire country is more complex to define. Environmental taxes are intended to correct market failures. If this is achieved, overall economic efficiency in the economy increases. However, certain sectors will face higher production costs and will therefore be adversely affected. If there is a revenue recycling scheme in place and recycling takes place through a reduction in labour taxes, labour intensive industries will tend to gain at the expense of energy intensive sectors (De Kam 2002).

The different dimensions of competitiveness are described in Table 5.

Table 5: The different dimensions of competitiveness

	INDIVIDUAL FIRM	COUNTRY
Definition	Able to compete in international markets, with an adequate rate of return.	Favourable business climate, while correcting for market failures, resulting in an improvement in the overall economic outcome.
Relative Performance	If uncompetitive, risk losing market share and eventually close down.	If uncompetitive, grow more slowly and enjoy fewer opportunities than more competitive countries.
Environmental Tax	Impact on the bottom-line.	Impact on the overall performance of the economy

Source: Republic of South Africa 2008

The second dimension of competitiveness is relative performance, in terms of individual firms and countries. A firm that is uncompetitive is at risk to lose market share, or to close down. However, a country cannot close down. But countries with low competitiveness could experience slower than optimal economic growth, with lower real wage growth and fewer economic opportunities than more competitive countries (Stern 2006). On a country level, improving competitiveness would entail new policies and revamping institutions to enable the economy to adapt more freely to changing environments and exploiting new opportunities. This should include measures to improve national productivity. National competitiveness could further be enhanced through environmental measures that encourage emission mitigation, if these measures are carefully designed and if these measures provide incentives to innovate. Therefore, innovation associated with countering climate change could stimulate global economic growth (Stern 2006).

Environmental taxes and competitiveness

When implementing environmental taxes, the objectives of these taxes should be clearly stated at the onset (OECD 2001). An environmental tax will have an impact on the competitiveness of certain industries, especially energy intensive industries. According to the OECD (2001), due to the influence and large interests of industry, energy taxes cannot be introduced without significant exemptions and other special provisions to reduce the burden on at least the worst hit sectors. Exemptions and other special provisions could be inefficient if the unilateral imposition of environmental taxes creates a possibility for leakage. Also, exemptions and special provisions differ in the way in which they affect the original emission reduction incentives of the tax. The most efficient emission reduction could be achieved if equal tax rates are levied on all agents and then compensate the worst hit sectors separately. If this is not possible, low tax rates that are raised slowly over time could be levied in these sectors as opposed to complete exemptions or zero-rates (UP 2007).

However, exemptions create inefficiencies in pollution abatement and run contrary to the objective of environmental taxes, that is, the polluter should pay principle.

Potential loss of competitiveness

Popular view dictates that trade liberalisation will shift power from governments to firms, thus making it easier for firms to resist costly environmental regulation. This becomes possible if firms refer to their need to stay competitive. However, the argument will only hold if environmental measures decrease the competitiveness of firms and governments respond by setting less stringent environmental policies (Greaker 2004).

De Kam (2002) reported that environmental taxes imposed in OECD countries did not reduce the competitiveness of industries within these countries. This might be due to partial exemption provided to energy intensive industries in these countries. In fact, it is clear from the OECD/EU database that environmentally-related taxes are almost exclusively levied on households and the transport sector (De Kam 2002).

However, the OECD (2001) indicated that economic instruments, used for pollution abatement purposes are likely to have detrimental effects on the international competitiveness of certain industries, especially if these instruments are implemented through a unilateral policy decision. This is because a unilateral environmental tax will increase the production cost in the country imposing the tax, thus forcing the prices of domestically produced products traded in the international market to higher levels. As a result, exports will become less attractive and imports more so. This will lead in the short run to lower domestic production, potential job losses and other adjustments caused by the tax in the economy (De Kam 2002).

