

The dividends from a revenue neutral tax on coal in South Africa

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Abstract

South Africa is a significant contributor towards CO₂ pollution on the African continent and authorities have started to examine different approaches available to manage the country's extensive resource base. In this regard, a concern towards sustainable development in South Africa is the current levels of carbon dioxide (CO₂) pollution in the country. Because the country is endowed with a significant portion of the world's coal reserves, this natural resource is used relatively cheaply to supply in more than 75 percent of the country's energy needs.

Even higher on the list of social preferences in South Africa, is the problem of unemployment. Because the country has a high unemployment rate (28%), which has been the subject of numerous research and policy debates in the country, the notion of a possible "double dividend" that currently features strongly within the European research agenda could also be applicable to the South African market and the possibility of the achievement of such a benefit should be investigated. The attainment of a double dividend would allow the South African government to reduce CO₂ emissions while the environmental tax revenue could be used to reduce the cost of labour, and thus decrease unemployment.

Although the notion of a double dividend seems attractive, economic literature indicates that the double dividend will only occur in certain circumstances, of which the existence of current market distortions, caused by existing taxation measures, seems to be a necessary condition. Further, in the case where a lower level of unemployment needs to be achieved, it is also necessary for the labour market to react positively to lower real labour costs.

Because the current tax system in South Africa is structured such that most of the tax burden falls on labour the aim of this research is to determine whether a fiscal reform that introduces a revenue neutral tax on the use of coal, will result in an increase in the overall welfare of South African citizens. We test this with an applied general equilibrium model of the South African version of the ORANI-G model. The model distinguishes between 45 sectors of production in South Africa, which includes the coal sector. 14 different households are distinguished along income groups, while capital, labour and land are included as primary factors of production. Distinction is also made between 4 different types of labour.

Because of the high level of unemployment in South Africa, we assume a short-run closure in the model that allows the level of employment to adjust in response to a policy shock, while capital and land remains fixed. Because the industries that make intensive use of coal are capital and land intensive the tax burden on capital and land is significant.

Background

The South African government has achieved remarkable results in the fiscal management of the country over the past decade. This achievement was the dual result of a broadening of the South African tax base and prudent fiscal management. Although much success has already been achieved, a number of concerns remain, of which environmental reform and the high level of unemployment constitute a major aspect.

In the first instance, South African policy makers will have to consider the objective of increasing future economic growth within a framework that ensures that the current economic achievements are sustainable. Sound management of natural resources is therefore becoming an integral part of the South African policy maker's responsibility. A significant concern towards sustainable development is the current levels of carbon dioxide (CO₂) pollution in the country. South Africa is endowed with a significant portion of the world's coal reserves and, as a result, this natural resource is used relatively cheaply to supply in more than 75 percent of the country's energy needs. The largest consumer of coal in South Africa is the electricity supply industry, which uses coal as a primary input to provide for the country's electricity needs. This, however, results in pollution, and with electricity generation from coal being the single largest source of CO₂ emissions it contributes towards 53 percent of aggregate national CO₂ emissions. Apart from this, the use of petroleum products that are derived from coal contributes another 14 percent to the national CO₂ levels. It is therefore not surprising that South Africa is the biggest contributor towards CO₂ pollution on the African continent.

South African policy makers have a number of policy instruments to their disposal to address this environmental concern, of which a system of national carbon taxes seems to be a definite consideration. There is, however, the danger that the environmental benefit that is provided by this type of taxation could be costly in terms of lower economic growth. This cost will be amplified if the regulations that are imposed on firms reduce the overall level of employment and investment in the economy.

The above criticism towards environmental taxation has resulted in a shift in the debate that surrounds environmental taxation. Rather than being judged as an instrument to control pollution, this type of taxation is presently seen (Goulder, 1994) as a revenue raising tool where the environmental benefits are uncertain, but whose potential for improving social welfare is large. Policy makers should therefore use the revenue obtained from environmental taxes to reform the current tax system in order to obtain certain economic objectives. This possibility seems quite attractive in the South African context, as the problem of unemployment and the skew welfare distribution is an even greater concern than that of environmental management.

Because South Africa has a high unemployment rate (which has been the subject of numerous research and policy debates in the country), the notion of a possible “double dividend” that currently features strongly within the European research agenda could also be applicable to the South African market (e.g. Capros et al, 1995). The possibility of the achievement of such a benefit in the South African context should be investigated.

Therefore, the dual objective of reducing long-term structural unemployment and reduce pollution (e.g. greenhouse gas emission) presents an intriguing opportunity. That is: the double dividend notion presents the possible opportunity for the South African fiscal system to be reformed by switching the burden of taxation from labour as a factor of production to factors of production that contributes towards higher levels of pollution. However, this issue is not uncontroversial and has gained a significant amount of interest from economists, environmentalists and policy makers.

The purpose of the research presented in this paper is to make use of a general equilibrium model of the South African economy to investigate whether the current structure of the economy would allow the attainment of a double dividend. The general equilibrium model that is used is a South African version of the generic ORANI model. It makes use of a 2001 Social Accounting Matrix (SAM) of the South African economy as its primary source of data. Because the relative abundance of coal in the South African economy has resulted in relatively low energy costs, we test whether a revenue neutral fiscal reform, that introduces a tax on the use of coal as an intermediate input, could result in an increase in the overall welfare of South African citizens. The revenue that is raised is returned to the economy by a decrease in the intermediate taxation of those products that are widely used by the poorest households in the South African economy and also relatively labour intensive in the production process. We've identified these products as food-, agricultural- and beverage products. By comparing this policy shock with one in which the tax is not returned to the economy, we conclude that a revenue neutral tax on coal could increase economic growth and employment in South Africa marginally and achieve a positive redistribution affect for the South African society.

