A Static, Stylized, CGE model applied to evaluate the incidence of Value Added Tax in South Africa.

by

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1. INTRODUCTION

South Africa's current macro-economic policy strategy GEAR is a program aimed at generating economic growth, creating sufficient employment opportunities, delivering social services, protecting its citizens and the redistribution of income (Budget Speech, 1997:2). The redistribution of income and wealth and the alleviation of poverty are key issues in South Africa, since South Africa is known to have one of the worst distributions of income and wealth in the world. The top 5% of the population owns 27% of all wealth, while the bottom 65% owns only 10% (Van Heerden,1996:286). The World Bank reported that the richest 10% of South Africa's population contributed 47,3% of GDP, while the poorest 10% of the population only contributed 1,4% of GDP (The World Bank: 1998/1999:327).

The redistribution of income also received attention in Minister Trevor Manuel's budget of 2001/2002 as can be seen from the tax relief extended to lower income groups. Workers earning less than R23 000 will pay no income tax, while workers earning R70 000 will pay about 12 percent less tax (Budget Speech,2001:14). Even though it was expected that the percentage Value Added Tax (VAT) would increase in this budget, the increase did not realize. In fact, the last percentage increase in VAT was in April 1993 when VAT increased from 10% to 14%. General opinion is

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that an increase in VAT would be in direct contradiction of the strategy to alleviate poverty as economic theory states that indirect taxes usually burden the lower income group more. Therefore, it is necessary to evaluate the effect of a change in VAT on different income groups, especially the lower income group, as well as the implication on government revenue

2. METHODOLOGY

A static, computable general equilibrium model that encompasses all the important South African taxes is constructed. The year 1996 is chosen as the base year, because the most recent input-output table obtained is for the year 1996[3] and it is also the year in which the last household census was held. A Social Accounting Matrix is completed to configure and balance the model. The model starts with an initial equilibrium and the economy is then shocked with a percentage increase in VAT (from 14 percent to 15 percent). The resultant change in the price index of the different income groups as well as the change in government revenue is observed.

3. A SOCIAL ACCOUNTING MATRIX

A Social Accounting Matrix is constructed to configure initial general equilibrium in the model. A Social Accounting Matrix illustrates two important concepts, namely inter industry flows and national accounting identities (Devarajan, et al. 1994 p. 3-2). Inter industry flows means the flow of commodities and production factors in the economy, while the national accounting identities involve the double-accounting principle that states that expenditures must equal receipts. A balanced Social Accounting Matrix sets up the configuration for initial equilibrium.

The following social accounting matrix is constructed for this model:

[3] Prof. James Blignaut, University of Pretoria, supplied the 1996 input-output table.

Table 1: The Social Accounting Matrix

		EXPENDITURE						
		Activities	**Commodities**	**Factors**	**Households**	**Government**	**Capital**	**World**
RECEIPTS	**Activities**		Domestic sales					
	Commodities	Intermediate goods			Consumption demand	Government consumption	Investment demand	Exports
	Factors	Value added						
	Households			Factor income		G transfers		
	Government			VAT + tariffs	Income taxes			
	Capital				HH Savings	G savings		F savings
	World			Imports				

(Devarajan et al,1994:3-3 and Ginsburgh et al, 1997:189)

The content of the social accounting matrix can be explained as follows:

HOUSEHOLDS

Total income of households is equal to income from the sales of production factors via the allocation matrix plus, all transfers from government. Transfers take the form of social welfare. Household expenditure includes the consumption of commodities, income tax, indirect taxes (VAT and import tariffs) and private savings. VAT is calculated on the value added by producers and is equal to the amount of VAT paid by consumers minus the VAT paid by producers on intermediate products. VAT is seen as a consumer tax. A balanced accounting matrix requires household income to be equal to household expenditure.

FIRMS

Firms generate all their income from the sale of goods. Goods are sold domestically as well as internationally (through exports). The expenditure of firms consists of the purchase of intermediate goods (M is seen as

intermediate goods), production factors (labor and capital), and company tax. Company tax is levied on the profit of firms.

GOVERNMENT

Government revenue consists of all the different taxes, namely import tariffs, income tax, company tax, and indirect tax (VAT). Expenditure includes government expenditure on commodities, transfers for example social services, and government savings. In South Africa's case government savings will be negative, since South Africa had a budget deficit of R29 billion or 6,5 percent of GDP during the 1996/1997 fiscal year (Budget Speech,1997). Social transfers are fixed due to the budgetary commitments of the fiscal authorities.