Competitiveness concerns are expected to be the strongest if the environmentally-related tax is imposed on internationally traded goods or key factors of production, and these goods or factors are freely traded with no border tax adjustment in place. Another critical factor is substitution possibilities. If there is limited scope for the identification and financing of cleaner production processes and technologies, the inability to substitute away from environmental taxes will adversely impact on the competitiveness of affected industries (De Kam 2002). On the other hand, competitiveness effects are not likely to be a major concern if the environmental tax is levied on the production of a product that cannot be readily imported or exported, and substitution is possible as well as relatively cheap.

According to Stern (2006), in the case of a unilateral tax, the potential impact on a small number of industries is such that leakage becomes possible. In other words, even if these sectors are not characterised by high trade intensity, there are incentives for import substitution and to relocate production to countries with less stringent environmental regulation. Therefore, some sectors (for example, steel and cement or even electricity for more inter-connected countries) might be more vulnerable where countries border other countries with less stringent mitigation regulation (Stern 2006).

Potential gain of competitiveness

There is also some evidence in the literature that suggests that environmentally-related taxes could increase the competitiveness of a country imposing the tax. For example, the Porter-hypothesis states: “Governments can tighten their level of environmental regulation, and firms will find that they become more competitive, not less” (Porter 1991). This hypothesis could be interpreted in at least two different ways. Firstly, emissions can be seen as a wasteful use of scarce resources. Scarce resources are transformed to pollution as a by-product of production. According to Porter and Von der Linde (1995) this could be seen as a sign that these resources are used in an incomplete, inefficient or ineffective manner. If these emissions are removed from the system, efficiency gains will be made as less scarce resources will be needed to produce final goods (Porter and Von der Linde 1995). Secondly, if stringent regulation is implemented in the correct manner, firms in tax paying countries could become more competitive than firms in countries without the same type of taxation. In other words, a tough environmental policy makes firms more internationally competitive than a weak environmental policy (Porter 1991).

Greaker (2003) referred to the scale advantages of abatement technology when he stated that emissions may be an inferior input in production. He also provided evidence that governments could exploit this in the international market place through setting a high emissions tax.

In 2004, Greaker supported the Porter-hypothesis by illustrating the possibility of improved downstream competitiveness due to tough environmental policies. Entry into the abatement services industry is expected to increase under tough environmental policies. This is expected to lead to a lower price on pollution abatement and consequently a more competitive polluting industry. Thus, Greaker (2004) proposed that governments should set an especially stringent environmental policy. However, this argument is only valid if the environmental policy is unilateral in nature. In other words, this incentive to set a stringent environmental policy will disappear if there is a global market for pollution abatement services.

Along the same line of argument, stringent environmental taxes could also increase firm competitiveness, since higher emission taxes lead to a reduction of marginal costs. This would be the case if emissions per unit of output decrease due to increased spending on research and development and if this effect dominates the direct effect of the environmental tax (Ulph 1994).It remains ambiguous to which extent governments should set a high emissions tax to exploit this relationship.

Computable General Equilibrium model results for South Africa

Van Heerden, Blignaut and Jordaan (2008) modelled a 10 percent increase in the price of electricity in South Africa. The aim was to determine the effect of such an increase on the consumer price index. A computable general equilibrium model of the Department of Economics at the University of Pretoria, UPGEM, was used in the study. The official 1998 Social Accounting Matrix of South Africa, which divided households into 48 groups and recorded 27 sectors, was used in the database. The UPGEM model's closure reflected a short-run time horizon. They found the direct impacts of an electricity generation tax on the economy to be mostly negative.

The model presented in this study simulates an equivalent increase in electricity prices, but looks not only at the South African economy, but also SACU, SADC and the European Union. Furthermore, a unilateral and multilateral tax is simulated to examine the possibility of negating the adverse competitiveness effects through multilateral tax implementation. The model also provides a detailed breakdown on industry level, and distinguishes between unskilled and skilled labour. This analysis should enable policy makers to assess the impact of the proposed electricity generation tax, whether unilateral or multilateral, on an international, national and industry level.

