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Reforming the value added tax in Zambia.

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CHAPTER 1 : INTRODUCTION

1.1 Background of the Study

Since the 1980's most developing countries have undertaken some type of reform or another to their tax systems. In the majority of these countries, these reforms have been carried out as a component of the wider economic policy reforms promoted by international financial institutions (IFIs). Zambia has not been an exception to this trend. During the 1990s, a tax reform package was implemented within the broader stabilization and structural adjustment programme. The contours of this package reflected the standard tax reform package *á la* IFIs which commonly includes shifting heavy reliance on trade taxes to domestic sales taxes, the rationalization of income taxes, and measures to reduce budget deficits and/or raise tax/GDP ratios. The package also prescribes a reduction and simplification of import tariff rates and elimination of export taxes. However, the key feature that emerged from the tax reform package in Zambia was the introduction of the value added tax to replace the retail sales tax.

What typically underlay the IFIs supported tax reforms were efforts to improve macroeconomic stability, make the economy more 'open' and improve the efficiency of the tax system and of tax revenue collection. Tax policy has continued to dominate the economic agenda of developing countries but with a different basis. The aftermath of structural adjustment programmes has seen the emergence of developmental initiatives such as the United Nations Millennium Development Goals (MDGs) and the Poverty Reduction Strategy Papers (PRSPs). The underlying objective of these initiatives is to address the impediments to the attainment of economic development and poverty reduction which has so far been elusive in almost all developing countries.

In Zambia specifically, after nearly two decades of pre-occupation with stabilization and structural adjustment policies and the successful implementation of the Poverty Reduction Strategy Paper (PRSP) which subsequently led to the achievement of the heavily indebted country (HIPC) initiative completion point in 2005, poverty remains

pervasive. According to the Living Conditions and Monitoring Survey (LCMS) report for 2004 published by the Central Statistics office (CSO), 68 percent of the population lives below the national poverty line. The proportion is much higher for rural areas at 78 percent. One of major impediments to realizing the goals of economic development has been a lack of financing in key economic sectors such as infrastructure, education, health and other social sectors. Thus, at both global and national levels, there have been calls for commitment towards raising additional revenue to finance increased public spending in line with the set out developmental goals.

Zambia's current economic development agenda is outlined in the fifth national development plan (FNDP): 2006-2010. The FNDP was launched in 2006 and it encompasses the MDGs as its long-term aspirations for economic development. The FNDP focuses on directing gains from economic growth more effectively towards the poor. This strategy, as identified by the FNDP, requires increased public spending towards strengthening the relevant economic and social infrastructure and enhancing agriculture and rural development. Thus, in the medium-term higher levels of government revenue will be required to accommodate the spending as envisaged in the FNDP. As one of its revenue measures, the FNDP seeks to strengthen the revenue base through the achievement of a robust and broad-based tax system. It is therefore inevitable that Zambia will have to continue with the process of reforming its tax system. This is more so given the glaring realities associated with other alternative revenue measures such as domestic borrowing and external financing.

The option of borrowing from the domestic financial market is not favourable because it will fuel macroeconomic instability in the light of the chronically large domestic debt and high nominal lending interest rates. The stock of domestic debt stood at 20 percent of GDP and nominal lending rate at 28 percent at end of 2006 (GRZ, 2007). While increased external aid in-flows is another option, over-time Zambia has to reduce its aid-dependence so as to rely on the domestic revenue base in order to finance developmental programmes in a predictable manner. Furthermore, debt-creating inflows are to be shunned completely to sustain gains from Zambia's new status as a non-heavily indebted poor country. Zambia's external debt stock fell from US$7.2 billion in 2001 to US$635 million as at end of December 2006 (GRZ, 2007).

All these realities have been recognized by the government and other like-minded institutions.

Given, the foregoing therefore, Zambia will have to rely more on its tax system for its revenue to finance its economic development agenda. It is therefore important to press ahead with tax reform in order to strengthen the tax system so that it can raise adequate revenue. There is a growing body of literature which emphasises the evaluation of any tax reform in order to take into consideration its likely differing economic impacts. While it is desirable to evaluate a tax reform against criteria of economic and administrative efficiency as noted by Gemmell and Morissey (2005), Deverajan and Hossain (1995) argues that welfare effects should also be taken into account. This is because, as noted by Devarajan and Hossain (1995), while the beneficiaries of public spending may be poor, if this spending is financed by a highly regressive tax, the net effect may not be pro-poor.

This thesis focuses on the economic effects of reforming the existing VAT in Zambia. VAT is one of the major taxes in the Zambia tax system accounting for a third of total tax revenue. Thus, it does qualify to be accorded its own analysis. Moreover, the FNDP (2006) specifically recognises the need to broaden VAT so that it can raise revenue as efficiently and equitably as possible. Therefore, this study will shed more light on the impacts some possible reforms to the VAT in Zambia.

1.2 Characteristics of Value Added Tax in Zambia

The Value-added tax (VAT) in Zambia was a central component of the tax reform process unveiled in the early 1990s. As spelt out in the budget speeches of 1993 and 1994, the main objective of the tax reform was to raise more revenue as simply, efficiently, and equitably as possible. This required the use of moderate tax rates applied uniformly to a broad base, with special tax breaks limited to those needed to protect the most vulnerable groups. In order to encourage growth, a need to shift taxes away from production towards consumption was also recognized. Hence, VAT became the chosen instrument of tax reform and came into being on 1st July 1995 replacing the existing sales tax.

Today, VAT in Zambia still remains a centerpiece in tax design and modernization like in most countries' fiscal systems. Latest figures as at 2005 (International Tax Dialogue), show that 129 countries have implemented a VAT of which 33 are from Sub-Saharan Africa. As observed by Keen and Lockwood (2007), this is not over yet as several countries are in the process of adopting a VAT.

The features of VAT adopted in Zambia largely reflect what Ebril et. al. (2002) refer to as 'best practice' in VAT design. It is a single rate multi-stage tax implemented through a credit-invoice mechanism. This means that it is a tax levied on every stage of production for all firms whose annual turn-over exceeds a specified threshold, with a mechanism for crediting tax paid on inputs against tax paid on outputs. Thus, if the credit chain remains unbroken, VAT ultimately comes to bear only on final consumption. In this manner VAT does not distort production decisions and does not create cascading. Cascading is simply the "tax on tax" that arises when tax is charged on both inputs and outputs of the same production process.

Furthermore, because VAT is levied at every stage of production, if the final seller is not taxed, for instance due to evasion, only the tax on the value-added at the final stage is lost. According to Keen and Smith (2007), herein lies the superiority of VAT over the retail sales tax it replaces as revenue is protected. In the case of the retail sales tax, all revenue is lost. An additional strength of VAT compared to its principal alternative is that it is 'self-enforcing'. This is in the sense that each trader has an incentive to ensure that its suppliers have themselves properly paid VAT so as to claim an appropriate input credit.

VAT in Zambia is based on the destination principle as opposed to the origin principle[1]. This means that goods and services crossing the international borders are taxed in the jurisdiction where they are consumed. Thus, VAT is levied on both domestic commodities and imports while a zero-rate is applied on exports. A zero-rate on exports imply that no tax is levied on exports but VAT paid on inputs into their production is reclaimable. In this way, commodities move between countries free of

[1] Origin principle refers to a system in which tax is collected by the country of origin.

VAT and in this sense trade remains undistorted. In addition VAT in Zambia allows for exemptions. This means that commodities falling under the exempt list are not liable for VAT and firms producing these are not required to register for VAT and hence cannot claim any VAT paid on inputs for their production. The core exemptions in VAT literature are those for basic health, basic education and financial services. As noted by Ebril et al (2001), the rationale for exempting the first two services lies in the notion that there are external benefits associated with basic health and education that warrant some degree of subsidization. As for financial services the rationale lies in the difficulty of identifying the appropriate output to tax

The foregoing describes the general features of VAT in Zambia. The specific features essentially take into account the level of the VAT rate, the extent to which commodities or traders are exempted from VAT and the extension of the zero-rate to commodities other than for export. Table 1.1 below presents the specific features of VAT in Zambia.

Table 1.1: Characteristics of VAT in Zambia - 2008

VAT rate	VAT Threshold	Zero-rated items	Exempted items
16 percent	K200 million (approx US $40,000)	-Exports -Aviation kerosene -Medical supplies -Supplies to privileged persons -Supply of packaged tours -Hotel accommodation in Livingstone town - Books Energy saving appliances, machinery & equipment - Raw materials for mosquito nets	-Health services -Educational services -Transport services -Books & newspapers -Conveyance, sale & lease (domestic) of real estate -Financial & Insurance services -Supply of Gold bullion -Funeral services -Basic foods & agriculture supplies -Domestic kerosene -Trade Union subscriptions -Water & sewerage -Mosquito nets -Statutory fees

Source: Zambia Revenue Authority (ZRA)

VAT was introduced at a rate of 20 percent in 1995, was later reduced to 17.5 percent in 1997 and in 2008 it was further reduced to 16 percent. These reductions have been largely prompted by calls from various stakeholders in the economy that the VAT rate was relatively high compared to countries in the region. A reduction in the VAT rate is also anticipated to bring in some gains on the compliance side and hence increase

revenue yield. The VAT threshold is currently set at approximately US $40,000. All firms with taxable annual turnover below this threshold are not liable to register for VAT. However, voluntary registration is provided for such firms upon meeting specified requirements in order to remove a constraint on transacting with registered suppliers.

It can be seen from Table 1.1 that exemptions beyond the core exemptions exists in Zambia. This is common in a number of other countries as well. Basic food and agriculture is one of the key exemptions in Zambia. To prevent cascading of VAT paid on inputs in Agriculture, a number of agricultural inputs are also VAT exempt. The rationale for exempting most of the items beyond the core exemptions largely lies in the notion that doing so will ameliorate the distributional consequences of the tax.

Other than exports and supplies related to exporting, there exists a number of other zero-rated items. The rationale for zero-rating medical supplies and school exercise books is the same as that of exempting health and education services but in addition this allows for a reduction in the cost of production as input VAT is reclaimable. Hotel accommodation in Livingstone, Zambia's tourists' capital and the supply of packaged tours are zero-rated on the grounds of attracting more tourists in the country by making these competitive in relation to other countries. Mosquito net raw materials are zero-rated in order to encourage local production of mosquito nets, thereby making them more accessible so as to reduce the prevalence of malaria.

In recent years Zambia has been hit by electricity power outages due to demand that outstrips the country's generating capacity. Measures are under way to expand the existing power generating capacity. In the meantime to cushion these power outages, energy saving appliances, machinery and equipment have been zero-rated. This will encourage energy saving and therefore ameliorate the problem of power outages while capacity is being expanded.

While all the non-standard VAT zero-rated and exempted supplies in Zambia can be rationalized, they are likely to have an impact on revenue yield. Zero-rating other than that of exports reduces VAT revenue because while no tax is paid on output, VAT

paid on inputs is reclaimable. Exemptions on the other hand can have many effects and some of them quite complex as noted by Ebril et al.(2001).

Firstly, exemptions break the VAT chain and depending on where the break occurs, they may increase or reduce revenue. If the break occurs early in the VAT chain due to exemption of an intermediate or input good, the result is an increase in net revenue. This is due to the cascading of tax on inputs as the price used by downstream firms using the exempt item rises to cover the increased cost and therefore the tax on output of downstream firms increase. On the other hand if the VAT chain breaks just prior to the final sale, the result is a loss in revenue because the value-added at the final stage escapes tax.

The second case against exemptions is that exemptions of items used as inputs in other production processes distorts production choices, thereby eliminating one of the merit key features a well-functioning VAT renders. The irreclaimable VAT on inputs that is implied by the exemption causes producers to substitute away from these inputs. This distortionary consequence of an exemption can spread beyond the sectors directly affected.

Furthermore, the tax cascading that an exemption introduces induces some firms to self-supply. This is a situation where a firm undertakes vertical integration so as to avoid the tax. In other words, exempt firms will have an incentive to supply taxable items to themselves. While this is said to mitigate the production inefficiencies introduced by the exemption, it does so at a cost of a reduction in VAT revenue. The activities of a taxable firm integrated into an exempt firm will no longer be available for levying of the tax.

Exemptions compromise the destination principle. In practice to avoid this, for example, agricultural output in Zambia is exempt when sold on the domestic market and zero-rated when exported. However, when export companies in Zambia make use of agricultural output in their production, they bear indirectly the irreclaimable input VAT. This in a way undoes the feature of VAT being neutral to international trade.

Finally, one of the important consequence of exemptions is that exemptions 'feed on one another', a term used by Ebril et. al. (2001) to dramatize what is referred to as exemption creep. This is a situation in which an exemption creates direct pressures for further exemptions both upstream and downstream. A good example of an upstream pressure can be seen in the exemption of agricultural output in Zambia which has also led to exemption of agricultural inputs, specifically, fertilizers, stock feeds, pesticides, fungicides and herbicides.

In summary, the value added tax in Zambia does conform to most of the features of what Ebril et. al (2001) refer to as 'best' in VAT design. However, it does have some non-standard features. While almost all of the non-standard features have been rationalised, they do have an impact on the functioning of VAT and therefore on the revenue it can collect. Consequently, shedding some of the exemptions is one of the possible ways in which VAT in Zambia can be reformed.

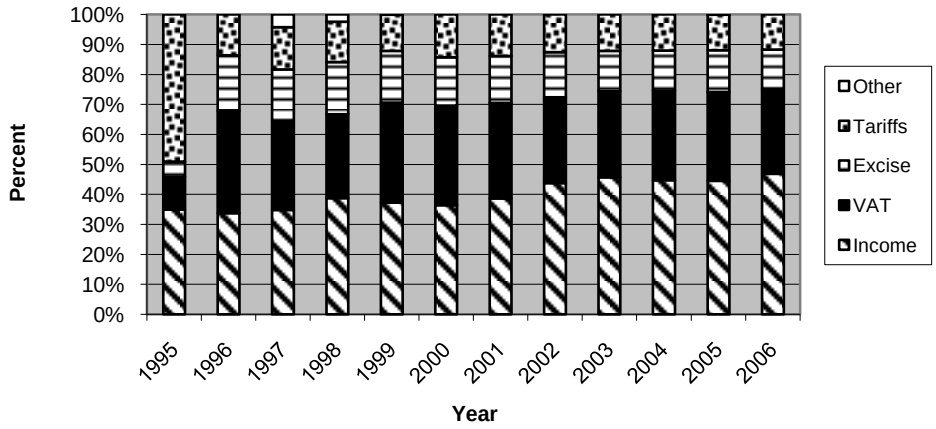
1.3 VAT Revenue Performance in Zambia

VAT has invariably been one of the most important sources of tax revenue in Zambia, coming second only after income tax as Figure 1.1 shows. In the years following its inception, VAT contributed about a third to total tax revenue. It can be observed further that together with its associated excise tax, VAT was seemingly able to recoup the revenue share lost from tariffs in the trade liberalization process. Trade liberalization in Zambia saw the slashing of the maximum tariff rate from 100 percent to 25 percent and the reduction of tariff bands from 11 to 4. Hence the revenue from tariffs, comprising about 50 percent of total tax revenue, which Zambia heavily relied on, was no longer available. The finding on the ability for VAT in Zambia to recover the loss in revenue from trade liberalisation has been empirically documented in the study by Baunsgaard and Keen (2005).

However, in recent years a troubling situation has arisen. The share of VAT in total revenue has been falling with income tax recouping most of this loss. This is notwithstanding the fact Zambia's economy is typical of a developing country with a

large share of agriculture in total output; large informal sector activities and occupations; many small establishments; and so on. These characteristics as advanced by Tanzi and Zee (2000), reduce the possibility of relying more on income taxes than on VAT. It is thus expected that VAT will continue playing a dominant role in tax revenue in Zambia.

Figure 1.1: Tax Revenue Collections in Zambia 1995-2006 (percentages)



Gallagher (2004) points out that the international norm is that where VAT exists, it should be able to generate about 35 percent of all tax revenues. With VAT revenue collections in Zambia falling below 30 percent of total tax revenue is an indication that there are still gains to be had from VAT. Table 1.2 shows that the ratio of total tax to GDP which averaged just above 18 percent in the earlier years of VAT has dropped to 17 percent in recent years.