FOREIGN SECTOR

The foreign sector's receipts will be in the form of payment received for exports to South Africa, while their expenditure will be in the form of payment for imports from South Africa plus all foreign savings. In the base year, 1996, there was a net outflow of capital and therefore foreign savings will be negative.

THE MARKETS

Commodities flow from producers to the consumers (the households). Commodities consist of domestically produced goods, as well as imports. Households, firms, the government, as well as producers (through investment in capital goods) consume commodities. The supply of commodities must be equal to the demand thereof.

Production factors flow from households (the owners thereof) to producers. The labor and capital owned by the households form the supply of production factors. The owners of these production factors are remunerated. The remuneration received by households is equal to the value of sales, less the cost of intermediate goods. This is also known as the value added. The demand for production factors is derived from sales. The supply of production factors should be equal to the demand thereof.

SAVINGS AND INVESTMENT

Lastly, the model requires investment to equal total savings. Total savings consist of savings by households, government and the foreign sector.

The SAM gives the framework for the model to follow.

4. THE STYLIZED MODEL

The model is adapted from Devarajan et al (1994). The model is a multi-sector model. Sectors included in this model are households, firms, the government and the foreign sector. There are two markets, namely the commodities market and the factor market. The factor market consists of two inputs only, namely capital (K) and labor (L). The commodities market consists of three products. Two of these three products are produced domestically (D and E), while the other product is imported (M). D is products that are produced and consumed domestically. The model is applied assuming inter industry flows. The industries specified in the model will be classified according to the classification of the SNA by kind of economic activity. Therefore the nine-sector classification is used. All major South African taxes are included in this model. This model allows for income tax on households, indirect taxes (VAT), import tariffs, export subsidies and company tax.

Assumptions of the model:

(1) It is assumed that there is only one consumer and one producer in the economy.

(2) It is assumed that the single consumer is rational and will therefore strive to maximize his/her utility subject to his/her income. The utility function is a constant elasticity substitution (CES) function. The budget constraint is determined by the relevant net prices of D and M and the transfers received from the government.

(3) The producer maximizes revenue subject to total costs and technology. The production function used is a Cobb-Douglas production function that exhibits constant returns to scale. Input consists of primary factors (K and L) as well as intermediate goods.

(4) South Africa is assumed to be small relative to the world markets thus world prices are fixed.

(5) Lastly, it is assumed that consumers and firms do not consider the impact of household tax and company tax respectively when making their utility maximization or profit maximization decisions. Company taxes will not affect the production problem as long as the marginal tax rate is less than unity. If the marginal tax rate is less than unity the profit maximization problem of max (pq – t(pq)) yields the same result as max(pq), where p is price, q quantity and t the tax rate (Ginsburgh et al. 1997:161).

Notational conventions followed are:

i and *j*	represents the sectors,
h	represents households endowed with labor and capital,
f	represents the factors capital, low income-, middle income- and high income groups.

The sectors, households and factors will be shown in brackets.

DOMESTIC PRODUCTION

Domestic production consists of two commodities, namely *D* and *E*. *D* is the part of domestic production consumed domestically and E is the portion of domestic production exported. The production functions for *E* and *D* are Cobb-Douglas production functions that exhibit constant returns to scale:

$$D(i) = A^{D}(i)L^{a(i)}(i)K(i)^{(1-a(i))}$$

$$E(i) = A^{D}(i)L^{a(i)}(i)K(i)^{(1-a(i))}$$

The producer chooses between the production of commodities E and D using the function:

$$X(i) = CET\ (E(i); D(i); g(i); r(i))$$

with

$$X(i) = a^t(i)\left[g(i)E(i)^{r^t(i)} + (1-g(i))D(i)^{r^t(i)}\right]^{\frac{1}{r^t(i)-1}}$$

thus,

$$\frac{E(i)}{D(i)} = \left[\frac{(1-g(i))\ p_e(i)}{g(i)\ p_d(i)}\right]^{\frac{1}{r^t(i)}}$$ where $1 < r(i) < +\infty$ and $g(i)$ the share

parameter.