3. MODEL AND DATA

3.1 The GTAP model

The multi-region computable general equilibrium Global Trade Analysis (GTAP) model is designed for comparative-static analysis of trade policy issues. All GTAP datasets are represented in three primary datasets namely: the set of regions and countries, the set of produced commodities and sectors, and the set of primary factors (Rutherford and Paltsev 2000). The version of the model used in this paper distinguishes five regions, shown in Table 6, and the 57 GTAP sectors has been aggregated into 11 sectors shown in Table A1 in the Appendix. In addition to the 11 sectors, there are three other agents in each region: a capital creator, a household and the government.

Table 6: 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

The GTAP model mediates between world savings and investment through the explicit modelling of international transport margins and a global bank. Also, differential price and income responsiveness across countries are captured through a consumer demand system (Hertel and Will 1999).

The common base year for the GTAP 7 database, as used in this paper, is 2004 and macroeconomic data is used to update the regional input-output tables. All the coefficients in these updated regional input-output tables are then scaled-up to external GDP data, in 2004 US dollars, from the initial national currency units. Then, gross capital formation, government consumption and private consumption are used to update the values of these aggregates in the regional input-output tables (Hertel 1997).

GTAP optimises the behaviour of agents in competitive markets to determine regional supplies and demands of goods and services. This behaviour will also determine the sector demands for primary factors, i.e. natural resources, capital, land and labour. There is skilled labour, unskilled labour and a single, homogenous capital good in each region. In the standard comparative static applications of the model, total supplies of all primary factors are fixed in each region. For the applications reported here, we adopt a different treatment, with unskilled labour allowed to move across regions to eliminate any initial disturbances created in the unskilled labour market, but we fix skilled labour with a variable skilled wage rate. Given the limited supply of skilled labour in the skilled labour market and the high structural unemployment in the unskilled labour market, this treatment will be a more accurate description of the South African economy than the standard comparative static applications.

Other key assumptions:

- The entire final demand system is treated as the demand system of a representative household. Therefore, it is not possible to analyse the welfare effects of a unilateral or multilateral tax on different households as there is effectively only one household in the model.

- It is assumed that nominal savings as well as private and public consumption expenditures in each region move with regional income. Furthermore, if there is a change in rates of return on capital, national investment will respond. Global investment is fixed. Therefore, a region that benefits the most from an exogenous shock will increase its share of global investment, at the expense of other regions that benefit less.

- Capital stocks are fixed in these simulations. However, rates of return are allowed to vary and this assumption will accommodate the unchanged capital.

- It is also assumed that all technology variables are unchanged. Therefore, an increase in the price of electricity will have no impact on the technology used in the electricity generation industry.

- Lastly, exogenously imposed shocks in each scenario will have no effect on commodity tax rates, other than those used to impose the shock.

3.2 The GTAP database

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

3.3 Simulation design

The version described in the previous section is used to model different 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 weighed average of 10 percent (Blignaut, Chitiga-Mabugu and Mabugu 2005). The second and third scenarios model the effects of a 10 percent electricity generation tax in SACU and SADC respectively. The fourth scenario models a 10 percent electricity generation tax in South Africa and the European Union. The reason for the last three simulations is to investigate to the possibility that the negative competitiveness impact of environmental taxes could be negated through multilateral implementation instead of unilateral implementation.

Since an output tax drives a wedge between the price received by producers and the price paid in the market, we imposed the shocks via changes to output taxes in the production of electricity.

4. RESULTS

This paper considers the impact of unilateral and multilateral electricity generation taxes of 2c/kWh on competitiveness, under the four scenarios discussed in the previous section. Note that revenue neutrality was also simulated and the results reflected no significant differences from the results reported below.

Under the first scenario, South Africa imposed a unilateral 2c/kWh tax on electricity generation. The results of this simulation have been discussed in Seymore *et al* (2009), and are summarised in Table 7.