Table 1.2: VAT Revenue Performance 1995-2006

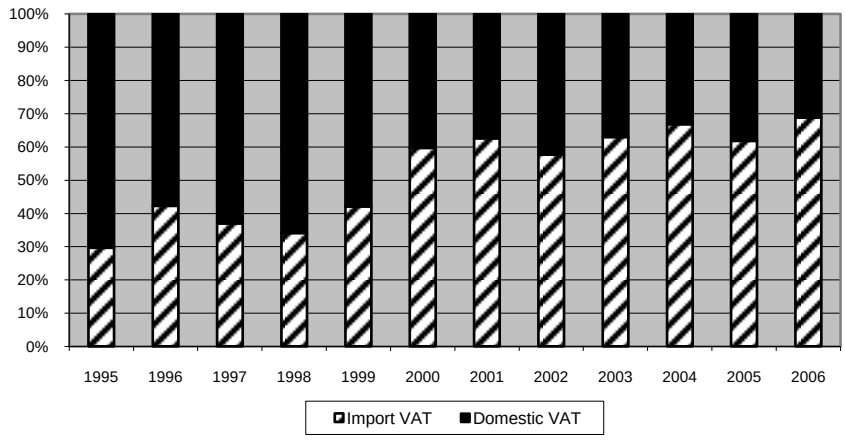
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total tax % GDP	18.3	18.4	18.6	18.1	17.2	17.3	18.6	17.5	17.3	17.6	17.2	16.1
Domestic VAT % GDP	1.4	3.6	3.5	3.3	3.3	2.3	2.2	2.1	1.8	1.7	1.9	1.5
Import VAT % GDP	0.6	2.7	2.0	1.7	2.4	3.4	3.7	2.9	3.1	3.5	3.1	3.1
Total VAT % GDP	2.0	6.3	5.5	5.0	5.7	5.7	5.7	5.0	4.9	5.2	5.0	4.6
Potential VAT % GDP	12	13	11	12	13	12	10	10	10	10	10	11
Real GDP growth %	-2.8	6.9	3.3	-1.9	2.3	3.6	4.9	3.3	5.1	5.4	5.1	5.8

Source: ZRA, World development Indicators (WDI) 2007 and Author's calculations.

The latest drop to 16 percent is recorded in 2006. This reduction has largely been due to the declining VAT yield. The revenue yield of VAT as a share of GDP has declined from around 6 percent to 5 percent in recent years. According to Bird and Gendron (2006), VAT yield rises when GDP grows. This is so because a consumption tax such as VAT should at least grow at the same rate as GDP. In other words, its GDP elasticity should be approximately unity. VAT yield as a percent of GDP has fallen by 16 percent from 2001 to 2005 while real GDP for the same period has grown by 20 percent.

Another notable feature in the performance of VAT in Zambia is the rise in the share of VAT collected at the border relative to that collected from the domestic sector. As Figure 2.2 shows, in the initial years of VAT existence, import VAT comprised of about one-third of total VAT revenue. Since 2000 the share of import VAT in total VAT revenue has risen to two-thirds, swapping one-for-one with the share for domestic VAT. Baunsgaard and Keen (2005), advances that often half or more of VAT is collected at the border in developing countries.

Figure 1.2: Import and Domestic VAT



This is basically due to the well-known relative administrative ease of collecting custom duties. However, the sharp switch in shares of import versus domestic VAT in the Zambian case requires further investigation as it may have implications on the sustainability of VAT revenue.

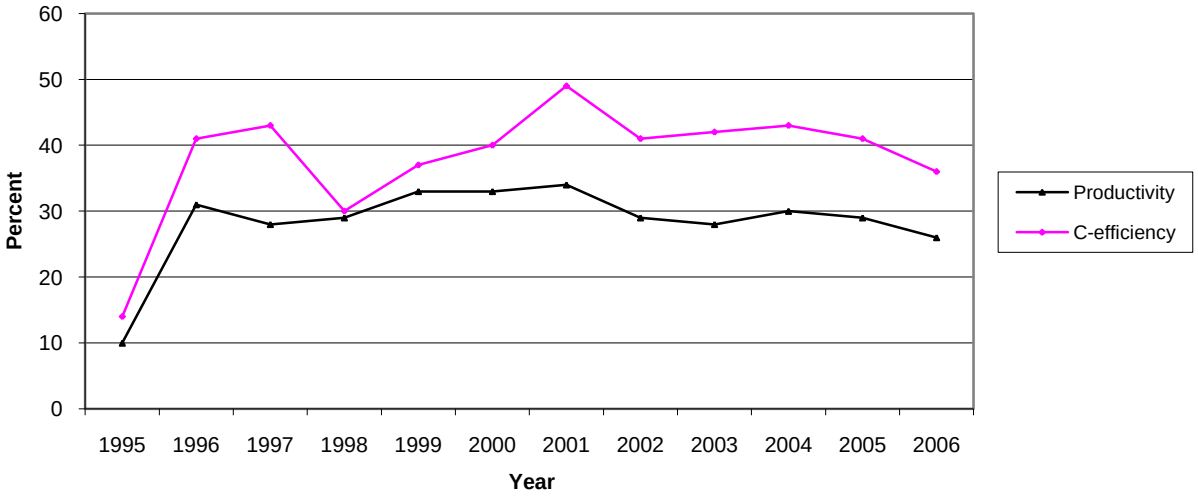
To get further insight into the performance of VAT, Figure 1.3 presents VAT efficiency indicators. A VAT efficiency indicator measures how well VAT is applied. According to Ebril et al (2001), it is an indicator of the extent to which VAT bears uniformly upon a broad base. The two common indicators are the VAT efficiency (productivity) and C-efficiency ratios. VAT efficiency or productivity measures how much revenue in terms of GDP is generated by each percentage point of the VAT rate. It measures how productive VAT is with reference to GDP as a base.

However, VAT taxes consumption and not production. Therefore, the more accurate measure of its base is consumption. Using consumption as a base for VAT instead of GDP yields the 'C-efficiency' ratio. The 'C-efficiency' measure is applicable particularly where differential VAT rates or zero-rating applies. A value higher or lower than unity indicates deviations from uniformly taxing all consumption. A 'C-efficiency' value less than 100 percent is an indication of tax base erosion due to zero-rating, exemptions, differential VAT rates or poor enforcement. A 'C-efficiency' value of above 100 percent is as a result of an augmented VAT base. This may arise if investment is included in the VAT base or there is a break in the VAT chain so that both final consumption and some of the constituent intermediate goods are taxed. In summary, the closer the two measures are to unity, the more efficient VAT is in collecting revenue. According to Aizenman and Jinjarak (2005), the difference between these two alternative measures is that C-efficiency ratio is normalized by reference to a consumption-type VAT while the efficiency ratio is normalized by reference to an income-type VAT.

Figure 1.3 suggests that both the efficiency and 'C-efficiency' ratios (expressed in percentage form) increased after the introduction of VAT. Thereafter both show an oscillating trend around a particular level (VAT efficiency around 30 percent and the C-efficiency around 40 percent) while tending downwards. This shows that on average VAT in Zambia generates 0.3 percentage points of GDP in revenue for every one percentage point of the standard rate. According to Cnossen (1998), a VAT with

few exemptions can generate on average 0.4 percentage points of GDP in revenue for every one percentage point of the standard rate.

Figure 1.3: VAT Productivity and C-efficiency 1995-2005



The average efficiency ratio, at 0.3 associated with VAT in Zambia falls below this average. Thus, relatively VAT in Zambia is applied to a narrow base. According to Figure 1.3, between 1998 and 2001, the C-efficiency increased steadily indicating some attempts in expanding the base. Thereafter, the ratio dropped and has remained around 0.4, which deviates significantly from unity (100 percent). The inescapable conclusion from the above analysis, though based on simple measures, is that VAT performance has been weakening.

1.4 Objectives of the Study

My main objective in this study is to analyse the economic effects of reforming VAT in Zambia in order to make it generate more revenue. More precisely, I look at the effects of broadening the VAT base on macro variables, industry level variables and household level consumption (welfare). The existing VAT exemptions offer possible options for extending the VAT base. One of such options is to extend the VAT base to agriculture. This option has generated heated debate on its likely impacts and therefore has dominated tax policy in Zambia over the years. In 1995 at the introduction of VAT, agriculture was VAT exempt. By 2001, it was re-classified as zero-rated. In 2004, it was reverted to exempt status. In 2006 an order to standard-rate

agriculture was passed but before the order took effect, the order was amended to revert agriculture to exempt status once again. Despite all these changes and the ensuing debate, no empirical study exists on the impacts of reforms to VAT in Zambia. Therefore, analysing the effects of extending the VAT base will provide an empirical foundation and shed more light on ongoing debate about the likely impacts of reforming VAT, particularly on the country's worse-off socio-economic groups. From the foregoing therefore, the specific objectives of the study are:

- To empirically determine who pays VAT in Zambia on the basis of household expenditure,
- To adapt a standard computable general equilibrium (CGE) model by specifically modelling VAT with an imperfect rebate system.
- To carry out simulations to quantify the short-run impacts of extending the VAT base to 1) uniformly all the sectors and 2) the agriculture sector on the macro level, sectoral level and on the consumption (welfare) of different socio-economic groups using a CGE model.

1.5 Outline of the Thesis

In order to achieve the objectives outlined in the previous section, this thesis is organised under five chapters as follows: The next chapter, Chapter 2 uses welfare dominance to empirically determine who pays VAT in Zambia on the basis of household expenditure data obtained from the Living Conditions Monitoring Survey (LCMS) for 2004. The question of who pays VAT is fundamental in determining whether VAT in Zambia is regressive and what this implies for the policy of broadening the VAT base to cover some commodities which are currently outside the base.

In Chapter 3, I use a standard CGE model by Lofgren et. al. (2002) and modify it by specifically modelling VAT with rebates. I calibrate the model so obtained to the social accounting matrix (SAM) for Zambia. On the basis of the model, I simulate two types of VAT reforms and investigate their short-run impacts on the economy. The first simulation involves increasing the actual VAT rate in all sectors. This experiment mimics a general VAT reform towards a full VAT whereby the VAT system covers

all sectors with very minimal exceptions. This would be the ultimate stage in VAT reform. However, in this study it is carried out so as to act as a benchmark for comparing the results obtained from the second simulation, which is the focus of the study, so as to determine whether the model reacts in a consistent manner to the simulations. The second simulation is a subset of the first experiment and the focus of the Chapter. The simulation entails widening VAT coverage to only one particular sector of the economy. The experiment mimics Government's decision in the 2006 National Budget to standard rate agriculture except for maize, maize meal and infant food. This was an initial attempt by government to address the issue of a narrow VAT coverage by bringing in more and more sectors under the VAT net. Chapter 4 makes up the summary and concluding remarks.

1.6 Concluding Remarks on Major Findings

In this study welfare dominance was conducted on VAT paid by different households on different commodities on the basis of household expenditure obtained from the LCMS (2004). The purpose of this was to empirically determine who pays VAT in Zambia and therefore what the implications are for the policy of extending the VAT coverage. The conclusion from findings of this analysis is that on the overall, VAT is regressive. However, the burden of VAT is largely borne by urban households compared to rural households and the former are relatively better off compared to the latter. This indicates that VAT can be extended to cover some of the currently exempted items, in particular agricultural foods, at low welfare cost. This would create fiscal space to undertake more activities as envisaged in the Fifth National Development Plan (FNDP) 2006-2011.

Further, a CGE model was developed using the standard CGE model by IFPRI as a template. The model specifically captured VAT with rebates on intermediate inputs. An imperfect rebate system was allowed for to capture the imperfections in the functioning of the rebate system due to existence of the informal sector and other VAT liable activities outside the VAT net. On the basis of the model, herein after referred to as the Zambia CGE VAT model, two broad simulations of VAT reform were conducted. The first one involved extension of VAT coverage to all sectors (FULLVAT). This mimics a full VAT with minimal or no exclusions. The second

simulation involved the extension of the VAT coverage to the agricultural sectors except the staple food agricultural sector, maize (AGRIVAT). The overall conclusions from the foregoing are as follows. Extending the VAT coverage to all sectors with very minimal or no exclusions should be accompanied with reductions in the VAT rate, given that a full VAT reform with income tax as a recycling instrument proved to be the most welfare worsening scenario in the short run. In the same vein, calls for further reductions in the VAT rate as observed in the on-going debate on VAT reform in Zambia, should be made bearing in mind that if revenue has to be preserved, more sectors should be brought under the VAT net. Important to note however, is that the study is not able to establish by how much the reduction in the VAT rate should be as the model used actual VAT rates which deviate from the standard VAT rate.

The second and final conclusion is that contrary to the widely held view in the debate on VAT reform in Zambia, extending the VAT coverage to agricultural sectors apart from maize sector is not likely to hurt the worse-off socio-economic groups. The short-run welfare losses of such a reform appear to be more disproportionately borne by the urban households whose incidence of poverty is low compared to the rural households. Therefore, bringing more agricultural commodities under VAT coverage provides one of the viable options to reforming VAT in Zambia.

CHAPTER 2 : WHO PAYS VALUE ADDED TAX IN ZAMBIA?

2.1 Introduction

Developing countries have historically relied heavily on trade taxes as sources of revenue because, according to Ghura (1998), they are easier to collect. Over time, with the reduction in collection costs, the reliance is expected to shift to other indirect taxes such as VAT. The shift from trade taxes to VAT is evident in the Zambia case. Therefore, VAT in Zambia remains one of the major instruments for revenue generation.

However, a broad-based tax on consumption such as VAT is generally considered to be a regressive tax. Jenkins et al (2006) ascribe this to the hypothesis that because poorer households spend a greater proportion of their income on consumption, they are also bound to pay a higher average rate of taxes compared to higher income households. Thus, the question begging to be answered is how regressive Zambia's VAT is. If the above hypothesis holds for Zambia, then what does it entail for the policy of broadening the VAT base?

In this chapter, I empirically examine who pays VAT in Zambia. This question is fundamental in determining whether VAT in Zambia is regressive. By definition, a tax is said to be regressive (progressive) if the poorer (richer) individuals pay a higher proportion of their income in taxes. In other words, regressivity (progressivity) of a tax indicates the extent to which a tax deviates from proportionality in favour of richer (poorer) individuals.

I address the question by conducting a tax incidence analysis using household survey data as outlined in Sahn and Younger (1999). Major examples of tax incidence analysis in developing countries are Fourie and Owen (1993), Younger (1996), Sahn and Younger (1999), Younger et al (1999), Chen et al (2001), Rajemiso et al (2003), Munoz and Cho (2003) and Houghton et al (2006).The main methodology of

conducting a tax incidence analysis is welfare dominance. Under this methodology, a tax is said to be regressive (progressive) if its concentration curve dominates (is dominated by) concentration curves of other taxes or the Lorenz curve of expenditure. Studies on the incidence of VAT have usually assumed that the consumption of the same commodities is taxed at the same effective rate for households at different incomes. Jenkins et al (2006) argue that this not what obtains in practice, in particular with regard to developing countries, due to a large presence of the informal sector. The economy in Zambia is characterised by a modest informal sector even though currently there are no official estimates yet on how large the sector is. Using evidence from another similar country's study and estimates from a prior study on VAT in Zambia, I allow for VAT compliance patterns to vary by commodity and region (urban/ rural) in my analysis.

I conduct welfare dominance for total VAT, food VAT and non-food VAT payments in order to assess whether each of these tax payments is regressive or not. In order to do this assessment, I construct tax concentration curves and Lorenz curves of expenditure on the basis of household expenditure from the Living Conditions Monitoring Survey (LCMS) for 2004. By comparing concentration curves of these tax payments to one another as well as to the Lorenz curve of expenditure I infer regressivity of each of the VAT payments. I construct concentration curves for VAT payments for the whole country and by region in terms of rural and urban. I also conduct welfare dominance on selected commodities which are considered as good tax handles in tax literature. These are alcohol and tobacco\cigarettes. To this I add cosmetics also.

Results from the distribution of effective VAT rates review that VAT in Zambia is mildly regressive as the top expenditure households face lower effective VAT rates, relative to their expenditure levels than the remainder of the households. This is confirmed by the dominance of the concentration curve for total VAT payments over the Lorenz curve of expenditure. A rural-urban split indicates that VAT is more regressive for urban households compared to rural households. VAT on food is found to dominate VAT on non-food. In terms of rural and urban, VAT on food for urban

households dominates VAT on food for rural households. Hence, urban households bear a heavier burden of VAT on food than rural households. Results also show that for the rural households, non-food VAT is more regressive than food VAT. Lastly, VAT on cigarettes is more regressive than VAT on alcohol while the least regressive is VAT on cosmetics. This means that poorer households bear a heavier burden of the tax on cigarettes and alcohol compared to richer households.

I therefore conclude that that the burden of VAT is largely borne by urban households who are relatively better off compared to the rural households. This indicates that VAT can be extended to cover some of the currently exempted items at low welfare cost. This would create fiscal space to undertake more activities as envisaged in the Fifth National Development Plan (FNDP) 2006-2011.

The remainder of the sections are organised as follows. In Section 2.2, I provide a theoretical framework of my study and in Section 2.3 I describe the methodology employed. The Household expenditure data used in the analysis is summarised and described in Section 2.4. The results of the analysis are presented in Section 2.5 and Section 2.6 concludes the Chapter.

2.2 Theoretical Framework

The question of who really pays VAT introduces the notion of tax incidence. Tax incidence refers to those who experience a loss in real income due to the imposition of a tax. A distinction is made between statutory incidence and economic incidence. The place of statutory incidence refers to who the law specifies as liable to pay the tax and the place of economic incidence refers to who ultimately bears the burden of the tax. Divergence between the two places of incidence arises due to the possibility of tax shifting. VAT is levied all stages of production but due to its apparatus of rebating VAT paid on inputs against total output VAT payable, the burden of VAT is ultimately borne by consumers, hereafter simply referred to as households .