Section 2 describes the broad characteristics of the model that are used within this analysis, while section 3 briefly describes the South African labour market. We deem the description of the South African labour market as necessary because this market has unique characteristics that affect both the model closure, and our choice of products that should experience a direct positive benefit from the tax reform (i.e. a tax reduction). In section 4 we describe the model closure, and the results of the simulations are summarized in section 5.

2. Model characteristics

2.1. Framework

We make use of a South African general equilibrium model that reflects the ORANI general equilibrium modelling methodology. It is therefore a comparative-static model and simulation results are reported as deviations from a base case. The results do not represent changes over a period of time, but rather differences with respect to the base case at a given point in time. As described in section 4, we choose a closure that represents a short-run economic environment, but we assume that the supply of highly- and semi-skilled labour is fixed within the South African economy. This assumption reflects the reality of the relative shortage of highly- and skilled labour, and the abundance of unskilled and informal sector labour in South Africa.

2.2. Database

The main source of data that forms the basis of the model is a 2001 SAM. The SAM distinguishes between 45 different products and 45 different industries. Each of these industries is allowed to produce only one output. With regards to the production of coal, the database includes the South African coal mining industry that supplies coal to the South African economy and the rest of the world. Although coal is used in the production processes of most industries in the South African economy, there are 4 industries that make relative intensive use of coal. These are:

1. the coke and refined petroleum industry,
2. the basic iron and steel industry,
3. the basic non-ferrous metals industry, and
4. the electricity industry.

Within the database, distinction is made between 4 groups of labour:

1. highly skilled,
2. skilled,
3. semi-and unskilled,
4. informal labour.

Apart from this, South Africa's households are divided into 14 different groups according to their income. The original SAM also distinguishes between 7 different types of government expenditures, 13 different export destinations and 12 different types of fixed investment in the South African economy. For purposes of this study the different export destinations, government expenditures and types of fixed investment are aggregated to allow for aggregated government expenditure, aggregated exports and aggregated investment for the

South African economy. The different industries, products and labour groups are summarized in Appendix 1.

2.3 Model elasticities

The elasticities that we use in the model are obtained from a combination of econometric estimations and a review of the relevant literature. The lack of both historical data and relevant research material on some of the markets of the South African economy, rendered the attainment of the true elasticities a difficult task. The methodology that we used to obtain the relevant elasticities is briefly described.

2.3.1 The CES substitution elasticity between different skill types

There is very little (if any) data available for the estimation of the CES substitution elasticities between highly skilled, semi-skilled, unskilled and informal sector workers. It is therefore not surprising that the current literature does not provide any insight into the exact values that these elasticities will obtain. The uncertainty that surrounds the substitution elasticity between different skill types in South Africa is, however, not unique and Dixon et al (1980) also state that there is considerable uncertainty that exist within the literature about the extent to which changes in occupational wage relativities influence occupational labour demands in Australia. Despite the uncertainty and difficulty that surrounds these elasticities, analysis of the South African labour market indicates that one should not expect a high degree of substitutability between the different types of labour in South Africa, as structural and institutional factors allow very little substitution within the labour market. One could therefore assume a low elasticity of substitution for the South African labour market. Given the Ryland and Parham (1978) result for the Australian economy, an elasticity of 0.2 is assumed for the South African model.

2.3.2 The CES substitution elasticity between primary factors

A review of current literature of the elasticity of substitution between primary factors in the South African economy has not shed any light on the expected elasticities for the industries included within this study. An attempt is therefore made on estimating these substitution elasticities by following a widely used approach pioneered by Ferguson (1965), in which the elasticity of substitution is estimated by making use of conditions of profit maximization. The elasticities that are obtained for each industry are summarized in Appendix 2.

2.3.3 The Armington elasticities

Although Armington elasticities can be estimated separately for each level of demand (i.e. household, investment and import demand), available data can seldom sustain such an attempt. Because of the data inadequacies, we followed Dixon et al (1980) and imposed the restriction that the elasticity of substitution between a specific domestic and imported good is the same for use as an input in the production process, investment or household consumption. Dixon et al (1980), defends this assumption by pointing out that most of Australia's major imports are used predominantly in the one end-use category only, and it seems as if this assumption will suffice for South Africa as well. We therefore estimate the Armington elasticities for the South African industries by making use of a methodology set out by Reinert and Roland-Holst (1992) and Kapuscinsky et al (1996). The elasticities are summarised in Appendix 2.

2.3.4 Household expenditure elasticities

Once again, the literature about South African household expenditure does not provide information about household expenditure elasticities at a level that will provide insight into the expenditure pattern of each of the 14 households. This is not surprising as very little historical data are available for the expenditure of each household group distinguished within the database. The lack of data also hampers econometric estimation of the expenditure elasticities of the 14 households.

Expenditure elasticities are estimated for an "aggregated household" that encompasses the expenditure of the 14 households that are distinguished within this study. It is then assumed that these expenditure elasticities are representative for each of the individual households. Despite the lack of data for disaggregated households, there is sufficient data available to estimate the aggregated household's expenditure elasticity for each of the 45 products in the model. The demand function that is estimated is the commonly used log-linear demand equation that represents household consumption as a function of disposable income and relative prices. The expenditure elasticities are summarised in Appendix 2.

2.3.5 The Frisch household consumption parameter

The Frisch parameter is usually fixed at a value of -1.82 in the ORANI models. This value represents a weighted average of values for different types of Australian households. This value is, however, also based on pooled international evidence, and the assumption is therefore made that this value also holds for the South African version of the ORANI-G model.

2.3.6 The foreign elasticity of demand for South African products

In order to derive, and motivate the use of the price elasticities of exports, the methodology behind the ORANI model of the Australian economy has been used. Demand elasticities in the ORANI model are assumed to be -4 for those goods for which Australia does not have sufficient market share to influence the market price. The Centre for Policy Studies at Monash University has indicated that model results do not change significantly if the elasticities increase beyond -4 for those commodities that are very price elastic.