Table 7: Results of Scenario 1

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Real GDP	-0.28	0.01	0.01	0.00	0.00
Real private consumption	-0.40	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 wages	-0.63	0.07	0.04	0.00	0.00

Higher production costs will result in terms of trade deterioration of 0.15 percent for South Africa. However, the decrease in domestic demand will outweigh the decrease in domestic production. Therefore, contrary to the expected outcome, despite the higher production costs and weaker terms of trade, the real export volume increases by 0.7 percent and the real import volume decreases by 0.69 percent. The industry breakdown is presented in Appendix A2.

Table 8: Results of Scenario 2

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Real GDP	-0.28	-0.09	0.01	0.00	0.00
Real private consumption	-0.40	-0.09	0.03	0.00	0.00
Real public consumption	-0.18	-0.08	0.01	0.00	0.00
Real investment	-2.30	-0.35	0.09	0.01	0.01
Real import volume	-0.70	0.13	0.06	0.00	0.00
Real export volume	0.70	0.21	-0.01	0.00	-0.01
Terms of Trade	-0.15	0.04	0.03	0.00	0.00
Unskilled employment	-0.77	-0.25	0.02	0.00	0.00
Skilled employment wages	-0.63	-0.22	0.05	0.00	0.00

The second scenario modelled the effects of a 10 percent electricity generation tax in South Africa and the rest of SACU. The macroeconomic results for South Africa remained the same, except for a marginal greater decrease in real public consumption, real investment and real import volume. Real investment decreased by 2.3 percent in stead of 2.29 percent. South Africa is seen as the gateway to Africa for many multinational organisations. A decrease in the real GDP of other SACU countries might deter real investment in South Africa. In fact, a multilateral tax as modelled in scenario 2 will result in a 0.09 percent decrease in the real GDP of other SACU nations.

For the rest of SACU, the multilateral tax under scenario 2 will adversely affect all the macroeconomic variables, except international trade. The terms of trade, calculated as the ratio between export prices and import prices, are expected to improve by 0.04 percent, and as a result, exports are expected to increase 0.21 percent and imports to increase 0.13 percent. The terms of trade for the rest of SACU can be expected to improve. The reason for this is the prominent role that South Africa plays in trade with these countries (see section 2). Since the adverse effects of electricity generation taxes is greater in South Africa than in the rest of SACU (Table 8), the relative trade position of the rest of SACU is expected to improve.

As expected, the impact on the European Union and the rest of the world is insignificant. But, the effect on the rest of SADC is mostly positive. The only macroeconomic variable decrease experienced by the rest of SADC is a 0.01 percent decrease in real export volume. This is due to the greater relative improvement of the rest of SACU's terms of trade (0.04 percent) compared to 0.03 percent in the rest of SADC.

The results of scenario 3 are presented in Table 9. A multilateral tax in all SACU and SADC countries will affect South Africa more negatively than a unilateral tax in South Africa only. The South African deterioration in terms of trade (-0.16 percent) and the weaker demand in the rest of SACU (-0.11 percent decrease in real private consumption and -0.1 percent decrease in public consumption) and the rest of SADC (-0.74 percent decrease in real private consumption and -0.16 percent decrease in public consumption) will result in a decrease of 0.74 percent in the real import volume. Exports will increase by 0.69 percent compared to 0.7 percent under scenario 1. Also, real investment decreases by 2.33 percent and unskilled employment by 0.78 percent.