The price equations for E and the composite production good X follows:

$$p_e(i) = EXR(1+t_e(i))p_{we}(i)$$

$$p_X(i) = \frac{p_d \cdot (i)D(i) + p_e(i)E(i)}{X(i)}$$

The value added price is calculated as follows:

$$p_v(i) = p_x(i) - \sum_j p_q(j) \cdot a(j,i)$$

$$INT\ (i) = \sum_j a(i,j) \cdot X(j)$$

DOMESTIC DEMAND

Apart from the demand for D, there is also a demand for imported goods M. The demand for imported goods is relative to the demand for domestic produced goods (D). Thus demand depends on the relative prices of D and M.

$$\frac{M(i)}{D(i)} = f(p_m(i); p_t(i))$$

The consumer chooses between the consumption of commodities D and M using constant elasticity of substitution function (CES):

$$Q(i) = CES\ (M(i); D(i); d(i);\ r(i))$$

with

$$Q(i) = a^V(i)\left[d(i)M(i)^{-r^V(i)} + (1-d(i))D(i)^{-r^V(i)}\right]^{\frac{-1}{r^V(i)}}$$

thus

$$\frac{M(i)}{D(i)} = \left[\frac{d(i)\,p_d(i)}{(1-d(i))\,p_M(i)}\right]^{\frac{-1}{(1+r^V(i))}}$$

where $-\infty < r(i) < -1$ and $d(i)$ the share parameter.

The price equations for composite demand and imports are respectively

$$p_q(i) = \frac{p_d(i)D(i) + p_m(i)M(i)}{Q(i)}$$

$$p_m(i) = EXR\ (1 + t_m(i))\ p_{wm}(i)$$

INCOME AND TAXES

Household income consists of income from labor and capital sold. The income from capital is equal to the return on capital less depreciation.

$$Y_h(i) = Y_{LOW}(i) + Y_{MIDDLE}(i) + Y_{HIGH}(i) + Y_{CAP}(i)$$

Government revenue is equal to:

$$GR = TARIFF + VAT + HHTAX - EXPSUB$$

where

$$TARIFF = \sum_i p_{wm}(i) \cdot M(i) \cdot t_m(i) \cdot EXR$$

$$VAT = \sum_i (p_q(i) \cdot Q(i) - p_q(i) \cdot INT(i)) \cdot t_{VAT}(i)$$

$$HHTAX = \sum_h \sum_i Y_h(i) t_h(i)$$

$$EXPSUB = \sum_i p_{we}(i) \cdot E(i) \cdot t_e(i) \cdot EXR$$

EXPENDITURE EQUATIONS

$$CD(i) = \sum_h \sum_i \frac{cles(i) \cdot (1 - mps_h(i)) \cdot Y_h(i) \cdot (1 - t_h(i))}{p_q(i)}$$

$$GD(i) = b_G(i) \cdot gdtot$$

$$DST(i) = dstr(i) \cdot X(i)$$

$$FXDINV = INVEST - \sum_i p_q(i) \cdot DST(i)$$

$$DK(i) = \frac{kshr(i) \cdot FXDINV}{p_k(i)}$$

$$ID(i) = \sum_j b(i, j) \cdot DK(j)$$

$$DEPREC = \sum_i depr(i) \cdot p_k(i) \cdot FDSC_{CAP}(i)$$

Depreciation per sector is calculated by multiplying the depreciation rate with the value of fixed capital stock.

PRICES

$$p_k(i) = \sum_j p_q(j) \cdot b(j, i)$$

$$p_q(i) = \frac{p_d(i) D(i) + p_e(i) E(i)}{Q(i)}$$

SAVINGS

$$SAVINGS = HHSAV + GOVSAV + DEPREC + FSAV \cdot EXR$$

$$HHSAV = \sum_h \sum_i Y_h(i)(1 - t_h(i))(1 - mps_h(i))$$

$$GOVSAV \quad = GR \; - \sum_{i} p_q(i) \cdot GD\,(i)$$

Foreign savings are determined exogenously.

EQUILIBRIUM CONDITIONS

The quantity demanded of the composite good Q is equal to the demand for intermediate goods, consumption demand, public demand, investment demand and inventory investment.

$$Q(i) = INT\;(i) + CD\,(i) + GD\,(i) + ID\,(i) + DST\;(i)$$

The demand and supply of production factors L and K should be equal:

$$FDSC_{CAP}(i) + FDSC_{LAB}(i) = fs(i)$$

Since capital stock and labor supply are fixed, the demand for factors will also be fixed. Aggregate demand and supply of L and K will be equal. This clearing condition will be met automatically, and is therefore redundant and can be dropped.