In this regard, South Africa is generally accepted to be a small open economy with little pricing power in international markets. Therefore, the price elasticity of -4 has been adopted for all of the industries that are included in the South African version of the ORANI model.

3. The South African labour market

The unemployment rate in South Africa is exceptionally high and arguably the most pressing concern that faces policy makers. Even according to the conventional (narrow) definition, which applies a job search test, one in every four adults in South Africa who wanted work and actively looked for it, was unemployed. Apart from this, there is also extreme wage inequalities and disparity in the incidence of unemployment between different race groups. While Africans faced unemployment rates of 41 percent in 1994, the rate for whites was only 6 percent in the same year. The level of unemployment among Africans is one of the highest in the world, and could be the highest if compared with rates of countries of similar, or larger, population size. The difference between unemployment within different skill groups are further confirmed if one takes into account that South Africans with higher education (highly skilled and skilled labour) face an unemployment rate of only 6 percent, while labour market participants with only a primary education or less, suffer an unemployment rate close to 40 percent. This phenomenon could partially explain the labour allocation by race because there is a high gap between education and skill attainment between racial groups. The White population group has a higher level of education and skills than the other population groups, while the African population group lag well behind Asians and Coloureds in terms of education and skill attainment.

One could conclude from the research that has been conducted about the South African labour market that this market operates at a level of full employment for the highly skilled and skilled labour force, while the unskilled and informal sector labour force suffers a high level of unemployment. Although a considerable amount of research has been performed about the reasons for unemployment, little attention has been directed towards determining whether this unemployment is voluntary or involuntary. The answer to this problem is important for two reasons.

1. Research on the attainment of the double dividend has indicated that the labour supply function holds important consequences for the success of a double dividend policy. E.g. if labour supply is very inelastic, wages could increase as a result of the policy, while employment levels remain constant. This could ultimately result in an increase in the inflation rate and reduce the positive impact of the policy.
2. It gives an indication of how the labour supply curves of the unskilled and informal sector labour should be treated within the model closure. If unemployment is voluntary, it is a supply side problem and the labour supply curve should be treated accordingly. However, if the level of unemployment is involuntary it is a demand side problem.

In one of the few research papers on this problem, Geeta Kingdon and John Knight (2001) performed research in which they attempted to determine whether unemployment in South Africa is voluntary or involuntary. They came to the conclusion that it is very likely that most of the unemployed workers are involuntarily unemployed and would accept formal sector jobs at the going wages. They also stated that it would be remarkable if the unemployed in South Africa choose to remain deprived, and it appeared as if limited opportunities for entering into the informal sector provided no real alternative to unemployment. These findings are confirmed by studies that analyse the reasons for unemployment and one can conclude that the unemployed in South Africa are not voluntarily unemployed and that they do not obtain a higher level of utility because less labour is supplied. In fact, most studies indicate that the unemployed will be willing to work at real wages that are lower than the current wages within the labour market. Once again, this is especially true for the unskilled labour force and it seems as if the elasticity of labour supply for the unskilled labour is highly elastic.

4. Model closure

4.1 The economic environment

Given the above background, a suitable closure was established to test the effects of a revenue neutral coal tax on the South African economy. In establishing this closure, the features of South African factor markets were considered, as well as the economic variables that need to be evaluated in the experiment. This includes variables such as coal consumption, labour absorption and the welfare of the South African society.

The closure that is adopted to test the effects of a revenue neutral tax on coal in South Africa can be classified as a short-run closure within the ORANI methodology, even though it is assumed that the supply of highly-skilled and skilled labour is also fixed. This assumption is made to reflect the realities of the South African labour market. As described above, it seems that the supply of unskilled and informal sector labour seems to be highly elastic and that a

significant amount of unemployment exists within the unskilled and informal labour markets. A realistic closure for these two components of the South African labour market would therefore be to exogenise the real wages for these two groups and assume that the unskilled and informal sector employment will change in the face of a policy shock, while real wages remain constant.

The supply of highly skilled and semi-skilled labour seems to be different from unskilled and informal sector labour. There seems to be very little (about 6 percent) unemployment in these two groups of South Africa's labour force and wages tend to adjust as the demand for this type of labour increases or decreases. It is therefore plausible to assume that the labour supply of highly skilled and semi-skilled labour is highly wage elastic and that wages will adjust in the face of policy shocks, without much scope for a change in the level of employment in these two groups.

Because of the significant unemployment rate among unskilled and informal sector workers, it is assumed that capital and land remains fixed within the model (short-run assumption) and that the price of capital and land will adjust in the face of any policy shocks. This assumption allows firms to change the amount of unskilled and informal sector workers that they employ in order to adjust output. Although a lower wage for unskilled labour should result in a lower cost of labour, it should also result in a lower wage for households that supply the unskilled labour.

Because the model does not obtain much information on the theory behind the macroeconomic aggregates, it is assumed that government spending, investment spending and the trade balance are exogenous. This assumption allows the consumer expenditure to be endogenised, which will allow for the analysis of the welfare effects of the policy shock on the South African society.

Apart from the above, all technical change and shift variables are exogenised. This assumption allows for the evaluation of the economic effects of the introduction of the revenue neutral tax on the intermediate use of coal in the absence of any technological improvements in the economy. Finally, all tax rate variables are exogenised and the tax rate on the intermediate use of coal, food, agricultural products and beverages can be shocked to determine the effect of such a shock on the South African economy.