Table 9: Results of Scenario 3

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Real GDP	-0.28	-0.10	-0.54	0.00	0.00
Real private consumption	-0.41	-0.11	-0.74	0.00	0.00
Real public consumption	-0.18	-0.10	-0.16	0.00	0.00
Real investment	-2.33	-0.37	-3.13	0.01	0.01
Real import volume	-0.74	0.08	-1.22	0.00	0.00
Real export volume	0.69	0.18	0.13	-0.01	-0.01
Terms of Trade	-0.16	0.02	-0.11	0.00	0.00
Unskilled employment	-0.78	-0.28	-1.03	0.00	0.00
Skilled employment wages	-0.63	-0.24	-0.11	0.00	0.00

Furthermore, all other SACU and SADC countries will be adversely affected with the exception of the rest of SACU and the rest of SADC's international trade position. Again, this improvement is due to the relative position of the rest of SACU and the rest of SADC countries to South Africa. Thus, contrary to the idea that multilateral taxation will negate the effect of an electricity generation tax in South Africa, multilateral taxation will reinforce the negative effects of a unilateral electricity generation tax on the South African economy.

Table 10: Results of Scenario 4

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Real GDP	-0.26	0.02	0.02	-0.37	0.02
Real private consumption	-0.38	0.03	0.06	-0.50	0.04
Real public consumption	0.16	0.00	0.01	-0.24	0.03
Real investment	-1.67	0.37	0.62	-1.09	0.40
Real import volume	-0.61	0.12	0.18	-0.55	0.17
Real export volume	0.42	-0.05	-0.15	0.05	-0.25
Terms of Trade	-0.13	-0.01	0.07	-0.06	0.04

Unskilled employment	-0.74	0.08	0.02	-0.91	0.06
Skilled employment wages	-0.61	0.03	0.13	-0.72	0.04

Scenario 4 modelled a multilateral electricity generation tax of 10 percent in South Africa and the European Union. From the results in Table 10, it can be seen that a simultaneous tax in both regions will have a smaller negative effect on the South African economy, compared to a unilateral tax in South Africa only (Table 7). This is in line with expectations as the European Union is the largest trading partner of South Africa, an the loss of competitiveness to the European Union, will under this scenario, be negated. However, the cost to the European Union will be significant.

CO_2 abatement benefit: South Africa

The CO_2 abatement has been calculated, using the greenhouse gas emissions inventory as developed by Blignaut, Chitiga-Mabugu and Mabugu (2005). Economic benefit accruing to CO_2 abatement was calculated at R100 per ton, based on a low estimate of approximately Euro 8 for a Certifiable Emission Reduction certificate. As reflected in Table 11, the imposition of a unilateral electricity generation tax will lead to a reduction in CO_2 emissions worth R970 million. If the electricity generation tax is imposed multilaterally across all SACU or all SADC countries, the benefit of a reduction in emissions will be reduced to R962 million and R933 million respectively. Furthermore, if the electricity tax is levied in South Africa and the European Union, emission reduction will be worth R626 million.

Table 11: CO_2 abatement benefit: South Africa

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	CO_2	Benefit (R million's)	CO_2	Benefit (R million's)	CO_2	Benefit (R million's)	CO_2	Benefit (R million's)
Electricity	-9.49	948.68	-9.40	939.84	-9.11	911.09	-5.97	597.07
Grains and crops	0.02	-2.44	0.02	-2.44	0.02	-2.12	0.02	-1.57
Livestock and meat products	0.00	0.14	0.00	0.16	0.00	0.17	0.00	0.21
Mining and extraction	-0.03	2.75	-0.03	2.75	-0.03	2.67	-0.04	3.54
Processed food	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles and clothing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Light Manufacturing	0.02	-1.94	0.02	-1.78	0.01	-1.46	0.01	-0.81
Heavy Manufacturing	-0.18	18.41	-0.18	18.41	-0.17	17.39	-0.20	20.45
Utilities and construction	-0.05	4.82	-0.05	4.85	-0.05	4.90	-0.04	3.57
Transport and communication	0.00	-0.45	0.00	0.00	0.00	0.00	-0.03	3.15
Other services	0.00	0.50	-0.01	0.52	-0.01	0.52	-0.01	0.55
Total	-9.70	970.48	-9.62	962.31	-9.33	933.17	-6.26	626.16

A multilateral electricity generation tax across SACU or SADC countries will not only have a marginal negative effect on the South African economy, but also result in emission reductions lower than in the case of a unilateral electricity generation tax. As expected, a multilateral electricity generation tax in South Africa and the European Union will not only have a smaller negative effect on the competitiveness of South Africa, but also lead to lower emission reductions than under a unilateral electricity generation tax. Since the multilateral electricity generation tax limits the negative competitiveness effect on the South African economy, production decreases are smaller than under a unilateral tax, leading to lower emission reductions.