In accordance with Sahn and Younger (2002), in order to determine each household's loss in real income due to VAT, I rely on basic duality theory. This is because the dual representation of household behaviour, captured by the expenditure function provides a straightforward way of determining the effect of VAT on households via the effect of the tax on prices household face. The household expenditure function is formally given by:

$$y = e(\boldsymbol{P}, u) \tag{1}$$

This is the minimum amount of money that a household must spend to achieve utility level u given a vector of prices $\boldsymbol{P}$**.** On the basis of the expenditure function two measures that capture gain or loss from a tax change are derived. These are the equivalent variation (EV) and the compensating variation (CV). Formally, letting subscripts 0 and 1 represent levels before and after a tax change, respectively, the two measures are defined as:

$$EV(\boldsymbol{P}^0, \boldsymbol{P}^1, y) = e(\boldsymbol{P}^1, u^1) - e(\boldsymbol{P}^0, u^1) = y - e(\boldsymbol{P}^0, u^1) \tag{2}$$

$$CV(\boldsymbol{P}^0, \boldsymbol{P}^1, y) = e(\boldsymbol{P}^1, u^0) - e(\boldsymbol{P}^0, u^0) = e(\boldsymbol{P}^1, u^0) - y \tag{3}$$

Creedy (1997) defines the equivalent variation for a tax change as the amount of money given to the loser (or taken from a gainer) to ensure that the individual achieves the post-change utility at pre-change prices. He further defines the compensating variation as the amount of money which (at post-change prices) needs to be given to a loser (or taken away from a gainer) in order to restore the individual to the pre-change utility. Assuming that the tax change affects only one price, P_i , and considering only the CV, the Taylor expansion of equation (3) is:

$$CV(P_i^0, P_i^1, y) \approx x_i^c(P_i^0, u^0)(P_i^1 - P_i^0) + \frac{1}{2}\left(\frac{\partial x_i^c(P_i^0, u^0)}{\partial P_j}\right)(P_i^1 - P_i^0)^2 + \cdots \tag{4}$$

where $x_i^c(P_i^0, u^0)$ is generated by Sherpherd's lemma and is therefore the compensated demand function. Note that Equation (4) is only valid for marginal tax changes. The first term in equation (4) is the change in expenditure that the household would have to undertake to keep utility constant without changing demand for good i or any other good. This is the first-order approximation to the CV. The second term accounts for behavioural changes induced by the tax change, that is, changes in the

amount demanded due to a tax change. It thus represents a movement along the demand curve. According to Sahn and Younger (2002) this demand response to a tax change may be ignored as a first approximation. To graph this approximation I make use of equation (3) and invoke Shephard's lemma to yield:

$$CV(P_i^0, P_i^1, y) = e(P_i^1, u^0) - e(P_i^0, u^0) = \int_{P^0}^{P^1} x_i^c(P_i^0, u^0) dP_i \quad (5)$$

This means that the difference in expenditure given by equation (3) is simply equal to the integral of the compensated demand function from P^0 to P^1.

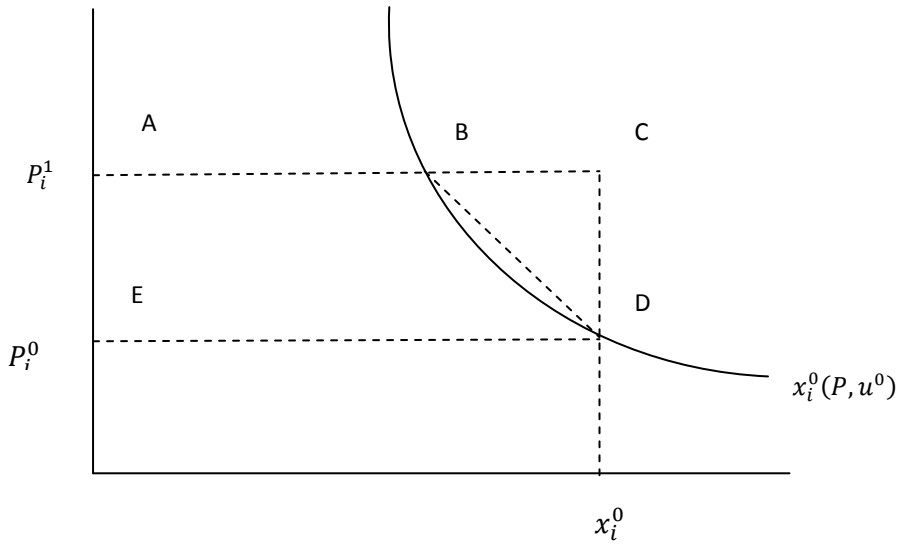


Figure 2.1: Compensating Variation for VAT on a commodity

This integral is depicted in Figure 3.1 as area ABDE. The area ACDE depicts the first term in the Taylor expansion in (4) while triangle BCD depicts the second term. To determine loss in real income due to a tax change, the only information generally required is the first-order approximation depicted by area ACDE. This captures the loss in real income due to tax changes. The taxes paid give the loss in real income. In analyses of tax incidence, the focus is not merely on total taxes paid but on the share of taxes paid by different groups. The groups are usually defined by welfare levels, poor and non-poor or each quintile of a welfare distribution.

In the case of VAT, one of the intuitive analyses is to look at VAT paid by each different group on various commodities. A comparison can then be made whether VAT on a particular commodity yields a better welfare distribution than on another commodity.

2.3 Methodology

I use the theory of marginal condition welfare dominance (hereafter, welfare dominance) to make comparisons of VAT paid by each different group on the various commodities. The framework for applying welfare dominance is due to Yitzhaki and Slemrod (1991). Welfare dominance has its roots in finance literature where it is referred to as second-degree stochastic dominance criterion. This criterion analyses the effect of portfolios on utility. The notion is adapted to taxation vis-a-vis welfare by making changes to the methodology since taxation affects welfare differently compared to portfolios.

The concept of welfare dominance seeks to answer whether, given two commodities A and B, a small reduction in the tax on A financed by a small increase in tax on B improves social welfare given that income is C. This is answered by comparing concentration curves. According to Kakwani (1977), a concentration curve is an umbrella group of curves to which the more widely known Lorenz curve is a special case. The Lorenz curve is simply a concentration curve of income and is defined as:

$$L(p) = \frac{\int_0^p Q(q)dq}{\int_0^1 Q(q)dq} = \frac{\int_0^p Q(q)dq}{\mu} \tag{6}$$

where $L(p)$ is the cumulative percentage of total income held by a cumulative proportion of the population when income is ordered in increasing magnitude. The numerator sums incomes of the bottom p-poorest of the population, while the denominator sums the incomes of all. Given that the population size is normalised to 1, the denominator represents the average standard of living.

The concentration curve for a tax is defined as:

$$C_T(p) = \frac{\int_0^p T(q)dq}{\int_0^1 Q_T(q)dq} = \frac{\int_0^p T(q)dq}{\mu_T} \quad (7)$$

where μ_T is the average tax paid across the population. The concentration curve gives the share of taxes paid by the p- poorest households or individuals in the population. The intuitive derivation of the concept of welfare dominance is offered by Yitzhaki and Slemrod (1991) who later apply it to commodity taxation in Israel. The starting point is a social welfare function given by a sum of identical indirect utility functions:

$$W = \sum_h w[v^h(y_h, P_1, \ldots . P_n)] \quad (8)$$

where y and P are defined as before, w is the social evaluation of the utility of individual or household h and v denotes indirect utility. All that is required of this social welfare function is that social evaluation of the marginal utility of or the marginal welfare, denoted by β, be positive and non-increasing. Formally, this implies that, $\beta(y) = (\partial w/\partial v^h)(\partial v^h/\partial y) > 0$ and $\partial\beta/\partial y \leq 0$.

I now consider a hypothetical reform where a small increase in tax on commodity 1, denoted by x_1^h , subsidizes a small decrease in tax on commodity 2, denoted by x_2^h so as to keep total revenue constant. The first-order approximation to the change in social welfare is

$$dW = \sum_h \left(v_1^h dP_1 + v_2^h dP_2\right) \quad (9)$$

where v_i^h is the derivative of the h'th household's utility with respect to the the i'th price. Invoking Roy's identity, equation (9) can be written as:

$$dW = \sum_h -\lambda^h \left(x_1^h dP_1 + x_2^h dP_2\right) \quad (10)$$

where λ^h is the marginal utility of income of the h'th household. Turning to the revenue constraint of government, total commodity tax revenue, R can be expressed as

$$R = \sum_k t_k X_k \quad (11)$$

where $X_k = \sum_h x_k^h$ and t_k is ad valorem tax rate applied to the k'th commodity (there are k taxed or subsidised commodities in all and the producer prices are normalised to one). For tax revenue neutrality to hold, it is required that

$$dR = \left[X_1 + \sum_k t_k \frac{\partial X_k}{\partial P_1}\right] dP_1 + \left[X_2 + \sum_k t_k \frac{\partial X_k}{\partial P_2}\right] dP_2 = 0 \quad (12)$$

Manipulating equation (12) algebraically in the following manner yields:

$$dP_1 = \frac{\left[X_2 + \sum_k t_k \frac{\partial X_k}{\partial P_2}\right]}{\left[X_1 + \sum_k t_k \frac{\partial X_k}{\partial P_1}\right]} dP_2$$

$$= \frac{\left[1 + \left(\frac{1}{X_2}\right) \sum_k t_k \frac{\partial X_k}{\partial P_2}\right] X_2}{\left[1 + \left(\frac{1}{X_1}\right) \sum_k t_k \frac{\partial X_k}{\partial P_1}\right] X_1} dP_2$$

$$= \alpha \frac{X_2}{X_1} dP_2 \quad (13)$$

where α is the ratio of the marginal cost of public funds and therefore it captures the efficiency dimension of the tax substitution. Yitzhaki and Thirsk (1988) interprets it as the differential welfare cost of raising public funds by taxing, in this case, commodity 1 more heavily and using the proceeds to subsidize commodity 2. Given that I do not deal with efficiency issues in this Chapter, I do not dwell on the interpretation of α.

Substituting equation (13) into (10) and re-arranging terms yields the following principal result under the concept of welfare dominance.

$$dW = \sum_h -\lambda^h \left[\frac{x_2^h}{X_2} - \alpha \frac{x_1^h}{X_1}\right] X_2 dP_2 \quad (14)$$

If the expression in (14) is positive, then there is an improvement in social welfare due to the tax change. By definition, λ^h is positive but a decreasing function of income and given the experiment assumed, dP_2 is negative. Thus, for expression (14) to be positive and therefore, for household h to benefit from the tax change, it follows that

$$\frac{x_2^h}{X_2} - \alpha \frac{x_1^h}{X_1} \geq 0$$

If the inequality is reversed then that household's welfare is reduced by the tax change. The necessary condition for equation (14) to hold, for all admissible social welfare functions, is that for the poorest household consuming x_2^1 and x_1^1:

$$\frac{x_2^1}{X_2} - \alpha \frac{x_1^1}{X_1} \geq 0$$

The next poorest household consuming x_2^2 and x_1^2 experiences an increase in welfare if

$$\frac{x_2^2}{X_2} - \alpha \frac{x_1^2}{X_1} \geq 0$$

However, even if the second household was harmed by the tax change, aggregate welfare could still increase. Generalizing from the above arguments, the requirement for welfare dominance is that for a revenue-neutral commodity tax reform which shifts the tax burden from the j'th to the i'th commodity, social welfare will increase if the following condition is satisfied:

$$\sum_h \left(\frac{x_j^h}{X_j} - \alpha \frac{x_i^h}{X_i} \right) \geq 0, \text{ for all k} \qquad (15)$$

The expression in the brackets of equation (15) is simply the vertical difference between the concentration curve for commodity j and the concentration curve for commodity i multiplied by α. If the value of α is unity, welfare dominance occurs whenever one concentration curve lies wholly above another throughout the entire distribution. If the concentration curve of one commodity lies above the concentration curve of another commodity, then the first commodity dominates the second. This implies that a small tax decrease in the first commodity accompanied by a tax increase in the second, keeping revenue constant, increases welfare. In other words, the tax on the first commodity is regressive compared to the second commodity in that the poorer households pay more taxes associated with the first commodity than the second commodity. Non-dominance occurs if concentration curves cross.

Apart from comparing tax concentration curves to each other to determine progressivity of taxes, I also compare tax concentration curves with the Lorenz curve of income, which in my case is the Lorenz curve of expenditure. The graphical illustration in Figure 2.2 shows the Lorenz curve of income. The concentration curve for a tax can also be drawn in the same figure.

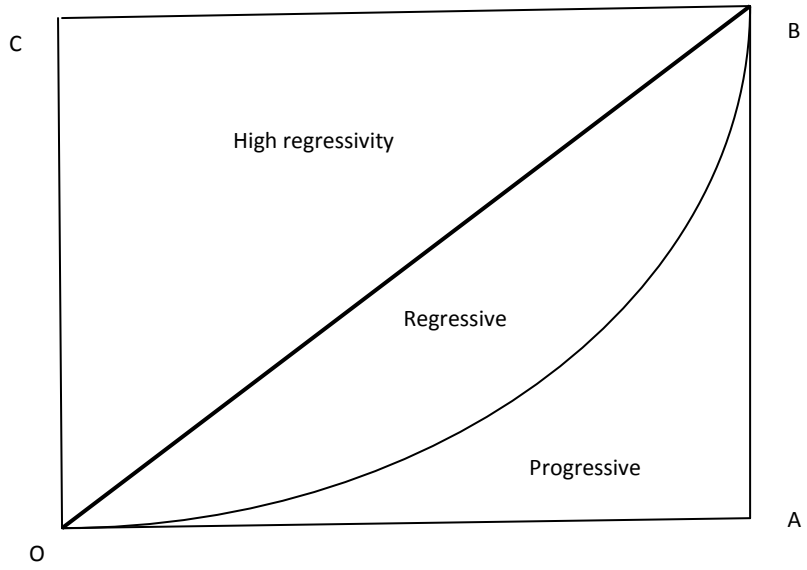


Figure 2.2: Concentration Curve for Taxes

According to Kakwani (1977a), tax progressivity is related to the concept of tax elasticity. Tax elasticity is simply the responsiveness of the tax function to income. Since tax elasticity is always unity for proportional taxes, the magnitude of the difference of the tax elasticity from unity, denotes a measure of tax progressivity. The distance between the tax concentration curve and the Lorenz curve of income depends on tax elasticity. Thus if tax elasticity is unity at all income levels, the two curves coincide and the tax is said to be proportional.

It is shown in Kakwani (1977b), that the larger the difference of the tax elasticity from unity, the greater is the distance between the Lorenz curve of income and the tax concentration curve. A tax is progressive (regressive) if its concentration curve lies anywhere below (above) the Lorenz curve. Thus, the most progressive tax is the one whose concentration curve lies the lowest. The tax will be highly regressive if its concentration curve lies above the line of equality, OB.

Although visual inspection of a concentration curve in comparison with another concentration curve or the Lorenz curve may give an impression whether there is dominance, it is not sufficient to conclude whether or not dominance is statistically significant. Thus, in addition to visual observation, I use the multiple comparison approach (MCA) to test for dominance (see Sahn and Younger, 2000). In this approach standard errors for 19 evenly spaced ordinates on each curve are computed

and are used to test for differences between the ordinates taking into account multiple testing. The decision rule is that if there is at least one ordinate at which curve A lies significantly above curve B and there is no ordinate at which B lies above curve A, then curve A dominates curve B.

If the concentration curves intersect, however, then non-dominance occurs and the test is inconclusive. In order to draw conclusions, I make use of the extended Gini as outlined by Yitzhaki and Thirsk (1988). The extended Gini is a weighted integral of the area between the 45-degree straight line and the Lorenz curve. The formula for the extended Gini is:

$$G(v) = -\frac{cov(y, [1 - F(y)]^{v-1})}{\mu_y} \; ; v > 1.$$

Here v is a parameter chosen by the investigator capturing inequality-aversion, F(y) is a cumulative tax payment, y measures the tax payment and μ_y is the mean value of the distribution. When v = 2, G(2) is the traditional Gini coefficient. The higher the v, the greater is the emphasis on the bottom of the expenditure distribution. In other words, the more weight is given to commodities consumed by the poorest households. When the extended Gini coefficient for a given tax is greater than the extended Gini coefficient of expenditure per adult equivalent, the tax is considered to be progressive.

2.3.1 Calculating the VAT burden.

The two key variables underlying the concentration curve for VAT are: the VAT paid, the distribution of which is my subject of interest; and a variable capturing welfare or living standards, against which the distribution is to be assessed. In tax incidence literature, the most commonly used variables to capture welfare are annual income per capita and expenditure per capita. However, the most preferred choice in the majority of studies is expenditure per capita or expenditure per adult equivalent (Bird and Miller, 1989; Munoz and Cho, 2003; Sonne-Schmidt, 2007). This is because while incomes tend to fluctuate overtime, people tend to try to maintain their level of consumption over time. Thus, current household expenditure is a better measure of permanent income of a household.

Following this argument, I use household expenditure per adult equivalent as a variable defining welfare in my analysis. Compared to using expenditure per capita which uses household size, expenditure per adult equivalent recognises the fact that households enjoy a certain degree of economies of scale in consumption. I use the adult equivalent scale from the LCMS (2004) report to calculate household expenditure per adult equivalent.