The foreign sector should balance:

$$p_{wm}(i) \cdot M(i) = p_{we}(i) \cdot E(i) + FSAV$$

Exogenous balance of payments is equal to the world price of imports less the world price of exports, and

$$SAVING \;\; = INVEST$$

5. CALIBRATING THE MODEL

The production and trade parameters will be obtained by solving the model equations in reverse.

The production function:

$$a(i,f) = \frac{[WF(f) \cdot wfdist(i,f) \cdot FDSC(i,f)]}{X(i)} \cdot P_v(i)$$

$$AD(i) = \frac{X(i)}{\prod_f (FDSC(i,f)^{a(i,f)})}$$

The CES function:

The sectoral elasticities are given (sigc).

$$r^V = \frac{1}{sigc(i)} - 1 \qquad \text{if sigc(i)} \neq 0.$$

$$d(i) = \frac{\frac{p_m(i)}{p_d(i)} \cdot [\frac{M(i)}{D(i)}^{(1+r^V)}]}{1 + \frac{p_m(i)}{p_d(i)} \cdot [\frac{M(i)}{D(i)}^{(1+r^V)}]}$$

$$a^V(i) = \frac{Q(i)}{(d(i) \cdot M(i)^{-r^V(i)} + (1-d(i)) \cdot D(i)^{-r^V(i)})^{-1/r^V(i)}}$$

The CET function parameters are calculated in a similar manner.

Parameters for the Cobb-Douglas production function, the CES function and the CET function can be specified outside the model based on econometric results. The parameters obtained from inside the model should be compared with econometric results when possible.

6. MEASURING STANDARD OF LIVING

Standard of living can be determined using consumer price indexes, production price indexes or a GDP deflator. In this case a GDP deflator will be used. The GDP deflator will be calculated (before and after the 1% increase in VAT) by dividing nominal GDP at market prices by real GDP. This index will then be compared with the initial 1996 GDP deflator for low-, middle- and high-income groups to determine the percentage difference. This will indicate how each income group is affected by the 1% increase in the VAT rate.

$$Pindex = \frac{INT + VAT + TARIFF}{CD + DST + ID + GD + \sum_i E(i) - \sum_i (1 - tmrea(i)) \cdot M(i)}$$

Curves are estimated to determine the price index for low, middle and high income groups from the price index (Pindex) obtained above. Three curves are estimated with Pindex the independent variable and Pindex(low), Pindex(middle) and Pindex(high) as the dependent variable respectively.
The linear curves estimated are based on the following formula:

$$Y = b_0 + b_1 X$$

Table 2: Curves estimated

Income group	β_0	β_1
Low	-0.8960	1.0050
Middle	0.4866	0.9868
High	0.1452	0.9986

7. SIMULATION RESULTS

The price index changed increased with 0.9%. The results obtained for the different income groups can be summarized as follows:

Table 3: Results obtained

Income groups	Before 1% increase	After 1% increase	Percentage change
Low	-0.490226	-0.4864606	-0.76809%
Middle	0.8850257	0.8887228	0.41773%
High	0.5483900	0.5521313	0.68223%

The indexes above are only relative indexes and the values should not be taken as absolutes. These relative indexes are mainly used to determine the change in prices.

Government revenue increased with 2,45%.

8. CONCLUSION

The standard of living of the lower income group actually improve due to the increase in social transfers. This can be explained by the increase in government revenue that would flow to the lower income groups through government transfers in the form of social services. The standard of living of both the middle and high-income groups decline.

The percentage change in VAT also results in a decline in investment through the decline of the price of capital. The decline in investment will mean that capital stock in future periods decline. A decline in capital stock will result in lower production and also lower demand for labor that might impact negatively on the standard of living of all income groups. Since this model is static this effect is not determined.

Therefore, according to this model, a percentage increase in VAT would not affect the lower income groups negatively if the higher government revenue flow to the lower income group; also because most necessities used by the lower income groups are exempted from VAT in any case. Therefore, any policy measures aimed at promoting growth, the redistribution of income, employment and the general increase in the standard of living can consider an increase in VAT. Government revenue increased with almost 2,5% through the increase in VAT. If this increase in revenue is used for the purpose of redistribution, it will assist redistribution and the alleviation of poverty.

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