A sensitivity analysis has been conducted on the price elasticity of demand for electricity in the South African economy, the rest of SACU, the rest of SADC, the European Union and the Rest of the World. The elasticities have been found to be robust at a 10 percent variation using the Stroud quadrature method.

5. CONCLUSION

The South African Government announced, in the 2008 Budget Review, the intention to tax the generation of electricity from non-renewable sources with 2c/kWh. This tax is to be collected by the producers/generators of electricity at the source. The intention of the tax is to serve a dual purpose of managing the potential electricity shortages in South Africa and to protect the environment (Republic of South Africa 2008).

The primary objective of this paper was to evaluate the impact of such an electricity generation tax on the international competitiveness of South Africa. Also, different scenarios were assessed to establish whether the loss of competitiveness could be negated through an international, multilateral electricity generation tax.

Literature confirms that an environmental tax will have an impact on the competitiveness of a country. Four scenarios were modelled. Under the first scenario, South Africa imposed unilaterally a 2c/kWh tax on electricity generation, the next two scenarios considered a multilateral tax in all the SACU countries, followed by a multilateral tax in all the SADC countries. The last scenario looked at a 10 percent electricity tax in both South Africa and the European Union.

It was shown that an electricity generation tax will indeed affect the competitiveness of South Africa in a negative way. Furthermore, SACU and SADC wide implementation will marginally reinforce these negative effects. However, a multilateral electricity generation tax across SACU or SADC countries will result in emission reductions, but lower than in the case of a unilateral electricity generation tax.

In contrast, the cost to the South African economy could be limited, if the European Union would follow suit and implement an electricity generation tax. As expected, a multilateral electricity generation tax in South Africa and the European Union will have a smaller negative effect on the competitiveness of South Africa. But, on the other hand, also lead to lower emission reductions than under a unilateral electricity generation tax. Therefore, one could argue in favour of global rules for environmental taxes, this will ensure minimum negative competitiveness effects on participating countries.

It is important to note that the GTAP analysis presented in this paper has some limitations. The entire final demand system is treated as the demand system of a representative household. Since there is effectively only one household in the model, it is not possible to analyse the welfare effects of the tax on different households. Also, GTAP as a multi-country model focuses on the interaction between countries resulting from the flow of goods and services. As a result, the savings and investment linkages are relatively weak and do not pick up any potential shifts in financial or physical assets, flowing from the imposition of an electricity generation tax across borders.

The emergence of new industries cannot be predicted in GTAP. These new industries, such as coal generation with carbon capture and storage, must be exogenously introduced, with the size as well as timing being specified by the modeller. In this study it was assumed that no new industries will emerge as a result of the electricity generation tax. Thus the impact analysis is a relatively short to medium term analysis.

The GTAP version used in this paper is comparative static. Thus, an analysis of the inter-temporal linkages between savings and consumption, and investment and capital is not possible. Also, there is no endogenous mechanism to project the time-pattern of investment changes. However, GTAP is able to project the likely changes resulting from an electricity generation tax on capital formation by region and industry. A comparative-static model also prevents a analysis of the short term and long term adjustment costs associated with an electricity tax.

The possible effects of climate change have not been included in the simulations discussed in this paper. There are no assumptions made about the possible costs under 'business as usual', as a result of climate change.