On the basis of Sahn and Younger (2002), I calculate VAT paid by each household as follows:

$$T_{ih} = t_i P_{ih} x_{ih} \tag{16}$$

where t_i is the statutory VAT rate and the VAT paid by a household h on commodity i is T_{ih}, which is a proportion of tax exclusive value of purchases. However, what are observable at household level are tax inclusive values of purchases formally defined by

$$e_{ih} = P_{ih} x_{ih} + t_i P_{ih} x_{ih} = (1 + t_i) P_{ih} x_{ih} \tag{17}$$

Re-arranging equation (17) yields the value of tax exclusive purchases

$$P_{ih} x_{ih} = \frac{1}{(1+t_i)} e_{ih} \tag{18}$$

Substituting for the expression of the value of tax exclusive purchases in equation (16) yields the following equation for the calculation of VAT paid by each household:

$$T_{ih} = t_i P_{ih} x_{ih} = \frac{t_i}{(1+t_i)} e_{ih} \tag{19}$$

I make use of equation (19) to calculate VAT paid, where t_i is the statutory VAT rate at 0.17 which is uniform for all goods and e_{ih} is the expenditure by a household on each good. The household expenditure data and adult equivalent scales are obtained from the Living Conditions Monitoring Survey (LCMS) for 2004, a nationally representative household survey conducted by the Central Statistical Office (CSO) in Zambia.

2.4 The Household Survey Data

The LCMS collects data at individual household level on various variables among them, household expenditure patterns. It covers both urban and rural areas in all the nine provinces of Zambia. For the 2004 survey a total sample of 19,340 households was drawn from a total of 2,110,640 households in Zambia. The LCMS (2004) covers expenditure items under the following broad categories:

- Food and non-alcoholic beverages
- Alcoholic beverages, cigarettes and tobacco
- Housing
- Public and private transport
- Clothing and foot ware
- Health services
- Education
- Remittances
- Personal care

Given the list of expenditure items, there are a few important issues that have been noted and taken care of, where possible when calculating the burden of VAT. Firstly, the list of expenditure reported in the LCMS (2004) only includes household expenditure on food, non-food re-current goods and services. The list does not report expenditure on durables. Thus, my analysis only covers VAT paid on non-durables similar to the study by Sonne-Schmidt (2007). Given that the commodities included in the study are most frequently purchased, the study is still able to provide a good approximation of the distribution of total VAT payments.

Secondly, it is important to recognize that even if a commodity is subject to VAT, the tax may not be levied or collected. This includes sales of small businesses, street and neighboured sales, and other informal sector transactions. The prevalence of transactions outside the VAT net is not only common in rural areas of Zambia where the informal sector is more dominant but has an appreciable presence particularly among the urban low income earners. Thus, consumption that is subject to VAT for

generally low income households tends to be lower than that for higher income households. Furthermore, certain commodities are likely to be more VAT compliant than others owing to the fact that their sales will partly or fully occur in the formal sector.

In order to take into account the differences in VAT compliance across households and commodities, I apply tax compliance coefficients on commodities by urban and rural areas. This method is akin to the study by Jenkins et al (2006). The difference is that the survey data used by Jenkins et al included information on types of establishments where the commodities where purchased. So they estimated their tax coefficients by commodity and establishment. I estimate my tax compliance coefficients wholly on the basis of the nature of the commodity but allowing them to differ by urban and rural.

I make use of the information on VAT compliance in Zambia from Pellechio and Hill (1996) and tax coefficients estimated by Jenkins et al (2006). Pellechio and Hill put the overall VAT compliance for Zambia at 0.5 in their study at the inception of VAT in 1995. The tax coefficients in Jenkins et al (2006) range from 0.65 to 1.00 with 0.70 as an estimate for compliance were establishment was unspecified. I allow my tax compliance coefficients to vary from 0.5 to 1, taking 0.7 as a median estimate. The resulting compliance coefficients are presented in Table 2.1. Looking at a commodity such as sugar, even though it will be sold by street vendors or neighboured stores VAT is levied and collected by the wholesaler or major retailer from where the vendor sourced the sugar. Therefore, its tax compliance is approximately equal to 1. This is bearing in mind that transport margins can be so high in some instances and therefore would entail a lower compliance coefficient due to VAT forgone on these margins. The tax compliance coefficient for alcohol and tobacco is equal to 0.7 and 0.5 for urban and rural areas, respectively. This is because these commodities are likely to be produced in the informal sector. The remainder of the compliance coefficients are estimated along the same lines allowing them to vary from 0.5 to 1. I multiply the VAT rate by these coefficients to arrive at VAT paid on these commodities.

Table 2.1: VAT Compliance Coefficients

Commodity	Rate	Compliance coefficient – Urban	Compliance coefficient - Rural
All food except listed below	E	-	-
Processed dairy products	S	1	1
Cooking oil	S	1	1
Eggs	S	0.7	0.5
Sugar	S	1	1
Honey	S	0.7	0.5
Wheat products	S	1	1
Non-alcoholic beverages	S	1	1
Alcoholic beverages	S	0.7	0.5
Tobacco products	S	0.7	0.5
Kerosene	E	1	1
Diesel for cooking & Lighting	S	1	1
Petrol/diesel/Lubricants	S	1	1
Clothing & footwear	S	0.7	0.5
Toiletries & Cosmetics	S	1	1
Other personal care articles	S	1	1
Water	E	-	-
Electricity	S	1	1
Rent	E	-	-
Home maintenance	S	0.7	0.5
Vehicle maintenance	S	0.7	0.5
Public transport	E	-	-
Education	E	-	-
Health services	E	-	-
Telecommunications	S	1	1

E= VAT exempt S= VAT standard rate
Source: ZRA VAT liability guide and Author's estimations

The third important issue is that some commodities are VAT exempt. Therefore they do not attract VAT on their final sales. However, they have VAT embedded in them since producers are not allowed a rebate on VAT paid on inputs in the production process. This is on assumption that the VAT on inputs is shifted to the consumer. Edminston and Bird (2007) outlines a method for estimating embedded tax which would require the use of an input-output matrix for taxed and VAT exempt supplies in Zambia. The input-output matrix would yield the value of intermediate sales of taxed commodities to exempt sectors. Based on this, the average input VAT paid by each exempt sector can be calculated. Dividing this average input VAT paid by the average total output of the exempt sector would yield an effective VAT rate embedded in the final sales of exempt commodities. This rate will lie between 0 percent and the applicable standard rate for VAT. It is this rate that would replace the statutory VAT rate t_i in equation (19) for household expenditure on VAT exempt commodities. However, due to the unavailability of adequate data on the input-output matrix for VAT commodities to exempt commodities, I was not able to take this issue into account.

2.4.1 Household Expenditure Summary Statistics

In Table 2.2, I present summary statistics with an eye to VAT, on household expenditure used in the study. The statistics are on the general household characteristics and budget shares of taxed commodities in total expenditure.

Table 2.2: Household Expenditure Statistics

	Total	Rural	Urban
General Characteristics			
Household size (average)	5.3	5.3	5.4
Adult equivalent (average)	4.6	4.5	4.7
Average monthly expenditure/adult equiv (ZMK)	230,395	150,404	323,175
Positive consumption (%)	96.6	94.2	99.4
Sample (households)	19,292	10,360	8,932
Budget Share (%)			
Total taxed commodities	25.6	19.0	33.2
Food	6.8	4.5	9.2
Non-Food	18.8	14.5	24.0
Alcohol	1.0	0.7	1.2
Ciggarette/tobacco	0.2	0.3	0.2
Electricity	1.2	0.1	2.4
Candles	0.6	0.3	0.9
Diesel for cooking & lighting	0.2	0.2	0.04
Petrol/diesel/oil	0.3	0.2	1.2
Telephone	0.6	0.1	0.4
Toiletries	4.7	4.0	5.5
Cosmetics	1.5	1.1	2.0
Cloth & Footware	8.3	7.2	9.6
House maintenance	0.03	0.01	0.1
Vehicle maintenance	0.1	0.08	0.2

Source: Author's calculations on the basis of LCMS 2004

The average household size in the sample was 5.3 while the average adult equivalent was 4.6. This brings out the concept of economies of scale in consumption since a higher standard of living per individual is associated with the use of adult equivalents compared with the use of household size. The average monthly expenditure per adult equivalent in 2004 was K230,395 (approximately US$48) with K150,404 (approximately US$32) for the rural area and K323,175 (approximately US$68) for the urban area.

The proportion of households reporting positive consumption on taxed commodities and hence more likely to be affected by VAT was around 97 percent. This proportion was higher for the urban area (99.4 percent) than rural area (94.2 percent). The households with zero consumption of taxed commodities were dropped from the analysis.

According to Table 2.2, only 25 percent of total expenditure on non-durables attracted VAT in 2004, with urban households (33.2 percent) spending more on taxed commodities compared to rural households (19 percent). Ebrill et al (2001), estimates that in developing countries and also in some developed ones, the VAT is actually levied on only about 50 to 70 percent of the total value of goods and services consumed. Even though my study covers only consumption on non-durables, an estimate of 25 percent indicates that even if consumption on all commodities were considered, the proportion attracting VAT is likely to be on the lower end of the 50 to 70 percent range. This is taking into consideration the fact that only a small proportion of the population in Zambia is likely to engage in the consumption not recorded in the survey.

In both the urban and rural areas, the highest proportion of expenditure on taxed commodities was for clothing and foot ware followed by food. However, urban households' expenditure on food was nearly as large as their expenditure on clothing. Hence, urban households' spent more on taxed food compared to rural households. While on the overall, urban households spent a higher proportion of their budget on taxed commodities, exceptions can be noted for particular commodities. These are expenditures on tobacco, cigarettes and diesel for lighting and cooking. For the diesel for lighting and cooking, this is expected since rural areas are less widely electrified than urban areas. While rural households may spend more on tobacco and tobacco products than urban households, they are likely to pay less VAT on these products. This is because rural households are likely to purchase more traditional brands of tobacco from the informal sector than tobacco products from the formal sector. When compliant and non-tax compliant commodities are combined together in one expenditure category, it leads to what Younger (1993) refers to as 'category confusion'. This may lead to an over-estimation of tax burdens. Thus, the importance of applying VAT compliance coefficients is delineated.

2.5 Results on the Distribution of the VAT Burden

I present results for the distribution on all households of the total VAT burden, the food versus non-food VAT and of VAT on cigarettes/tobacco, alcohol and cosmetics. I also present results on the same categories but with a rural-urban split. I find all the

dominance test results to be significant on the basis of the multiple comparison approach (MCA) rule.

2.5.1 Effective VAT rates by Expenditure Decile

Table 2.3 shows the effective VAT rates for each expenditure decile. The effective VAT rates are obtained by dividing the total VAT paid across all commodities by the average total expenditure for the year for each decile. Results suggest that the incidence of VAT is roughly progressive across the bottom eight deciles; that is, the average person in each decile pays more VAT as a proportion of total spending as one move up the deciles. However, the system becomes regressive as individuals enter the remaining top two deciles. The average person in the highest expenditure group (decile 10) pays 2.78 percent of total spending in VAT, or just 12 percent more than the 2.47 percent paid by those in the lowest expenditure group (decile one).

Table 2.3: Effective VAT rates by Expenditure Decile

Expenditure decile	Average expenditure per adult equivalent per year (ZMK)	VAT rate
1	192,445	2.47
2	403,450	2.55
3	588,436	2.67
4	783,322	2.88
5	1,028,913	3.09
6	1,333,807	3.18
7	1,783,950	3.47
8	2,527,725	3.62
9	4,104,239	3.43
10	14,000,000	2.78

Author's calculation using LCMS 2004.

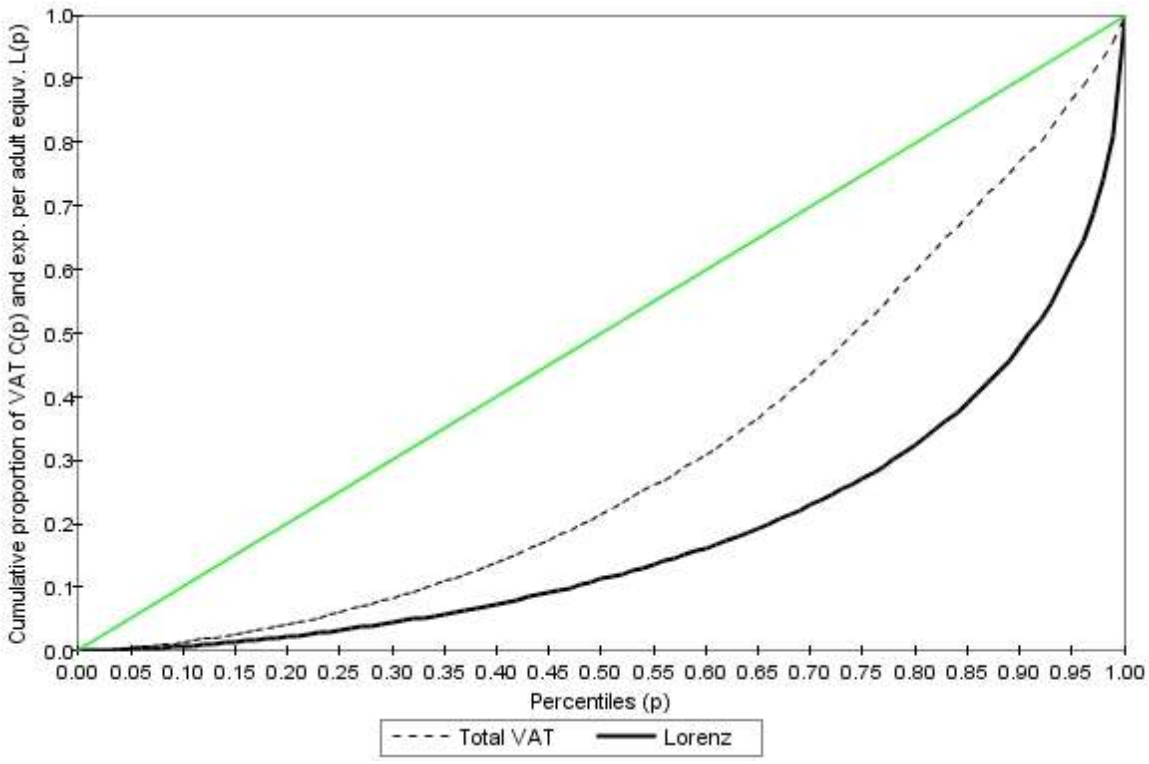
This is far below the 46 percent that the eighth decile pays more than the lowest decile. Given the wide differences in the average expenditure per adult equivalent of the two top deciles compared to the remaining deciles, the results suggest that the richest expenditure groups face the lowest effective tax rates. This is an indication of an increasing proportion of expenditure on exempted commodities in total expenditure as one move up the deciles. Essentially a zero VAT rate is applied on these expenditures in this analysis given that embedded VAT paid on inputs was not accounted for as pointed out in the caveat above. However, the picture may not change significantly given that a lower VAT rate than the standard VAT rate would be applied in the calculation of embedded VAT on exempt expenditures.

While it is not certain how the picture would look like if consumption of durables is included, the rough indication that can be drawn here is that for spending on regularly consumed commodities in Zambia, VAT is regressive. In order to confirm this rough result, I now analyse the concentration curves of VAT.

2.5.2 Welfare Dominance Results – Total VAT

Figure 2.3 shows that concentration curve for VAT at national level dominates the Lorenz curve of expenditure. Therefore VAT in Zambia is regressive. A number of studies on the incidence of VAT have also found similar findings. Fourie and Owen (1993) and Kearney (2003) found VAT to be mildly regressive in South Africa. Monoz and Cho (2003) also obtained a similar result for Ethiopia.