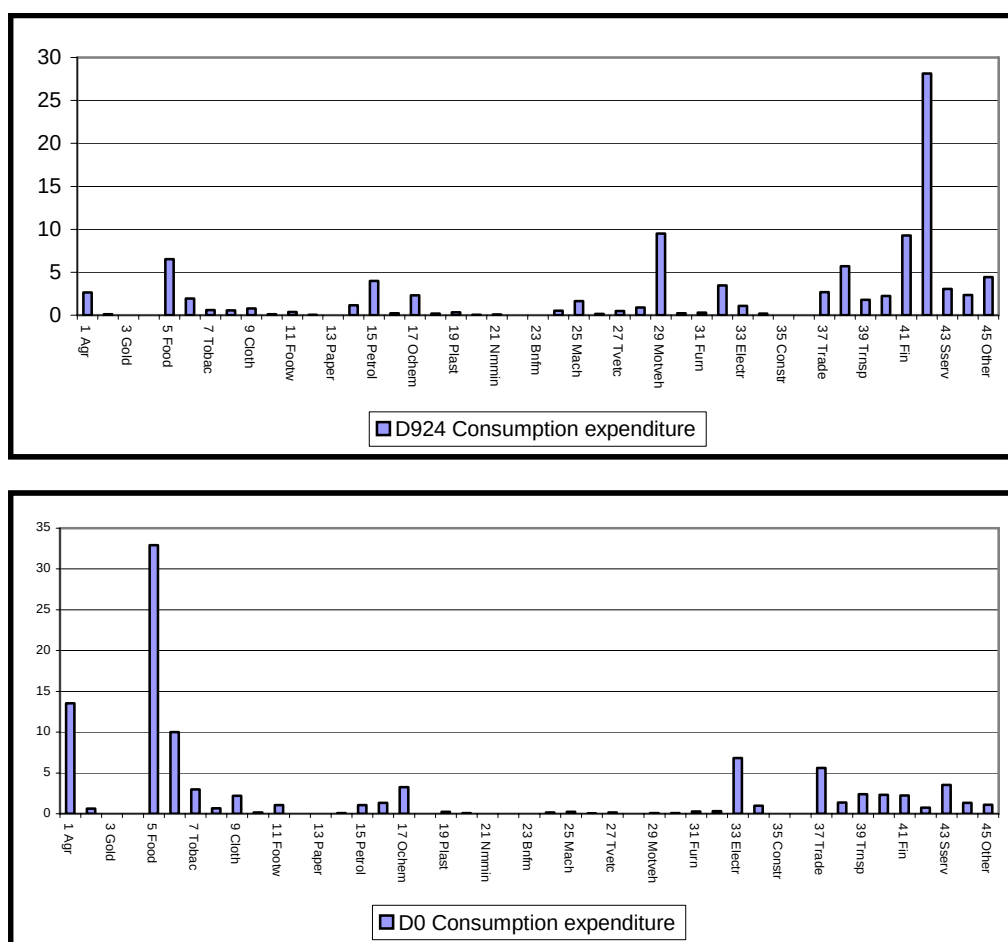
4.2. The policy shocks

The first policy shock that is simulated with the South African AGE model is a 50 percent increase in the tax rate on the intermediate use of coal across all industries in the South African economy. The tax increase of 50 percent is chosen in order to get a clear indication

of the economy-wide effects of such a tax. Of particular interest will be the effect of such a tax on the demand for coal, consumer welfare, employment and GDP growth. It must also be determined whether such a tax will result in a positive tax receipt for the government, and if it does, the magnitude of this tax receipt.

The second policy proposal is a revenue neutral shock in which a 50 percent tax on coal is introduced along with a revenue neutral cut in intermediate taxation of food, agricultural products and beverages. The assumption that is made in this scenario is that the revenue raised by the tax on coal is redistributed towards the economy by reducing the cost of those products that constitute the bulk of the consumption expenditure of the poorest households of the South African economy. Figure 1 reflects a comparison of the expenditure patterns of the poorest household groups (D0), with that of the richest (D924) in South Africa.

Figure 1: A comparison between the consumption expenditure patterns of the poorest and the richest households in South Africa

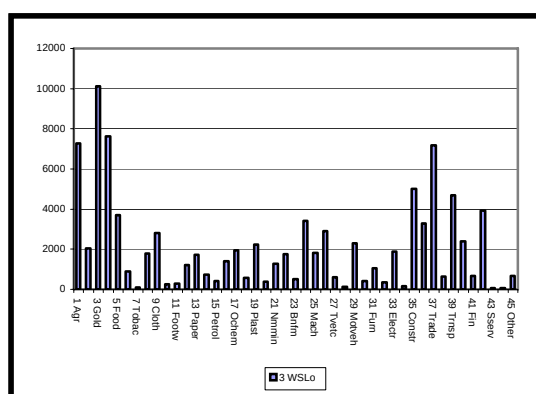


Source: SAM, 2001

Consumption expenditure on food, beverages and agricultural products constitute more than 50 percent of the total consumption expenditure of the poorest households (56.46 percent), while it only constitutes about 11.11 percent of the total expenditure of the richest households.

Apart from the potential impact that cheaper food, beverages and agricultural products will have on the poorest households, these industries are relatively labour intensive and contributes towards 12.5 percent of the unskilled employment in South Africa, and 6.5 percent of total employment in the country. Figure 2 shows that only the gold mining sector employs more unskilled labour than the agricultural sector.

Figure 2: Employment of unskilled labour in South African industries



Source: SAM, 2001

Given that the agricultural, food and beverage industries are relatively labour (unskilled) intensive, a tax that reduces the cost of these products should indirectly result in a decrease in the tax burden that this factor carries in the economy.

The results of this policy shock will indicate whether this treatment of a revenue neutral tax could result in a double dividend for the South African economy. This will be the case if the net result of the policy shock is a decrease in pollution that results from the use of coal, while welfare increases as a result of the lower cost of food-, agricultural- and beverage products. Other economic variables that are of interest are the change in the level of unskilled and informal sector employment and the change in economic growth in South Africa.

5. Results

5.1 A 50 percent tax on coal

Simulation results for selected macroeconomic variables are reported in Table 1.