APPENDIX

Table A1: Sectoral aggregation of GTAP

Identifier	Sectors in Region
Electricity	Electricity
Grains and crops	Paddy rice Wheat Cereal grains nec Vegetables, fruit, nuts Oil seeds Sugar cane, sugar beet Processed rice
Livestock and meat products	Cattle, sheep, goats, horses Animal products nec Raw milk Wool, silk-worm cocoons Meat: cattle, sheep, goats, horse Meat products nec
Mining and extraction	Forestry and fishing Coal Oil and gas Mineral nc
Processed food	Vegetable oils and fats Dairy products Sugar Food products nec Beverages and tobacco products
Textiles and clothing	Textiles Wearing apparel
Light Manufacturing	Leather products Wood products Paper products, publishing Metal products Motor vehicles and parts Transport equipment nec Manufactures nec
Heavy Manufacturing	Petroleum, coal products Chemical, rubber, plasticprods Mineral products nec Ferrous metals Metals nec Electronic equipment Machinery and equipment nec
Utilities and construction	Gas manufacture, distribution Water Construction
Transport and communication	Trade Transport nec Sea transport Air transport Communication
Other services	Financial services nec Insurance Business services nec Recreation and other services Public Admin, defence, health, education Dwellings

Table A2: Scenario 1 industry results

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
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

Table A3: Scenario 2 industry results

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Electricity	-4.25	-7.70	0.66	0.04	0.01
Grains and crops	0.31	-0.02	-0.02	-0.01	0.00
Livestock and meat products	-0.09	0.00	0.00	0.00	0.00
Mining and extraction	-0.35	0.16	-0.01	0.00	0.00
Processed food	0.01	-0.01	-0.03	0.00	0.00
Textiles and clothing	0.34	0.21	-0.05	0.00	-0.01
Light Manufacturing	0.11	-0.29	-0.16	0.00	0.00
Heavy Manufacturing	-0.18	0.08	-0.12	0.00	0.00
Utilities and construction	-1.85	-0.31	0.07	0.01	0.01
Transport and communication	0.00	-0.05	0.00	0.00	0.00
Other services	-0.2	-0.05	0.00	0.00	0.00

Table A4: Scenario 3 industry results

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Electricity	-4.12	-6.02	-9.77	0.06	0.02
Grains and crops	0.27	-0.07	0.41	-0.01	-0.01
Livestock and meat products	-0.10	-0.02	-0.30	0.00	0.00
Mining and extraction	-0.34	0.16	0.37	0.00	0.00
Processed food	-0.02	-0.06	0.35	-0.01	0.00
Textiles and clothing	0.34	0.19	3.49	-0.01	-0.01
Light Manufacturing	0.09	-0.33	-0.12	0.00	0.00
Heavy Manufacturing	-0.17	0.03	-4.26	0.00	0.00
Utilities and construction	-1.87	-0.32	-2.32	0.01	0.01
Transport and communication	0.00	-0.08	-0.06	0.00	0.00
Other services	-0.20	-0.07	0.10	0.00	0.00

Table A5: Scenario 4 industry results

	SouthAfrica	SACUexclSA	SADCexclSACU	EU_25	restofworld
Electricity	-2.70	3.78	4.00	-3.41	0.46
Grains and crops	0.20	-0.08	-0.11	-0.08	-0.02
Livestock and meat products	-0.12	-0.10	-0.03	-0.21	-0.01
Mining and extraction	-0.45	-0.11	-0.10	0.01	-0.06
Processed food	-0.04	-0.16	-0.20	-0.23	-0.03
Textiles and clothing	0.25	0.35	-0.66	-0.01	-0.19
Light Manufacturing	0.05	-0.13	-0.34	-0.26	-0.03
Heavy Manufacturing	-0.20	0.33	-0.46	-0.34	0.03
Utilities and construction	-1.36	0.29	0.44	-0.84	0.31
Transport and communication	-0.07	0.03	-0.13	-0.22	0.00
Other services	-0.21	-0.05	-0.12	-0.21	-0.01

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