Figure 2.3: Concentration Curve of Total VAT Payments

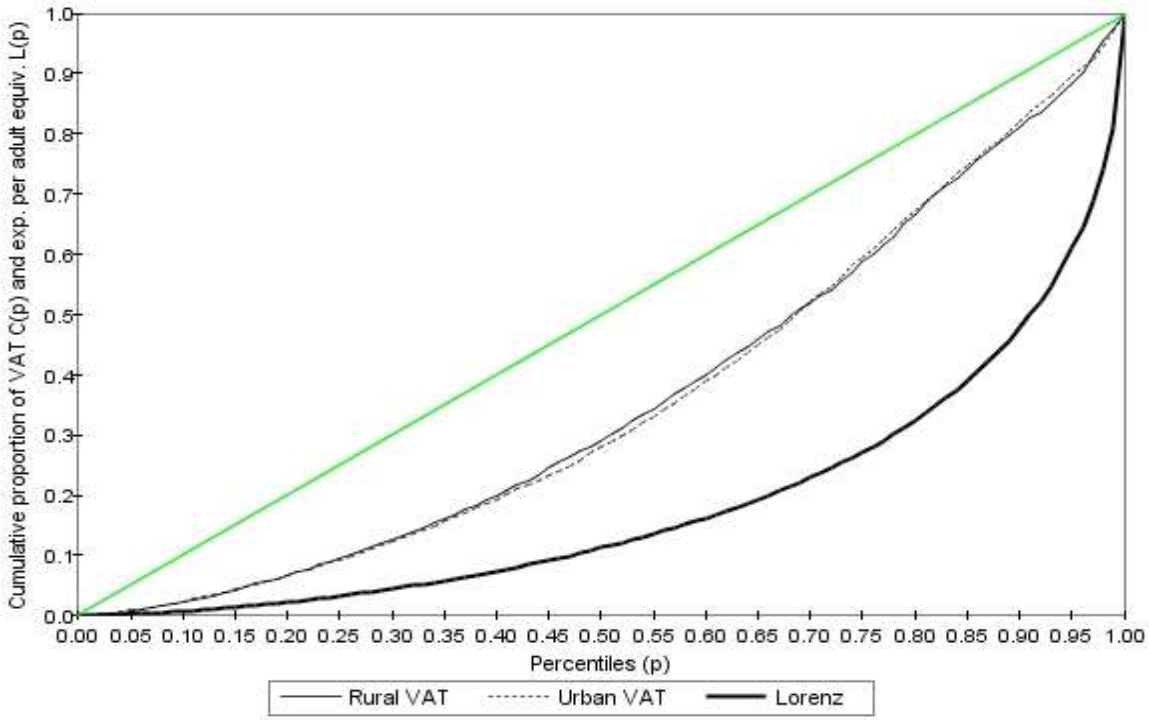


Owing to the fact that the calculations exclude VAT paid on durables, this result can be viewed as being indicative only. Perhaps the regressivity of VAT may be reduced if the tax on durables were taken into account as higher income households tend to spend more on these goods than lower income ones. However, this finding that VAT

is regressive based on welfare dominance confirms the finding above based on the effective VAT rates faced by different deciles. Important to note is that the results reveal that VAT is regressive notwithstanding the exemptions of a number of commodities on socio-economic grounds.

A much richer analysis would be to compare the distribution of the VAT burden between the rural and urban areas. Figure 3.4 plots the concentration curves for VAT payments in rural and urban areas on Zambia.

Figure 2.4: Concentration Curves for VAT Payments by Rural-Urban



Visible inspection of the graph as well as significance tests based on the MCA rule shows that non-dominance occurs. In other words, the concentration curves for VAT payments for rural and urban cross and therefore the dominance test is inconclusive. In order to draw a conclusion I apply the extended Gini approach. According to this approach when the extended Gini coefficient for a given tax is greater than the extended Gini coefficient of expenditure per adult equivalent, the tax is considered to be progressive. The extended Gini coefficients for payments of VAT in urban and rural areas plus the extended Gini for expenditure are presented in Table 2.5.

Table 2.4: Extended Gini-Coefficients of VAT Payments by Rural-Urban

V	Rural VAT	Urban VAT	Expenditure
2	0.592	0.493	0.634
4	0.814	0.721	0.807
6	0.883	0.797	0.856
8	0.918	0.836	0.882
10	0.939	0.860	0.898

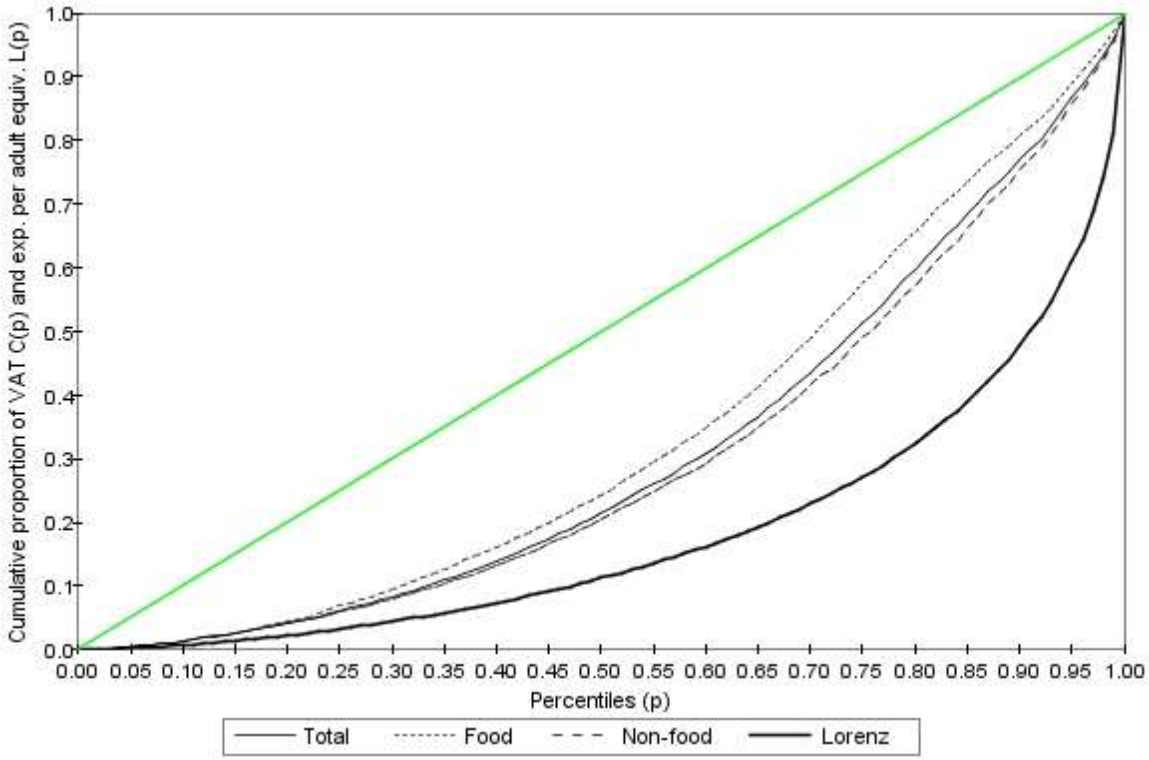
Source: Author's calculations

By attaching a higher weight to commodities consumed by the poorest households (that is, as V increases), VAT paid by the rural households becomes progressive while VAT paid by urban households remains regressive. Thus, the urban households pay more VAT relative to their expenditure compared to rural households.

2.5.3 Welfare Dominance – Food and Non-food VAT

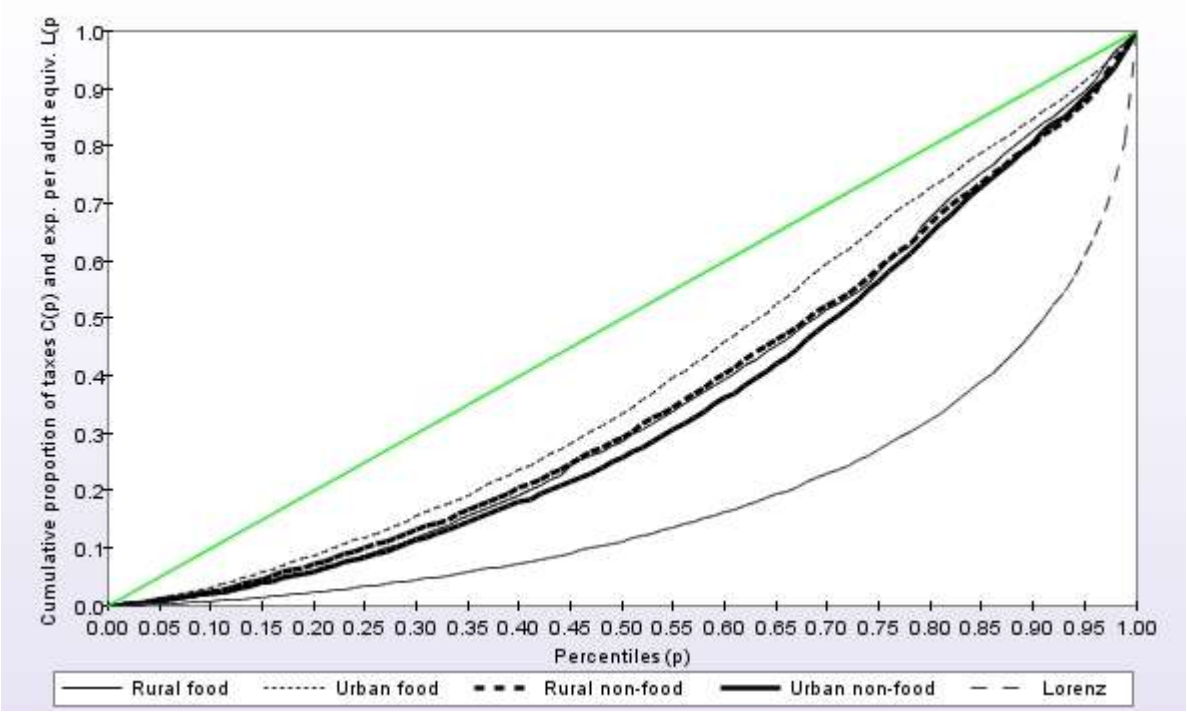
The argument that poorer households dedicate a greater proportion of their total expenditure on food lies behind the practice of exempting food items largely consumed by poorer households from VAT in a number of countries. Therefore, the analysis of food versus non-food VAT offers an interesting angle because it is likely to reveal the actual impact of the existing exemptions VAT. Figure 2.5 presents welfare dominance results for food and non-food VAT.

Figure 2.5: Concentration Curves for Food and Non-food VAT



Food VAT dominates non-food VAT implying that VAT on food is more regressive than VAT on non-food. The poorer households pay more VAT on food relative to their expenditure than the richer households. This indicates that excluding most food items from the tax base has not done much to make VAT less regressive for the poor.

Figure 2.6: Concentration Curves for Food VAT and non-food VAT by Rural and Urban.

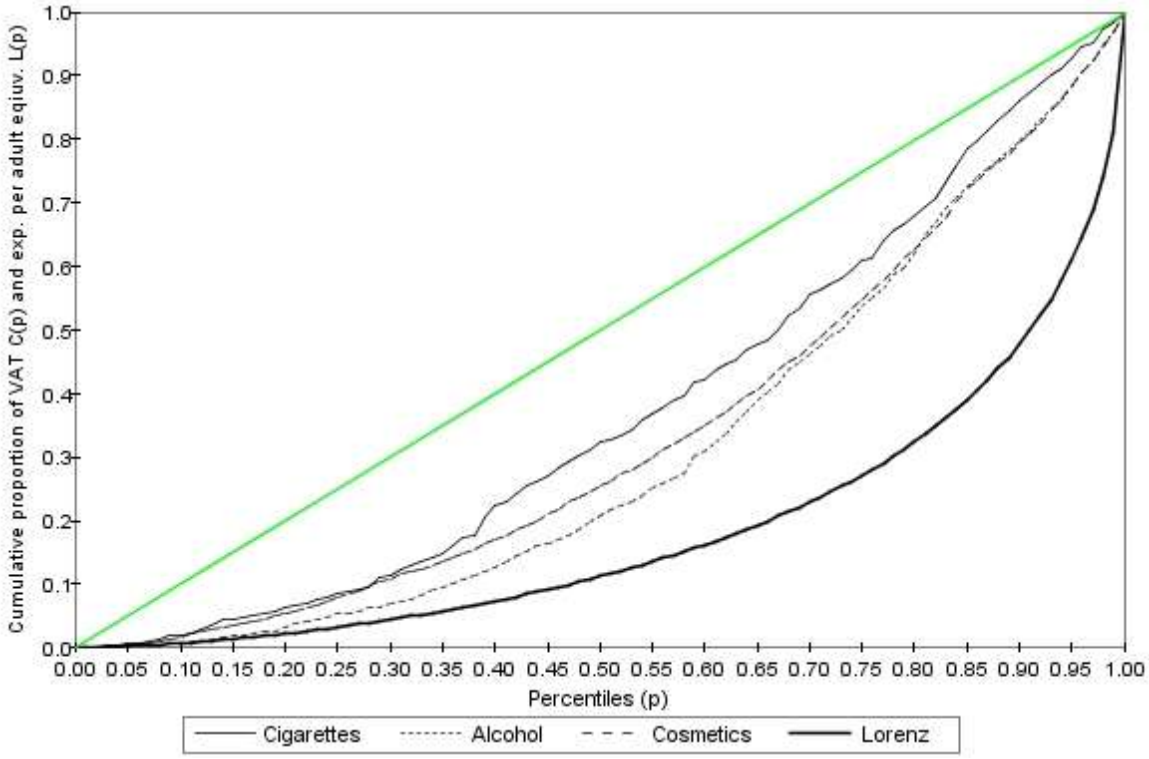


To explore this further, Figure 2.6 plots the concentration curves for food and non-food VAT by rural and urban. As can be observed from the graph, urban food VAT dominates rural food VAT. This means that urban households bear a heavier burden of VAT on food compared to rural households. Specifically, the poorer households who pay more VAT on food relative to their expenditure are in the urban areas. Figure 2.6 also shows that for the rural households, non-food VAT is more regressive than food VAT.

2.5.4 Welfare dominance – Cigarettes, Alcohol and Cosmetics

The results in Figure 2.7 show that VAT on cigarettes is more regressive than VAT on alcohol while the least regressive is VAT on cosmetics. Poorer households bear a heavier burden of the tax on cigarettes and alcohol compared to richer households. While category confusion may still persist in the data despite applying compliance coefficients, there is another factor which may make the tax burden appear more regressive than it actually is.

Figure 2.7: Concentration Curves for VAT on Cigarettes, Alcohol and Cosmetics



According to Younger (1993) in his study on tax incidence in Ghana, households with large expenditures on alcohol and tobacco are more likely to under-report their true consumption in the expenditure survey. If, in addition, consumption of these items increases more proportionally with income, richer households will have under-reported their consumption by proportionally more than poorer ones. Hence, the tax burden for alcohol and tobacco in this study may also be affected by what Younger observed in the study on Ghana.

2.6 Discussion and Conclusion

In this Chapter I have applied welfare dominance to compare the distribution of the burden from VAT in Zambia. The results obtained while rough, can help to inform the debate on VAT reforms in Zambia. The first finding shows that nationally VAT is regressive. This is notwithstanding exclusion from its base items that are considered to be heavily consumed by poorer households relative to their expenditure. Secondly, when the distribution of the VAT burden is split between the rural and urban area, VAT paid by rural households is found to be progressive while VAT paid by urban households is regressive. If it is true that the poor are mostly found in the rural area then the exclusion from the base of most food items at first instance may appear to be achieving its intended objective. However, according to the LCMS (2004) survey, rural households consumed a larger proportion of agricultural food commodities out of own produced commodities compared to their urban counterparts. This indicates that the policy of exempting food items may have a very limited impact on the food expenditure for rural households.

Consequently, while food VAT is found to be more regressive than non-food VAT, its tax burden is heavier on urban households than rural households. This is an indication that allowing most food items to be purchased on an exempt basis extends the tax relief to individuals and households with moderate high incomes.

Overall, what can be concluded from the foregoing is that VAT in Zambia is regressive and it is the urban low income households who bear the heaviest burden.

This finding corroborates those of most studies as observed by Steenkamp (2005) that not so much redistribution is taking place through the fiscal system from the tax side. It is on this basis that literature along the same lines argues that the objective of improving the position of the poor people is best pursued through the expenditure side rather than the tax side of the national budget (Brashares et.al., 1988, Steenkamp, 2005).

VAT is just one of the taxes in the tax system in Zambia and therefore inference on the regressiveness of the whole tax system cannot be made on the basis of findings in this Chapter alone. However, the findings indicate to the fact that perhaps equity considerations should not be addressed through VAT. The current level of development in the economy dictates that a modest proportion of expenditure by households will continue to be directed at informal sectors, which are largely excluded from VAT either due to threshold purposes or by design. Thus, if VAT was reformed in such a manner that it would raise additional revenue to finance social sector expenditures such as provision of education, health and infrastructure services, it would be more effective in addressing equity issues and therefore reduce poverty levels.

The finding in this Chapter that the burden of VAT is largely borne by urban households who are relatively better off compared to the rural households indicates that VAT can be extended to cover some of the currently exempted items at low welfare cost. This would create fiscal space to undertake more activities as envisaged in the Fifth National Development Plan (FNDP) 2006-2011.

CHAPTER 3 : REFORMING THE VALUE-ADDED TAX – A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

3.1 Introduction

The adoption of value-added tax (VAT) has been central to tax reforms undertaken in most developing countries in the past few decades. Consequently, as estimated by Ebrill et al (2002), about 70 percent of the world's population now live in countries with a VAT. Given this overwhelming presence of VAT, the tax policy issue is no longer whether to adopt or not to adopt VAT. Rather, the outstanding tax policy issue is how to properly design the VAT or improve on the existing design. As observed by Tanzi and Zee (2000), the VAT adopted in most developing countries often suffers from imperfections in its application in one form or another. For example, a number of countries use multiple VAT rates as opposed to the prescribed single rate. Furthermore, there is a strong tendency to exclude a number of sectors from the VAT base in these countries. According to VAT literature, such imperfections in VAT design undermine the proper functioning of VAT.