Table 1: The estimated macroeconomic effects of imposing a 50 percent tax on the intermediate use of coal (percentage changes)

Real GDP	-0.061
Employment	-0.131
Consumer prices	-0.24
Exports	-0.11
Imports	0.07
Export price	0.07

The tax on the intermediate use of coal raises the cost of intermediate inputs for those industries that are heavily dependent on the use of coal as intermediate input. This results in a decrease in the demand for these products and also a decrease in the primary factor composite that is employed by these industries. Analysis of the industry specific results indicates that it is especially the basic iron and steel industry (4.8 percent), the coke and refined petroleum industry (1.4 percent) and the electricity industry (1.1 percent) that experience a significant drop in value added. The use of the primary factor composite (capital, labour and land) falls along with the decrease in value added. As capital, land, highly skilled and semi-skilled labour are assumed to be fixed in the policy simulation, this fall in the primary factor composite within these industries translates into a fall in the level of employment of unskilled and informal sector labour, while the price of highly skilled and skilled employment falls along with the price of capital and land. The changes in the factors of production, for those industries that experience the biggest decline in value added, are reported in Table 2.

Table 2: The estimated effect of a 50 percent tax on the intermediate use of coal on selected industries (percentage changes)

	Nr. of unskilled workers	Nr. Of informal sector workers	Real wage: Highly skilled	Real wage: Skilled	Price of capital	Price of land
Basic iron and steel	-10.176	-10.176	-1.48	-1.22	-1.16	-0.59
Coke and refined petroleum	-5.28	-5.28	-1.48	-1.22	-1.16	-0.59
Electricity	-3.34	-3.24	-1.48	-1.22	-1.16	-0.59

Although there are some industries that experience a slight increase in their value added as a result of the tax on coal, the economy-wide effect of the tax is a fall in the level of employment

of unskilled (0.38 percent) and informal sector (0.32 percent) labour, while the price of highly skilled (1.48 percent) and skilled employment (1.22 percent) falls along with the price of capital (1.16 percent) and land (0.59 percent).

As reported in Table 1, the consumer price index decreases (0.24 percent). This is the result of the fall in the price of capital, land, highly- and skilled labour. Although there are industries that experience a significant increase in the price of their product, these products don't carry a high weight within the consumer basket (with the exception of electricity) and the net effect is a decrease in aggregate consumer prices. Aggregate consumption decreases, despite the decrease in consumer prices. This decrease in consumption is the result of the decrease in the level of employment (unskilled and informal labour) and the decrease in wages (highly skilled and skilled labour), which result in a fall in nominal household income (-1.073), a fall in real income and hence a fall in aggregate consumption.

With all the other demand side variables fixed, the contraction in consumption results in a decrease in gross domestic product. The estimated effects of the coal tax on disaggregated household consumption are shown in Table 3. This indicates that the lower income households suffer the biggest decline in their level of consumption.

**Table 3: Estimated change in household consumption
(percentage change)**

D0	-0.18	D7	-0.02
D1	-0.14	D8	-0.03
D2	-0.10	D91	-0.02
D3	-0.07	D921	-0.01
D4	-0.05	D922	-0.01
D5	-0.04	D923	-0.00
D6	-0.02	D924	0.01

In contrast to the consumer price, the aggregate price of exports increases. Because the basic iron and steel and coke and refined petroleum product industries are significant contributors towards South Africa's aggregate exports, the decline in the price of the factors of production is not enough to off-set the effect that the increase in the price of coal has on the South African export price. As a result of the increase in the export price (while we assume that the exchange rate remains constant), South Africa's aggregate exports decrease slightly. Imports also seem more competitive and increase slightly. The net result is a balanced trade balance (by assumption). Table 5 reports the change in exports for those industries that experience a significant fall in their exports as a result of the tax increase.

**Table 5: Estimated change in exports for a selected number of industries
(percentage change)**

Coke and refined petroleum products	-4.52
Non metallic mineral products	-3.83
Basic iron and steel products	-7.49
Electricity	-10.66

The estimated results indicate that a 50 percent tax on coal will have negative consequences for the South African welfare (consumption), exports, employment, and economic growth. Because capital and land is assumed to be fixed, and the industries that are the most reliant on coal are relatively capital intensive, the burden of the tax falls mostly on these fixed factors.

Despite the negative consequences of the tax on the South African economy, the domestic component of the coal industry decreases (0.64 percent). This decrease in the domestic use of coal will translate in a decrease in the CO₂ emissions that result from the use of coal. It should be noted that the decrease in the price of the primary factor composite results in a fall in the export price of coal and subsequently in an increase in coal exports (0.66 percent).

5.2 An increase in the tax on coal, with a decrease in the tax on food, agriculture and beverage products

Table 6 reports the results of selected macroeconomic variables, with the result of the previous simulation in brackets.

Table 6: The estimated macroeconomic effects of imposing a revenue neutral tax on the South African economy (percentage changes)

Real GDP	0.003 (-0.061)
Employment	0.038 (-0.131)
Consumer prices	-0.30 (-0.24)
Exports	-0.10 (-0.11)
Imports	0.06 (0.07)
Export price	0.06 (0.07)

A 50 percent increase in the tax on the intermediate use of coal still raises the cost of intermediate inputs for those industries that are heavily dependent on the use of coal as intermediate input. However, the decrease in the prices of the agricultural products, food and beverages has the opposite effect in that it decreases the cost of those industries that are relatively dependent on these products as intermediate inputs. This results in a decrease in

the demand for those products that are relatively coal intensive in production and an increase in the products that are relatively food/agriculture/beverage intensive in production. The changes in the demand for the products result in similar changes in the demand for primary factor composites that are employed within these industries. Analysis of the industry specific results indicates that the basic iron and steel industry (4.6 percent), the coke and refined petroleum industry (1.4 percent) and the electricity industry (1.1 percent) experience a relatively similar drop in value added as experienced in an environment where taxes were not returned to the economy through a reduction in other taxes. However, the reduction in the cost of food/agriculture/beverage products result in an increase in the value added of some industries; with the food (2.96 percent), leather (5.63 percent), tobacco (1.13 percent) and agricultural (0.95 percent) industries reaping the highest benefits. Table 7 reports the estimated effect of this policy proposal on the price of capital and land, and the level of unskilled employment in the industries that experience the most change as a result of the policy shock.

Table 7: Estimated changes in factors of production of selected industries
(Percentage change)

	Price of capital	Price of land	Employment of unskilled labour
Basic iron and steel industry	-0.17	0.18	-10.97
Coke and refined petroleum industry	-0.17	0.18	-5.24
Electricity industry	-0.17	0.18	-3.07
Food	-0.17	0.18	5.92
Leather	-0.17	0.18	9.88
Tobacco	-0.17	0.18	5.61
Agricultural	-0.17	0.18	2.79

The industries that are relatively coal intensive experience a decrease in the level of unskilled employment while the industries that obtain a positive benefit from the tax proposal experience an increase in the level of employment. On balance, the estimation indicates, that the economy-wide effect of the policy proposal is an increase in the level of unskilled employment (0.13 percent), while the price of capital falls (0.17 percent).

The fall in the consumer price index is higher than in the first policy simulation. Although the fall in the price of capital contributes towards this decrease, the decrease in the price of food and agricultural products is the main reason for this decline. This reflects the relatively high

weight that food has in the consumer basket. The decline in consumer prices outweighs the decrease in nominal wages (0.27 percent - the result of lower wages for highly skilled and skilled labour), and aggregate consumption increases slightly. It is, however, significant that the estimated change in disaggregated household consumption indicates that the poorest households enjoys the highest increase in their consumption level, while the richest households experience a decrease in consumption. Table 8 reports the change in disaggregated household consumption expenditure.

Table 8: Estimated change in household consumption
(Percentage change – previous simulation results in brackets)

D0	0.39 (-0.18)	D7	0.10 (-0.02)
D1	0.39 (-0.14)	D8	0.00 (-0.03)
D2	0.38 (-0.10)	D91	0.06 (-0.02)
D3	0.35 (-0.07)	D921	0.11 (-0.01)
D4	0.30 (-0.05)	D922	0.11 (-0.01)
D5	0.24 (-0.04)	D923	0.09 (-0.00)
D6	0.17 (-0.02)	D924	0.08 (0.01)

Because food/agricultural/beverage products don't have the same significance in the richer household's consumption basket, they don't experience the same fall in consumption prices as the poorer households.

The estimated aggregate price of exports increases as a result of the increase in the price of coal. This increase is only partially offset by the decrease in the price of food/agriculture/beverage products and the primary factor composite. As a result of the export price increase, aggregate exports decrease. The exports of individual products do, however, vary with some experiencing a sharp fall, while others experience a significant increase. Not surprisingly, the industry that experiences the biggest drop in exports is the electricity industry (12.5 percent), while the food industry experiences the biggest increase (12.64 percent).

The environmental effect of this policy simulation remains positive as the domestic demand for coal decreases (0.67 percent). Because the export price of coal does not drop as much as in the previous simulation, the increase in coal exports are not enough to offset the domestic effect. The coal industry therefore experiences a fall in total output (-0.18 percent).

6 Discussion

The results from both policy simulations indicate that an increase in the level of taxation of coal should result in positive environmental benefits for South Africa as the domestic demand

for coal decreases. This decrease in domestic use of coal should result in a decrease in the level of CO₂ emissions in the country. Whether this reduction would be enough to reduce the level of CO₂ emissions to internationally accepted standards remains to be analysed.

Despite the positive environmental benefits, the estimation results indicate that the tax on coal would, however, have negative consequences for the South African economy. Of greatest concern is the negative effect that such a tax would have on the welfare of the poorest households and the level of employment of the unskilled labour force. The negative effects are mostly the result of the reduction in employment and wages as a result of the decrease in primary factor demand. Because the immediate policy concern in South Africa is the high level of unemployment and the unequal distribution of welfare, any policy that could aggravate the situation would not find favour with policy makers.

There are numerous ways in which the revenue raised from the tax on coal could be applied. However - because of the socio-economic imbalances in the country - a policy that benefits the poor should find favour with South African policy makers. In this regard our analysis indicates that a reduction in the taxation of food, agricultural products and beverages should negate the negative effects that arise from the tax on coal. Because expenditure on these three products constitutes more than 50 percent of the poorest households' budgets, the lower prices result in an increase in the welfare of these households.

The analysis also indicates that this treatment of the tax revenue will decrease the tax burden on labour as the industries that attain the highest benefit from the tax policy are relatively labour intensive. It does, however, increase the tax burden on capital, as the industries that are negatively affected by the policy proposal are relatively capital intensive. The result is therefore a slight increase in the level of unskilled employment and a fall in the price of capital.

We are, however, mindful of the fact that the short-run closure that we have adopted assumes that the government would maintain aggregate consumption and investment at predetermined levels. This could be unrealistic. It is, however, hard to determine whether (and how) the government will adjust its investment and consumption spending in the face of the relative price changes that are brought about by a revenue neutral tax policy. One could only assume that the government would focus its policy on increasing the welfare of the poorer households (i.e providing food), which would probably enhance the effect of the tax policy, by increasing the demand for the labour intensive products further.

Another factor that needs to be assessed is the (unobserved) welfare effects that a reduction in the use of electricity would have on households. Our estimated results indicate that there would be a significant decline in the demand for electricity. The welfare effects of the revenue

neutral policy would have been easier to interpret if South African households had a plausible alternative to coal generated electricity. The reduction in the use of electricity represents a decrease in the use of energy in the country, which should have a negative effect on household welfare which we don't observe within the model.