The VAT as adopted in Zambia largely reflects what Ebrill et. al. (2002) refer to as 'best practice' in VAT design. Nevertheless, Zambia's VAT system deviates from 'best practice'. Firstly, it includes a number of goods other than exports under the zero rate. Secondly and most important, it has a relatively substantial number of exclusions in terms of VAT exempt sectors or commodities. This implies that the VAT base is relatively narrow. Hence, one of the key issues to improving VAT design in Zambia lies in addressing this narrow coverage.

A step towards addressing the problem of narrow coverage entails assessing the existing VAT exclusions. This is because in Zambia, formulation of VAT exclusions has been largely guided by general principles of VAT design. One principle for example, is that VAT should exclude commodities that are highly consumed by the poor. Consequently, the bulk of the agriculture and food sectors are VAT exempt among other exemptions.

While all this may have been worked out sensibly, what is not taxed or taxed need informed re-visiting from time to time. This is because circumstances change and what is sensible may well change also. Thus, in general, VAT reform needs to be an ongoing process. Given the growing need for government to raise more revenue from the tax system, the option of extending the VAT coverage remains one of the major contending proposals in the VAT reform process in Zambia. VAT exemptions not only narrow VAT coverage, they also distort producers' resource allocation decisions due to cascading of input VAT. In this light therefore, the existing VAT system in Zambia requires to be assessed for the possibility of broadening VAT coverage.

Given the foregoing, my aim in this chapter is to assess options on broadening VAT coverage in Zambia and their potential effects on the economy. Specifically, I carry out two major simulations in order to assess the economic impact of broadening VAT in Zambia. The first simulation involves increasing the actual VAT rate in all sectors. This experiment mimics a general VAT reform towards a full VAT whereby the VAT system covers all sectors with very minimal exceptions. This would be the ultimate stage in VAT reform. In Zambia, a number of common place VAT exemptions exist for supplies such as agriculture commodities, public services, financial services and other private services. There has been a movement from exemption to full taxation in a number of these common place exemptions particularly in developed countries. For developing countries, a review of such moves to full taxation is likely to take a slot on the VAT reform agenda in future and therefore it is useful in this study to take a snapshot of the likely impacts of such a move. In this study, the full VAT experiment is also used as a benchmark for comparing the results obtained from the second simulation, which is the key experiment, so as to determine whether the model reacts in a consistent way to the simulations.

The second experiment is a subset of the first experiment and is the main focus of this Chapter. The experiment entails widening VAT coverage to the agriculture sectors minus maize sector. The experiment mimics the government's decision in the 2006 National Budget to standard rate agriculture except for maize, maize meal and infant food. The maize sector is a source of Zambia's staple food, maize meal, and leaving it

out of the VAT base in the decision was largely guided by socio-economic reasons. This decision to extend VAT coverage was an initial attempt by government to address the issue of a narrow VAT coverage by bringing in more sectors under the VAT net than currently exists. However, this decision was abandoned before it came into effect due to subsequent outcries from various quarters of the economy regarding the likely impact of such a move. Thus, agriculture supplies were re-classified as VAT exempt.

According such special treatment to agriculture does not only exist in Zambia or developing countries for that matter. Many EU countries do practice this as well. As noted by Ebrill et al (2002), this special treatment of agriculture under VAT is largely attributed to two distinctive features of the sector. The first one being that the sector is largely dominated by producers in the informal sector and hence compliance and administrative costs are likely to be high. The second feature concerns the key role that the agriculture sector is perceived to play in the pursuit of wider distributional objectives. There are a number of differing views on these two points. However, the over-arching conclusion is that there is nothing inherent in agriculture that entails that it should not be subject to VAT. Therefore, a move towards taxing agriculture like any other sector, subject to the normal threshold should be part of the agenda of on-going VAT reform.

I analyze the impact of the agricultural VAT reform using a computable general equilibrium (CGE) model for the Zambian economy. Specifically, I focus on the macro-economic, sectoral and household consumption impacts. The use of general equilibrium models in tax policy is not new. It was pioneered by Harberger (1962) and was later extensively applied by Shoven and Whalley (1972). Shoven and Whalley (1984) provide a survey of CGE models applied to tax policy mostly for developed countries. The use of CGE models for tax policy in developing country context has also gained momentum. Examples dealing specifically with indirect tax policy in developing countries include Bovenberg (1987), Ajakaiye (1999), Chia et al (1999), Emini (2000), Rege (2002), Bye et al (2003), Kearney (2003), Levin (2005) and Go et. al. (2005).

A CGE model is an appropriate tool for such analyses because it provides a disaggregated view of the economy and thereby yields quantitative estimates of all important interactions. However, VAT modelling within a CGE framework is still in its infancy and literature remain thin on the ground.

The CGE model I use in this study is adapted from the standard CGE model developed by Lofgren et al (2002) for the International Food Policy Research Institute (IFPRI). The model was developed to be used with a number of Southern African countries' data. Zambia was one of these countries. However, the IFPRI model was not exclusively developed to analyse VAT. Therefore, it does not specifically model how VAT operates. Hence, I make adjustments to the model, borrowing from literature that has attempted to model VAT within the CGE framework. The key literature I use is by Emini (2000), Go et al (2005) and Levin (2005). I call the resulting model, the Zambia CGE VAT model.

The static simulation results reveal that a move towards a full VAT with an income tax as a revenue recycling instrument (FULLVAT1 reform) has the highest ability to increase VAT revenue to GDP. This is in contrast to a full VAT reform which uses an endogenously determined VAT rate to recycle revenue (FULLVAT2) and a move to towards an agricultural VAT reform (AGRIVAT). However, FULLVAT1 is likely to induce the worst contarction largely due to a contraction in private consumption. At sectoral level, for both FULLVAT1 and FULLVAT2 the final market prices of sectors that had relatively low VAT coverage *ex ante* increase relative to the CPI. For AGRIVAT the relative final market prices increase in the agricultural sectors directly affected by the reform.

The changes in relative prices of final market prices for all the reforms filter into prices for intermediate inputs. Sectors which used intermediate inputs which initially attracted no or minimal VAT rebates experience the lowest fall in relative intermediate prices. The changes in intermediate prices due to the presence of VAT rebates appear to have a re-allocation effect, within value- added, beneficial to labour

as predicted especially under FULLVAT1 and AGRIVAT. The short-run redistribution of factor income from capital towards labour is observed. Thus, the model was able to capture the rebate system well.

The household welfare effects of all the reforms are negative. Under FULLVAT1 the welfare effects tend to be uniform across the small to medium scale farm households in rural areas and the 'low to medium' income households in the urban areas. The non-farm rural households experience the worst loss in welfare while the urban employer household and the large scale farmers experience the least loss. Under FULLVAT2, the welfare losses follow the same pattern as in FULLVAT1 but are very minimal. The loss in welfare arising from extending VAT coverage to the agricultural sector is more pronounced among urban households than rural households.

The overall conclusions from the foregoing are as follows. Extending the VAT coverage to all sectors with very minimal or no exclusions should be accompanied with reductions in the VAT rate, given that a full VAT reform with income tax as a recycling instrument proved to be the most welfare worsening scenario in the short run. Secondly, contrary to the widely held view in the debate on VAT reform in Zambia, extending the VAT coverage to agricultural sectors apart from maize sector is not likely to hurt the worse-off socio-economic groups. The short-run welfare losses of such a reform appear to be more disproportionately borne by the urban households whose incidence of poverty is low compared to the rural households.

The remainder of the chapter is organised as follows. In Section 3.2 I present the structure of the Zambia CGE VAT model with explicit specification of how VAT operates in the model. I discuss the implementation of the model in section 3.3. This Section covers the model data from the Social Accounting Matrix (SAM) to the free parameters (non-SAM-based). I include in this Section a discussion of benchmark statistics that have an important bearing on understanding the model results. I also describe in detail the simulations I conduct on the basis of the benchmark equilibrium.

In section 3.4, I present simulation results. In Section 3.5, discuss the major findings and make concluding remarks.

3.2 The Structure of the Zambia CGE VAT model

Computable general equilibrium models are theoretically grounded in neo-classical Walrasian general equilibrium theory. The underlying assumption of Walrasian models is that there exists a market-clearing-price-adjustment mechanism in both product and factor markets that yields a competitive equilibrium (Gunning and Keyser, 1995; Ginsbury and Keyser, 1997; Robinson, 2003). The work on general equilibrium theory was refined by Arrow and Debreu (1954) in their contribution on the existence of equilibrium for a competitive economy. Hence, CGE models are in economic literature are termed as applied cases of the Arrow-Debreu general equilibrium model.

The Zambia CGE VAT model, just like the IFPRI model on which it is based, stretches the neo-classical paradigm by including structuralist features such as unemployment. Furthermore, the neo-classical paradigm has been extended to allow for features that are prominent in a developing economy such as Zambia. These are home consumption of non-marketed goods and transaction costs or marketing margins in domestic and international trade. The overall framework of the model incorporates all flows in the economy starting from production to distribution and demand. The structure of the Zambia CGE tax model is explained in the next Sections and the following notation is adopted for the model:

Upper case letters are reserved for endogenous variables, unless they have a bar, in which case they are exogenous variables or normalising constants. Parameters and policy variables are denoted by Greek or lower case Latin letters. Producers or activities are indexed by $a \in A$. These activities produce commodities indexed by $c \in C$. The index set C is partitioned into three sets. These are exports $c \in CE$, domestic sales $c \in CD$ and, imports $c \in CM$. Factors used in production are indexed by $f \in F$. Households responsible for the supply of factors and consumption of

commodities are indexed by $h \in H$. Households belong to a set of domestic institutions $i \in INSD$, which includes government and enterprises. When these institutions do not include government, they are indexed by $i \in INSDNG$.

3.2.1 Production Structure

Producers are assumed to be constrained profit maximizers. The profit is the difference between the value of output and the total cost of inputs. Each producer maximises profits, taking prices as given, by choosing the level of output (QA) and level of inputs subject to technological constraints. Inputs include intermediate demands for commodities (QINT) and factor demands (QF). The technology is portrayed as a two-level nested technology. At the top of the nest, total output (QA) is a Leontief function of aggregate value-added (QVA) and aggregate intermediate input (QINTA). At the bottom level of the nest, QVA is a constant elasticity of substitution (CES) function of quantities employed of labour, capital and land (QF); and QINTA is a Leontief function of disaggregated intermediate inputs (QINT). Formally, this can be stated as:

$$\underset{QA,QF,QINT}{\text{Max}} PROFIT = PA_a(1 - ta_a)QA_a - \sum_c PQ_c QINT_{ca} - \sum_f WF_f \cdot WFDIST_{fa} QF_{fa} \qquad (1)$$

where PA is the price of the activity, PQ is the price of the commodities used as inputs, WF is the price of factors, $WFDIST$ is a wage distortion term and QF is the quantity of the factor and ta_a is indirect tax rate on production . This is done subject to the Leontief top level production technology:

$$QVA_a = iva_a QA_a \qquad (2)$$

$$QINTA_a = inta_a QA_a \qquad (3)$$

where *iva* and *inta* are the technical coefficients for value-added and composite intermediate input, respectively. This specification implies that the required combination of intermediates to value-added is determined by technology rather than from decision making of producers. The maximisation problem is also subject to a

bottom level technology where QVA is governed by a constant elasticity of substitution (CES) function of primary factors (labour, capital and land):

$$QVA_a = \alpha_a^{va}\left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{-\frac{1}{\rho_a^{va}}} \quad (4)$$

and the composite intermediate good combines various intermediates using a Leontief function:

$$QINT_{ca} = ica2_{ca} \cdot QINTA_a \quad (5)$$

In equation (4), α_a^{va} is the efficiency parameter in the CES value-added function, δ_{fa}^{va} is the CES value-added function share parameter, and ρ_a^{va} is the CES value-added function exponent. On the intermediate inputs side, *ica2* is the per unit quantity of the intermediate commodity in aggregate intermediate input for each activity. Substituting equation (3) into (5) and simplifying yields:

$$QINT_{ca} = ica_{ca} \cdot QA_a \quad (6)$$

Where *ica* (= i*ca2.inta*) is the quantity of intermediate input per unit of activity. Further substitution of equation (2) into (4), rearranging and simplifying yields:

$$iva_a \cdot QA_a = \alpha_a^{va}\left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{-\frac{1}{\rho_a^{va}}}$$

$$QA_a = \alpha_a^{qa}\left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{-\frac{1}{\rho_a^{va}}} \quad (7)$$

where α_a^{qa} (= α_a^{va} / *iva*) is the efficiency parameter in the production function. The profit maximisation problem may thus be restated as a maximization of equation (1) subject to equations (6) and (7). Substituting equation (6) into the maximand in (1) yields:

$$\underset{QA,QF}{\text{Max}}\ PROFIT = PA_a(1-ta_a)QA_a - \sum_c PQ_c ica_{ca} QA_a - \sum_f WF_f \cdot WFDIST_{fa} QF_{fa} \quad (8)$$

Forming the Lagrangian yields:

$$\mathcal{L} = PA_a(1-ta_a)QA_a - \sum_c PQ_c\, ica_{ca} QA_a - \sum_f WF_f\, WFDIST_{fa} QF_{fa} + \lambda\left(\alpha_a^{qa}\left(\sum_f \delta_{fa}^{va}\, QF_{fa}^{-\rho_a^{va}}\right)^{-\frac{1}{\rho_a^{va}}} - QA_a\right) \quad (9)$$

The first-order conditions for the producer's problem are:

$$\frac{\partial \mathcal{L}}{\partial QA_a} = PA'_a - \sum_c PQ_c \cdot ica_{ca} - \lambda = 0 \quad (10)$$

$$\frac{\partial \mathcal{L}}{\partial QF_{fa}} = WF_f \cdot \overline{WFDIST}_{fa} + \lambda \alpha_a^{qa}\left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{-\frac{1}{\rho_a^{va}}-1} \delta_{fa}^{va} QF_{fa}^{-\rho_a^{va}-1} = 0 \quad (11)$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = -QA_a + \alpha_a^{qa}\left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{\frac{-1}{\rho_a^{va}}} = 0 \quad (12)$$

where $PA'_a = PA_a(1-ta_a)$. Rearranging equations (10), (11) and (12) and substituting (10) and (12) into (11):

$$WF_f \cdot \overline{WFDIST}_{fa} = \left(PA'_a - \sum_c PQ_c \cdot ica_{ca}\right) QA_a \cdot \left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{-1} \delta_{fa}^{va} QF_{fa}^{-\rho_a^{va}-1} \quad (13)$$

Using equation (6) to substitute into (13):

$$WF_f \cdot \overline{WFDIST}_{fa} = \left(PA'_a QA_a - \sum_c PQ_c QINT_{ca}\right)\left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{-1} \delta_{fa}^{va} QF_{fa}^{-\rho_a^{va}-1} \quad (14)$$

Assuming that the revenue of the activity $PA'_a QA_a$ is fully exhausted by payments for value-added $PVA_a QVA_a$and the aggregate intermediate good $(\sum_c PQ_c QINT_{ca})$ equation (14) can be re-written as follows:

$$WF_f \cdot \overline{WFDIST}_{fa} = PVA_a QVA_a \left(\sum_f \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}}\right)^{-1} \delta_{fa}^{va} QF_{fa}^{-\rho_a^{va}-1} \quad (15)$$

Equation (15) implies that activities demand factors up to the point where the marginal cost of each factor is equal to the marginal revenue product of the factor. The production quantities of each activity, calculated as yields, θ_{ac}, multiplied by activity levels, QA_a, are allocated between market sales $QXAC_{ac}$ and household home consumption QHA_{ach} as depicted in equation (16):

$$QXAC_{ac} + \sum_h QHA_{ach} = \theta_{ac} QA_a \quad (16)$$

This equation allows for any commodity to be produced by one or more activities and any activity to produce one or more commodities. All commodities are assumed to enter the market except for home-consumed output, *QHA* whose opportunity cost is valued at factory/farm-gate prices, *PXAC*. Where a commodity is produced by more than one activity, its aggregate marketed production is governed by a CES aggregation function. Specifically, the choice between commodities from different sources is cast as an optimising problem:

$$\max_{QX,QXAC} Profit = PX_c QX_c - PXAC_{ac} QXAC_{ac} \quad (17)$$

Subject to:

$$QX_c = \alpha_c^{ac} \left(\sum_a \delta_{ac}^{ac} QXAC_{ac}^{-\rho_c^{ac}}\right)^{-\frac{1}{\rho_c^{ac}}} \quad (18)$$

where QX_c is output, sold at price, PX_c and produced with inputs, $QXAC_{ac}$ that are purchased at prices, $PXAC_{ac}$. Forming the lagrangian and solving yields equation (18) and equation (19) below as first order conditions:

$$PXAC_{ac} = PX_c QX_c \left(\sum_a \delta_{ac}^{ac} QXAC_{ac}^{-\rho_c^{ac}}\right)^{-1} \delta_{ac}^{ac} QXAC_{ac}^{-\rho_c^{ac}-1} \quad (19)$$

In the case of the Zambia CGE VAT model, a commodity is produced by a single activity implying that the value of the share parameter, $\delta_{a\,c}^{ac}$, is unity. Therefore, $QXAC = QX$ and $PXAC = PX$, irrespective of the value for the exponent.