7. Conclusion

Our analysis indicates that an increase in the tax on coal will have positive environmental benefits for South Africa. Such a tax would, however, have negative consequences for the South African economy in the form of a lower level of employment, consumption and economic growth. It is therefore important that the revenue from such a tax be used in such a manner that it reduces the negative effects of the tax. By decreasing the tax on products that are both labour intensive and an important component of (poor) household budgets, we find that it is possible to decrease the negative effect of the tax on coal and also obtain positive labour and welfare benefit.

References

- Black, P., and Rankin, N., 1998, "On the Cost Increasing Effects of the new Labour Laws in South Africa.", *The South African Journal of Economics*. Vol 66:4, p452-463.
- Bovenberg, A.L. and De Mooij, R.A., 1995, "Taxation and the Double-Dividend: The Role of Factor Substitution and Capital Mobility." *In Environmental fiscal reform and unemployment*, Boston: Kluwer, p 3–52.
- Capros, P., Georgakopoulos, P., Zografakis, S., Proost, S., van Regemorter, D., Conrad, K., Schmidt, T., Michiels, E., 1995, "First Results of a General Equilibrium Model (GEM-E3) Linking the EU-12 Countries." *In Environmental fiscal reform and unemployment*, Boston: Kluwer, p 3–52.
- Carraro, C. and Soubeyran, A., 1995, "Taxation and Employment in a Multi-Sector General Equilibrium Model." *In Environmental fiscal reform and unemployment*, Boston: Kluwer, p 3–52.
- Cooper, C.J., 1998, *Digest of South African Energy Statistics*.
- Dias, R., 2002, "Exploring the Nature of Unemployment in South Africa: Insights from the Labour Force Survey 2000." *Unpublished Paper Presented at the Development Policy Research Unit's 2nd Annual Conference on Labour Markets and Poverty in South Africa*.
- Dixon, P.B., Parmeter, B.R., Sutton, J., and Vincent, D.P., 1982, *ORANI: A Multisectoral Model of the Australian Economy*, Nort-Holland, Amsterdam.
- Ferguson, C.E., 1965, "Time Series Production Functions and Technological Progress in American Manufacturing Industry." *Journal of Political Economy*, 73: p135-147.
- Goulder, L. H., 1994. "Environmental Taxation and the "Double Dividend:" A Reader's Guide." Working paper No. 4896. *National Bureau of Economic Research*.
- Horridge, M, 2001, ORANI-G: "A Generic Single-Country Computable General Equilibrium Model." *Edition prepared for the Practical GE Modeling Course*, June 2001.
- International Energy Agency, 2001, *Key World Energy Statistics*.
- Intrilligator, M.D., 1978, *Econometric Models, Techniques and Applications*, Nort-Holland, Amsterdam.

Kingdon, G., and Knight, J., 2001, "Unemployment in South Africa: the nature of the beast". *Centre for the Study of African Economies, Department of Economics, Oxford*.

Kingdon, G., and Knight, J., 2001, "Unemployment and wages in South Africa: A spatial approach". *Centre for the Study of African Economies, Department of Economics, Oxford*.

Kingdon, G., and Knight, J., 2001, "Race and Incidence of Unemployment in South Africa". *Centre for the Study of African Economies, Department of Economics, Oxford*.

National state of the Environment Report – South Africa, 2003, "Climatic and Atmospheric Change", *National state of the Environment Report*.

Parry, I., W., Williams, R., C. and Goulder, L., H., 1999, "When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets." *Journal of Environmental Economics and Management*, 37, 52 – 84.

Repetto, R., 1995, "Shifting Taxes from Value Added to Material Inputs." *In Environmental fiscal reform and unemployment*, Boston: Kluwer, p 53–72.

Appendix 1: Breakdown of database used in the analysis.

1.1 The different types of industries and products of the model

Industry	Abbreviation	Industry	Abbreviation
Agriculture, forestry and fishing	Agric	Metal products, excluding machinery	MetProd
Coal mining	Coal	Machinery and equipment	Macheq
Gold and uranium ore mining	Gold	Electrical machinery	ElecMach
Other mining	Othmin	Television, radio and telecommunications equipment	Telv
Food	Food	Professional and scientific equipment	ProfEq
Beverages	Bev	Motor vehicles, parts and accessories	MotVeh
Tobacco	Tob	Other transport equipment	OthTrnsp
Textiles	Text	Furniture	Furn
Wearing apparel	Wear	Other industries	OthInd
Leather and leather products	Leath	Electricity	Elect
Footwear	Foot	Water supply	WatSup
Wood and wood products	Wood	Building and construction	BuildCnst
Paper and paper products	Paper	Civil engineering and other construction	Civil
Printing, publishing and recording media	Print	Wholesale and retail trade	WhSale
Coke and refined petroleum products	Coke	Catering and accommodation services	CatAcc
Basic chemicals	BasChem	Transport and storage	TranspStor
Other chemicals and man-made fibres	OthChem	Communication	Com
Rubber products	RubProd	Finance and insurance	FinIns
Plastic products	PlastProd	Business services	BusServ
Glass and glass products	Glass	Medical, dental and other health services	MedDent
Non-metallic minerals	NonMetMin	Other community services	OthComServ
Basic iron and steel industries	BasIrSt	Other producers	OthProd
Basic non-ferrous metals	BasNFer		

1.2 Employment of different types of labour in South African industries

Highly skilled

Occupations that are included in the highly skilled category include professional, semi-professional and technical occupations, as well as managerial and executive positions.

Skilled

Skilled occupations include clerical, sales, transport and service occupations. It also encompasses farmers and farm managers, artisans and production foremen and supervisors.

Semi- and unskilled

This group include all occupations that are neither highly skilled nor skilled.

Labour employed in the informal sector

Includes all labour that are supplied outside of the South African system of national accounts

The table below summarise the number of workers of each skill type that is employed within each industry:

Table A1: Number of workers employed within each industry

Industry	H	S	SS	I	Industry	H	S	SS	I
Agric	16,919	35,840	713,496	28,509	MetProd	8,149	28,825	65,816	3,824
Coal	2,908	12,712	30,711	1,724	Macheq	9,522	25,648	32,878	2,532
Gold	5,381	19,218	178,996	7,575	ElecMach	14,179	17,983	47,617	2,968
Othmin	7,078	29,426	121,457	5,877	Telv	2,466	3,128	8,282	516
Food	10,390	59,819	84,323	5,750	ProfEq	1,006	1,276	3,380	211
Bev	3,460	8,836	14,106	982	MotVeh	13,315	24,411	39,812	2,885
Tob	279	713	1,138	79	OthTrnsp	1,872	3,432	5,597	406
Text	2,726	8,248	42,428	1,987	Furn	2,315	11,332	31,255	1,671
Wear	5,621	17,611	109,633	4,943	OthInd	1,553	8,133	9,278	706
Leath	270	1,348	6,278	294	Elect	16,525	23,316	24,436	13,526
Foot	370	815	11,573	475	WatSup	1,933	2,727	2,858	280
Wood	2,407	26,756	44,915	2,756	BuildCnst	6,605	23,238	89,163	64,090
Paper	3,349	12,488	25,998	1,557	Civil	5,539	19,487	74,769	17,873
Print	11,092	34,706	15,012	2,262	WhSale	103,163	569,032	169,889	167,501
Coke	2,984	5,190	5,581	512	CatAcc	14,432	107,755	41,683	6,097
BasChem	3,852	8,785	15,100	1,032	TranspStor	14,996	113,474	51,779	95,785
OthChem	11,499	26,919	28,823	2,502	Com	9,806	46,215	24,646	3,001
RubProd	1,177	2,852	8,692	473	FinIns	52,991	133,239	7,289	30,805
PlastProd	5,280	12,795	38,995	2,123	BusServ	60,731	195,184	55,765	114,986
Glass	500	1,336	5,027	255	MedDent	34,099	36,183	1,569	11,884
NonMetMin	2,503	6,688	25,169	1,278	OthComServ	50,162	66,388	3,065	49,879
BasIrSt	4,839	13,203	21,549	1,473	OthProd	38,534	266,500	19,147	109,130
BasNFer	1,443	3,938	6,427	439					
Total number of employed:									
Highly skilled						1107836			
Skilled						2729498			
Semi-skilled and unskilled						3444628			
Informal						1019922			

Appendix 2:

2.1 Elasticity of substitution between capital and labour in the South African economy.

Industry	Elasticity of substitution	Industry	Elasticity of substitution
Agric	0.74	MetProd	0.91
Coal	0.38	Macheq	0.77
Gold	0.42	ElecMach	0.66
Othmin	0.29	Telv	0.83
Food	0.34	ProfEq	0.77
Bev	0.28	MotVeh	0.66
Tob	0.66	OthTrnsp	0.91
Text	0.66	Furn	0.58
Wear	0.78	OthInd	0.66
Leath	1.02	Elect	0.26
Foot	0.81	WatSup	0.173
Wood	0.38	BuildCnst	1.05
Paper	0.36	Civil	0.91
Print	0.61	WhSale	0.74
Coke	0.28	CatAcc	0.5
BasChem	0.83	TranspStor	0.66
OthChem	0.27	Com	1.45
RubProd	0.85	FinIns	0.34
PlastProd	0.73	BusServ	0.29
Glass	0.72	MedDent	0.35
NonMetMin	0.69	OthComServ	0.66
BaslrSt	1.01	OthProd	0.66
BasNFer	0.81		

Source: Own calculations

2.2 Estimated Armington elasticities

Product	Armington elasticity	Product	Armington elasticity
Agric	0.318	MetProd	0.85
Coal	1.423	Macheq	1.07
Gold	No imports	ElecMach	0.94
Othmin	0.94	Telv	0.91
Food	1.14	ProfEq	0.99
Bev	0.68	MotVeh	0.71
Tob	0.73	OthTrnsp	1.37
Text	1.24	Furn	0.75
Wear	0.68	OthInd	0.43
Leath	1.83	Elect	0.94
Foot	0.94	WatSup	No imports
Wood	0.37	BuildCnst	1.57
Paper	1.37	Civil	2.84
Print	0.42	WhSale	0.94
Coke	0.47	CatAcc	0.94
BasChem	0.56	TranspStor	1.17
OthChem	0.71	Com	0.94
RubProd	1.00	FinIns	0.94
PlastProd	0.94	BusServ	0.98
Glass	0.35	MedDent	1.05
NonMetMin	0.94	OthComServ	0.58
BaslrSt	0.94	OthProd	0.65
BasNFer	0.94		

Source: Own calculations

2.3 Household expenditure elasticities for the household consumption commodities distinguished within the model

Product	Expenditure Elasticity	Product	Expenditure elasticity
Agric	0.99	MetProd	0.86
Coal	1.72	Macheq	0.72
Gold	0	ElecMach	0.03
Othmin	0	Telv	2.24
Food	0.96	ProfEq	1.2
Bev	1	MotVeh	1.2
Tob	0.05	OthTrnsp	1.41
Text	0.43	Furn	1.85
Wear	0.25	OthInd	0.19
Leath	0.89	Elect	0.89
Foot	0.89	WatSup	0.62
Wood	0.65	BuildCnst	0
Paper	1.11	Civil	0
Print	0.75	WhSale	0.81
Coke	1.62	CatAcc	0.9
BasChem	1.69	TranspStor	1.68
OthChem	1.17	Com	2.31
RubProd	0.35	FinIns	1.84
PlastProd	0.71	BusServ	1.28
Glass	0.83	MedDent	1.83
NonMetMin	0.89	OthComServ	0.72
BaslrSt	0	OthProd	0.72
BasNFer	0		

Source: Own calculations