Figure 3.1 below outlines the just described production structure. In terms of the labour entering aggregate value-added, the model distinguishes among four types of labour. The distinction is on the basis of the highest education attained and this yields the labour types: 'no education', 'primary school', 'secondary school' and 'post-secondary'.

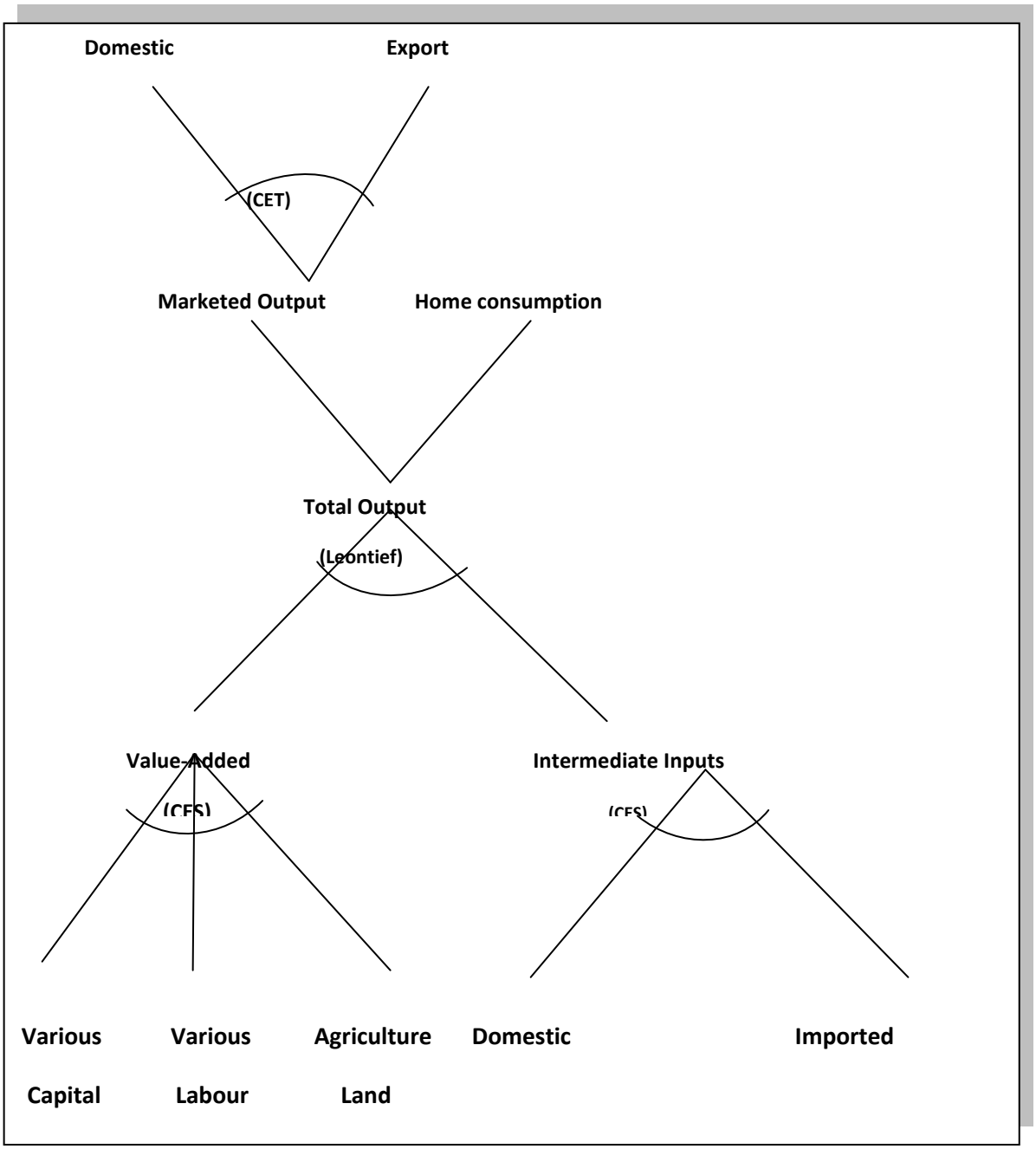


Figure 3.1: Structure of Production in Zambia CGE VAT Model

Various types of capital entering value-added are also distinguished. These are, agricultural capital, mining capital and 'other' capital. Land is another input entering value-added and it is associated with agricultural production only.

3.2.2 Commodity Markets Structure

As shown in Figure 3.1 above, for marketed commodities, substitution possibilities exist between production for the domestic and foreign markets. This decision by producers is cast as a sales revenue maximisation problem for a given output subject to a constant elasticity of transformation (CET) function:

$$\max_{QD,QE} PX_c QX_c = PDS_c QD_c + PE_c QE_c$$

Subject to:

$$QX_c = \alpha_c^t \left(\delta_c^t QE_c^{\rho_c^t} + (1-\delta_c^t) QD_c^{\rho_c^t}\right)^{\frac{1}{\rho_c^t}} \quad (20)$$

where PDS_c denotes domestic supply price, QD_c quantity of domestic supply, PE_c export price, QE_c the quantity of exports, , α_c^t a shift parameter, δ_c^t a share parameter. The elasticity of transformation is calculated as $\sigma^t = 1/\left(1-\rho_c^t\right)$, varying from zero to infinity as the value of the exponent ρ_c^t varies from infinity to unity. Forming the Lagragian and optimizing with respect to the quantities:

$$\mathcal{L} = PDS_c QD_c + PE_c QE_c + \lambda\left(QX_c - \alpha_c^t \left(\delta_c^t QE_c^{\rho_c^t} + (1-\delta_c^t) QD_c^{\rho_c^t}\right)^{\frac{1}{\rho_c^t}}\right) \quad (21)$$

The first order conditions besides equation (20) yields the relative supply of exports to domestic supply as a function of the prices.

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c}\frac{1-\delta_c^t}{\delta_c^t}\right)^{\frac{1}{\rho_c^t - 1}} \quad (22)$$

Commodities entering the market consist of both domestic output and imports. Figure 3.2 illustrates the process. Commodities are allocated on the basis of prices which account for both taxes and trade inputs (distribution margins).

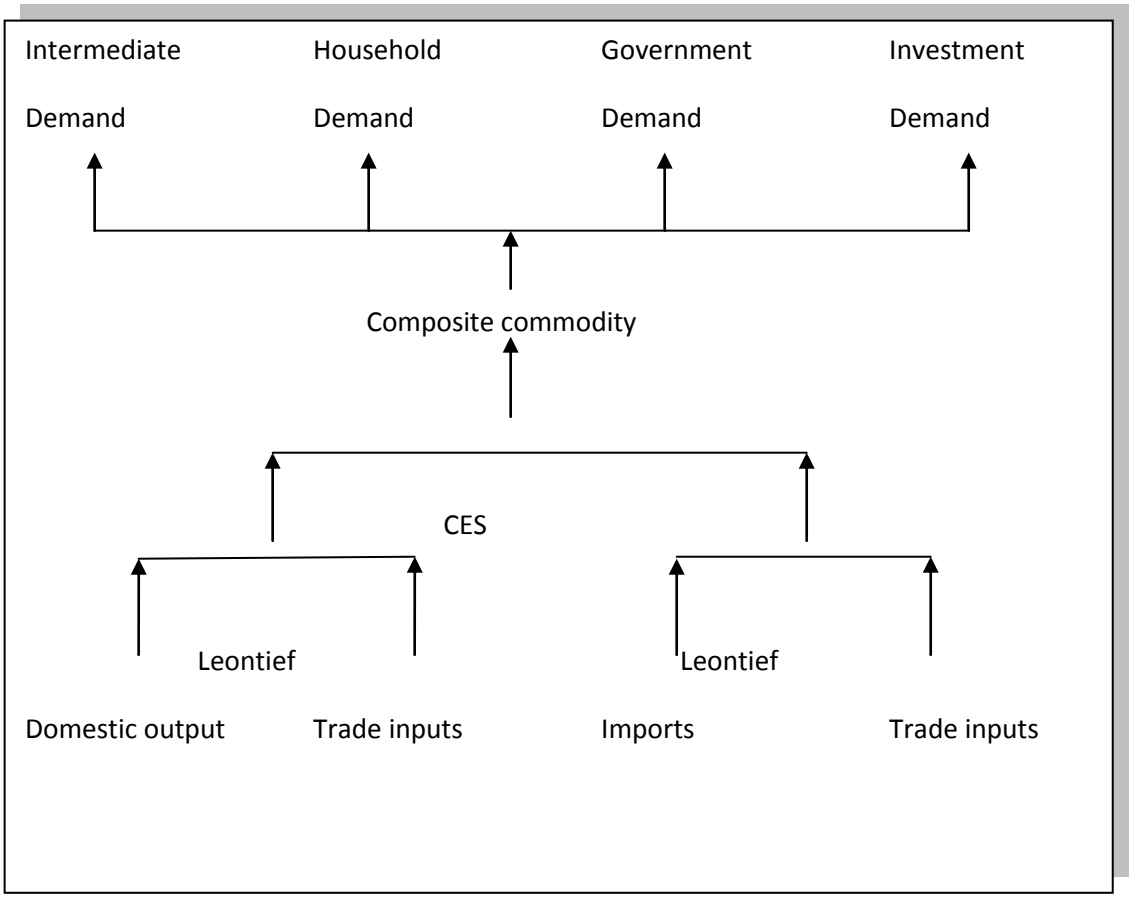


Figure 3.2: Commodity Markets in Zambia CGE VAT Model

In the domestic market, substitution possibilities exist between domestic commodities and related imported commodities. These commodities are assumed to represent imperfect substitutes which are combined through the CES Armington function. The domestic demander's problem is cast as a cost minimisation problem:

$$\min_{QM,QD} PQ_c \cdot (1 - tvat_c - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c$$

Subject to the *Armington* function:

$$QQ_c = \alpha_c^q \left(\delta_c^q QM_c^{-\rho_c^q} + (1 - \delta_c^q) QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}} \quad (23)$$

where QQ is the quantity of goods supplied to the domestic market (composite supply), PQ is the price of the composite supply, QM is quantity of imports, PM is the import price, PDD is the domestic demander's price of the domestic good. The

Armington function parameters are defined in the same way as the CET function parameters. The elasticity of substitution calculated as $\sigma^q = 1/(\rho_c^q + 1)$, varying from zero to infinity as ρ_c^q varies from infinity to negative unity. The first order conditions give the relative demand for imports versus domestic goods as a function of their relative prices

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c}\frac{\delta_c^q}{1-\delta_c^q}\right)^{\frac{1}{1+\rho_c^q}} \tag{24}$$

The Zambia CGE VAT model employs the small open country assumption, implying that export supply and import demand are infinitely elastic at given world prices. Therefore, Zambia is assumed not to command market power in both the export and import markets.

3.2.2 Institutions

The Zambia CGE VAT model includes four institutions. These are households, government, enterprises and foreigners or the rest of the world (ROW). The behaviour of these institutions in the model is described below.

Households in the Zambia CGE VAT model earn their income from the supply of production factors: labour, land and capital. They also receive dividends from enterprises, intra-household transfers, government transfers and remittances. Using this income, they pay direct income tax, save and make transfers to other households. The income that remains is spent on consumption. In their consumption decisions, Households have preferences over consumption of home and marketed commodities. They consume these commodities under a linear expenditure system (LES) of demand. The LES of demand is derived from the maximisation of the Stone-Geary utility function subject to a consumption expenditure constraint. This is formally stated as follows:

$$\underset{QH,QHA}{Max}\ U = \prod_{c\in C}\left[\left(QH_c - \gamma_{c\,h}^{m}\right)^{\beta_{c\,h}^{m}}\left(QHA_{a\,c\,h} - \gamma_{a\,c\,h}^{h}\right)^{\beta_{a\,c\,h}^{h}}\right]$$

$$\Rightarrow Max\ \ln U = \sum_{c} \beta_{ch}^{m} \ln\left(QH_{c} - \gamma_{ch}^{m}\right) + \sum \beta_{ach}^{h} \ln\left(QHA_{ach} - \gamma_{ach}^{h}\right) \quad (26)$$

$$subject\ to\ EH_{h} = \sum PQ_{c} QH_{c\,h} + \sum_{a \in A} \sum_{c \in C} PXAC_{a\,c} QHA_{a\,c\,h} \quad (27)$$

where U is household utility, QH denotes quantity of consumption of marketed commodities, EH is household consumption expenditure and is comprised of expenditure on market commodities (valued at market prices) and home commodities (valued at activity specific producer prices) , $\gamma_{a\,c}^{m}$ is the supernumerary consumption of the marketed commodity, $\gamma_{a\,c\,h}^{h}$ is the supernumerary consumption of the home commodity , $\beta_{a\,c}^{m}$ and $\beta_{a\,c\,h}^{h}$ are the marginal propensities to consume marketed and home commodities, respectively. Thus, $\sum_c \beta_{ac}^{m} + \sum_c \beta_{ach}^{h} = 1$.

$$\mathcal{L} = \sum_{c} \beta_{ac}^{m} \ln(QH_{c} - \gamma_{ch}^{m}) + \sum_{c} \beta_{ach}^{h} \ln\left(QHA_{ach} - \gamma_{ach}^{h}\right) + \lambda\left(EH_{h} - \sum_{c} PQ_{c} QH_{ch} - \sum_{a} \sum_{c} PXAC_{ac} QHA_{ach}\right) \quad (28)$$

Solving the Lagrangian in (28) with respect to QH and QHA yields the LES functions comprising of household consumption on marketed commodities and household consumption spending on home commodities:

$$PQ_{c} QH_{ch} = PQ_{c} \gamma_{ch}^{m} + \beta_{ch}^{m}\left(EH_{h} - \sum_{c'} PQ_{c'} \gamma_{ch}^{m} - \sum_{a} \sum_{c,} PXAC_{ac'} \gamma_{ac'h}^{h}\right) \quad (29)$$

$$PXAC_{ac} QHA_{ach} = PXAC_{ac} \gamma_{ach}^{h} + \beta_{ach}^{h}\left(EH_{h} - \sum_{c'} PQ_{c'} \gamma_{ch}^{m} - \sum_{a} \sum_{c,} PXAC_{ac'} \gamma_{ac'h}^{h}\right) \quad (30)$$

Explicit demand functions are derived by dividing both sides of equations (29) and (30) by the relevant price.

In the model government is portrayed as an institution that consumes but has no objective function to maximise. It is therefore treated as following specified rules of behaviour. It collects revenue from taxes, factors and transfers, which make up its income as depicted in equation (34).

$$YG = \sum_i TINS_i YI_i + \sum_a ta_a PA_a QA_a + \sum_c tm_c pwm_c QM_c + \sum_c tq_c PQ_c QQ_c + \sum_c tvat_c PQ_c QQ_c \quad (31)$$

where *YG* denotes total government revenue, *TINS* the direct tax rate for institutions, *YI* income for institutions, *tq* is the excise tax rate, *tm* is the import tariff and $tvat$ is VAT rate. The rest of the items are defined as before. Using this income the government makes transfers and purchases goods and services as depicted in equation (32):

$$EG = \sum_c PQ_c QG_c + \sum_i trnsfr_{igov} \overline{CPI} \quad (32)$$

where *EG* is total government expenditures and *QG* is quantity of commodities purchased by government. The inclusion of government to the CGE model allows readily introduction of taxes and tariffs. A distinction is made between indirect and direct taxes. Indirect taxes create wedges between prices paid and received by producers and consumers. Direct taxes are levied on total income.

Enterprises are portrayed as non-consuming entities in the model. There are two representative firms in the model, mining and non-mining. They earn income from ownership of capital. They in turn allocate this income to dividends, savings and direct taxes.

Transfer payments between the rest of the world and domestic institutions are all fixed in foreign currency. Foreign savings (the current account deficit) is the difference between foreign currency spending and receipts.

3.2.3 Equilibrium in Commodity and Factor Markets

Given the above maximisation problems of both producers and households, the CGE yields a competitive equilibrium of an allocation on quantities of output, input demands, and household demands supported by a vector of prices (wages and

commodity prices). The vector of prices ensures that both the factor and commodity markets clear so that:

$$\sum_a QF_{fa} = \overline{QFS}_f \tag{33}$$

$$QQ_c = \sum_c QINT_{ca} + \sum_h QH_{ch} + QG_c + QINV_c + QT_c \tag{34}$$

where $\overline{QFS}$ is the total quantity supplied of factors, $QINV$ is the quantity of goods demanded for investment and QT is the quantity of commodities demanded as trade inputs. Equation (33) imposes equality between the total quantity demanded and the total quantity supplied for each factor. The total supply of factors is fixed given the static nature of the model. Capital is immobile and sector-specific thus the quantity demanded for capital is fixed, $\overline{QF}_{fa}$, and the economy-wide wage for capital is also fixed, $\overline{WF}_f$, while the supply and wage distortions are unfixed (written as QFS_f and $WFDIST_{f\,a}$,respectively). Immobile and fully employed capital earns a flexible return that reflects its sector-specific scarcity value. In other words, the activity-specific return, $\overline{WF}_f \cdot WFDIST_{fa}$, vary to assure that the activity specific employment level for capital , $\overline{QF}_{fa}$, is consistent with profit maximization. For this specification, the flexible QFS_f merely records the total employment level.

Regarding equilibrium in the labour market, I assume that high-skilled labour comprising of the labour category 'post secondary school' is fully employed and immobile across sectors with an Activity-specific wage clearing this market similar to the case of capital above. The remainder of the labour categories ranging from unskilled to semi-skilled, are assumed to be unemployed and mobile across sectors. For these categories, the economy-wide wage is fixed (or exogenous), $\overline{WF}_f$, while the supply variable, QFS_f, is flexible and records the total employment level. This means that each activity is free to hire any desired quantity at its fixed activity-specific wage, $\overline{WF}_f \cdot \overline{WFDIST}_{fa}$. Given that some factors are fixed, their remunerations are residual after payments have been to the variable factors. This residual is allocated to the fixed factors on the basis of a fixed-proportion rule.

Equation (34) imposes equality between quantities supplied and demanded of the composite commodity. The composite commodity supply, *QQ*, drives demands for

domestic marketed output, *QD* and imports, *QM*. Thus, the market clearing variables are the quantities of imports for the import side and two interrelated domestic prices, *PDD* and *PDS*, for the domestic market output.

Utility maximisation and profit maximisation imply that supply and demand equations in the model are homogeneous of degree zero in prices. Doubling all prices does not alter equilibrium production and demand. In other words, the model exhibit strong neutrality of money. It determines only relative prices therefore, one price is chosen as numeraire on which the remainder of the prices are evaluated. The numeraire in the model is the consumer price index:

$$CPI = \sum_c PQ_c cwts_c \quad (35)$$

where $cwts$ is the weight of each commodity in the consumer price index. All simulated price and income changes are interpreted as changes relative to the CPI.

The first order conditions obtained above form a system of simultaneous equations on which any basic CGE model is founded. In order to capture the economy realistically, the following sections describe the macro aggregates and issues that are grafted onto the above framework. The macro aggregates are incorporated into the model in form of flow equilibrium and hence are associated with closure rules on these equilibria.

3.2.4 Macro-closures

The incorporation of actors such as government and the rest of the world introduces macroeconomic aggregates in the model. In the spirit of general equilibrium, it is a requirement that behaviour is specified regarding how closure or balance is achieved on the macro-aggregates. The CGE model includes three macroeconomic balances: the external balance (current account and trade balance), the savings-investment balance and the government balance. The closures on these balances have been chosen to reflect as much as possible the Zambian economic environment.

The Rest of the world brings in the issue of the balance of trade and what should be done about it. According to Robinson (2003), trade theory usually ducks the problem by assuming that it is always zero but in actual data, the trade balance is rarely zero. Therefore, the theoretically coherent treatment of the trade balance in CGE models is

to assume that it is exogenous and the resulting flow is identified as foreign savings, *FSAV*. Adding exports and imports also raises the issue of how the receipt-expenditure account of the ROW, the current-account, is brought into balance. The current-account balance, which is expressed in foreign currency, imposes equality between the country's spending and its earning of foreign exchange:

$$\sum_c pwm_c QM_c + \sum_f trnsfr_{row\,f} = \sum_c pwe_c QE_c + \sum_i trnsfr_{i\,row} + \overline{FSAV} \quad (36)$$

where pwm is the cost, insurance and freight (CIF) import price, $trnsfr$ denotes transfers to and from the ROW, *pwe* is the free on board (FOB) export price and *FSAV* is defined as above. All are denominated in foreign currency. The fact that all items in equation (33) are fixed except for imports and exports implies that the trade balance is also fixed. I assume that the real exchange rate, *EXR*, is flexible and therefore adjusts to maintain the fixed level of foreign savings.

The standard way of incorporating savings and investment in CGE models is to create a Savings-Investment account. This account collects savings and purchases investment goods. By doing so, a new flow equilibrium is added to the model. This requires the flow of savings to be made equal to the flow demand for investment goods as shown in equation (37).

$$\sum_i MPS_i(1 - TINS_i)YI_i + GSAV + EXR \cdot \overline{FSAV} = \sum_c PQ_c QINV_c \quad (37)$$

where *MPS* is the marginal propensity to save of institutions, *QINV* is the quantity of fixed investment commodities. The model does not include changes in capital stock. Equation (37) states that total saving is the sum of savings from domestic non-government institutions, the government, and the rest of the world. This is equal total investment, which is the sum of the values of fixed investment (gross fixed capital formation). A mechanism is introduced to achieve the savings-investment balance. The savings rate, *MPS*, by institutions is key to this mechanism. It can be specified as fixed, so that whatever is saved is then spent on investment or flexed so that savings adjust to meet the investment demand. I assume that saving is investment driven as in the study on Zambia by Lofgren (2004). This means that the value of savings adjusts to assure the savings-investment balance.

For the government balance, a common specification of rules of behaviour is that government expenditure is fixed in real terms; government revenue is determined by fixed tax rates; and government savings is determined residually as the gap between revenue and expenditure. Thus government savings, *GSAV* may be negative in the government balance in equation (38).

$$YG = EG + GSAV \tag{38}$$

In this analysis the government balance is an important part of the simulations. In all the simulations, I assume that GSAV is fixed and direct taxes of domestic institutions endogenously adjust uniformly to maintain the government balance. This means that direct taxes adjust to wipe out the increase in revenue that results from VAT reform and vice versa. This assumption is essential in assessing welfare impacts of tax reform in order to avoid a 'free lunch' that may result from increased government expenditure.

3.2.5 Specification of VAT in the Zambia CGE VAT Model

In order to equip the model to analyse VAT, I modify the foregoing specification of the model, which up to this point is simply the IFPRI standard model, by adding an explicit specification of VAT. This specification of VAT borrows heavily from Emini (2000), Go et al (2005) and Levin (2005). In these studies, VAT is specified as a European-style VAT, with rebates on intermediate inputs and investment purchases for all activities covered by VAT. This treatment removes the cascading effect on prices of taxes on intermediate goods and investment. In this manner VAT exhibit economic neutrality and thus does not distort resource allocation. This presumption can be illustrated using a heuristic analysis, due to Emini (2000), of the direct impact of VAT neutrality on factor payments. Emini uses this analysis in his assessment of the effects of replacing a general sales tax which cascades, with a VAT in Cameroon. In my analysis, I use it to illustrate the effect on factor allocation of moving from a narrow VAT coverage with a high potential for cascading, to a broader coverage with a potential of reducing cascading.

Invoking the assumption that the total revenue of an activity is fully exhausted by payments to value-added (factors) and intermediate inputs, the total payment for primary factors for each activity *(PVA)* can be stated as:

$$PVA_a = \frac{PA'_a QA_a - \sum_c (1+tvat_c) PQ'_c QINT_{ac}}{QVA_a} \quad (39)$$

where PQ'_c is the market price of composite commodities net of VAT and the rest of variables are defined as before. Equation (39) represents a situation where VAT on intermediate inputs in not rebated. In a VAT system where producers ultimately discharge their input purchases at prices excluding VAT, PVA is determined as in equation (40) below:

$$PVA_a = \frac{PA\prime_a QA_a - \sum_c PQ'_c QINT_{ac}}{QVA_a} \quad (40)$$

Thus, VAT implementation leads to a direct production cost reduction $\Im_a$, which is equal to the amount of rebate on VAT paid on input purchases:

$$\Im_a = REBATE_a = \sum_c tvat_c \, PQ'_c QINT_{ac} \quad (41)$$

Ceteris paribus, the reduction in production cost due to VAT rebates implies an increase in PVA if $tvat_c > 0$ holds for at least one intermediate input purchase used by an activity. The increase "ΔPVA_a" is as higher as the ex ante tax burden $\Im_a$ was heavier. In other words, setting *NVAT* as a sector with VAT exempt status and hence heavy tax burden from inputs, and *CVAT* as sector under VAT and therefore a light tax burden from inputs, it holds that:

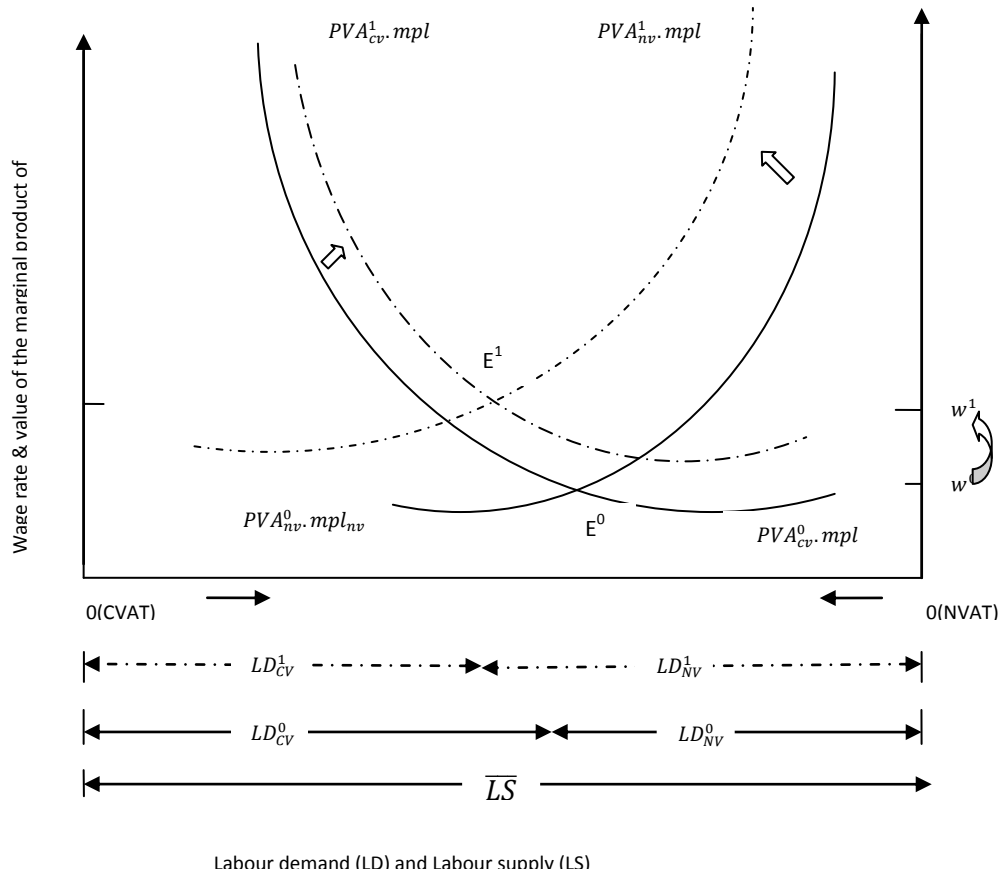
$$\Delta PVA_{NVAT} > \Delta PVA_{CVAT} \quad (42)$$

Considering a two sector economy under a short-run time horizon, the VAT allocative efficiency transmitted by equation (42) is depicted in Figure 3.3. Assuming that each of the two sectors uses two primary factors: labour, which is variable and mobile and capital which is specific and fixed, in order to maximize profits, each sector demands labour until the value of its marginal product is equal to the marginal cost (wage rate). For the economy as a whole, labour is allocated such that in equilibrium the value of the marginal product of labour is the same in all sectors and equal to the wage rate:

$$PVA_{cvat} \cdot mpl_{cvat} = PVA_{nvat} \cdot mpl_{nvat} = w \quad (43)$$

where *mpl* and *w* represent the marginal product of labour in the two sectors and the wage rate, respectively. Before the broadening of VAT coverage to both the exempt sector and non-exempt sector, the equilibrium point for optimal allocation of labour is E^0.

Figure 3.3: Short-run VAT effects on Resource Allocation



Source: Adapted from Emini (2000)

This point corresponds to the wage rate of w^0, labour demands equal to LD^0_{cvat} and LD^0_{nvat} for VAT sector and non-VAT sector, respectively. After VAT broadening, the value-added prices increase and shift from PVA^0_{cvat} to PVA^1_{cvat} , and from PVA^0_{nvat} to PVA^1_{nvat}. Given the relationship in equation (42), the value of the MPL increases more in the sector with a heavy ex ante input tax burden than the light one. The new equilibrium is at E^1. The shift from E^0 to E^1 entails a labour demand increase for the ex ante heavy tax burden sector and a corresponding decrease for the ex ante light burden sector.

VAT in Zambia is fashioned along the lines of a European-style VAT. However, in its implementation, it is characterised by partial neutrality. This partial neutrality is firstly due to the lag between the time inputs are purchased and therefore input VAT is paid, and the time the output VAT accrues. Given that interest rates are not zero, the input VAT imposes a cost on production to the extent that it reduces operating capital during the production process. Secondly, the partial neutrality is due to the existence of a number of VAT liable activities outside the VAT base. This is either because their turnovers are below the required threshold (they do not meet requirements for voluntary registration for below threshold firms) or because they operate in the informal sector. Therefore, I modify equation (41) to take into account this partial neutrality as follows:

$$\Im'_a = REBATE'_a = \varphi_c^{vat} \sum_c tvat_c \, PQ'_C QINT_{ac} \tag{45}$$

where φ_c^{vat} is a rebates efficiency parameter and has the range, $0 \leq \varphi_c^{vat} \leq 1$. If $\varphi_c^{vat} = 1$, then $\Im'_a = \Im_a$ and the VAT system exhibits full neutrality. For the experiments in this model, I adopt $\varphi_c^{vat} = 0.5$ for sectors covered by VAT and $\varphi_c^{vat} = 0$ for non-VAT sectors. However, in order to assess the influence of the efficiency in the rebate system on welfare, I run experiments under the scenario $\varphi_c^{vat} = 1$ and compare them to the earlier scenario. The significance or otherwise of the effects of VAT reform under the two scenarios should provide justification for strategies that aim at bringing as many activities as possible under VAT coverage.

In order to incorporate the above specification of VAT with rebates in my model, I make adjustments to some sections of the IFPRI standard model to yield the Zambia CGE VAT model. Given that a VAT rebate acts like a subsidy on intermediate input consumption, the price of the aggregate intermediate input is now less the rebate per unit of aggregate intermediate input as shown below:

$$PINTA_a = \sum_c PQ_c \cdot ica_{ca} - REBATE'_a / QINTA_a \tag{46}$$

where $ica_{ca} = QINT_{ca} / QINTA_a$ is the intermediate input quantity of a commodity purchased by an activity per aggregate intermediate input for that activity. I now define the value added tax revenue paid to the government, VATREV, as:

$$VATREV = \sum_C tvat_c \cdot PQ_C \cdot QQ_c - \sum_a REBATE'_a \tag{47}$$

In turn total government revenue is given by:

$$YG = \sum_i TINS_i \cdot YI_i + \sum_a ta_a \cdot PA_a \cdot QA_a + \sum_c tm_c \cdot pwm_c \cdot QM_c \cdot EXR$$
$$+ \sum_c tq_c \cdot PQ_c \cdot QQ_c + VATREV \quad (48)$$

Therefore equations (45) and (47) are the new equations I introduce to the model and equations (46) and (48) are the existing equations I adjust. The two new equations entails two new variables, hence the model remains square (total number of equations equal to total number of variables).

3.2.6 Measurement of Impacts of VAT Reform

In applications of CGE models, the focus is on introducing various distortions to the price system or quantity constraints and calculating the resulting inefficiencies and loss of welfare. The model application in this study focuses on VAT, a price-based parameter. When the economy is initially at its unfettered equilibrium, the perturbation in prices, activity levels and demands caused by changes in VAT induces convergence to a new, distorted equilibrium. By comparing the pre- and post-change equilibrium vectors of prices, activity levels, demands and income level, the policy is evaluated. It is thus straight forward to measure impacts of policy on these variables. However, how the impact on welfare is evaluated is less obvious.

To evaluate how much better off or worse off the households are in CGE models, Robichaud (2001) recommends use of the money metric indirect utility function. Varian (1992: pp.110) defines the money metric indirect utility function as the measure of how much money one would need at one set of prices to be as well off as one would be facing an alternative set of prices. Therefore, the money metric indirect utility function is used to obtain monetary measures of the welfare effects of different policy scenarios. The most common monetary measures are the equivalent (EV) and the compensating variations (CV).

According to Creedy (1997), the EV is the amount of money given to a loser (or taken from a gainer) to ensure that the individual achieves the post-change utility level, at the pre-change set of prices. He further defines the CV as the measure of the amount

of money which (at the new prices) needs to be given to a loser (or taken from a gainer) in order to restore the individual to the pre-change utility level. The EV is usually employed to evaluate welfare changes of tax policy.

On the basis of the utility function presented in Section 4.2.2 and its associated LES demand functions, the EV is calculated as follows: Let *U(QH,QHA)*, define the utility function, $V(PQ, PXAC, EH)$, the indirect utility function, and $m(PQ, PXAC, V)$, the money metric indirect utility function.

The indirect utility function, $V(PQ, PXAC, EH)$ is obtained by replacing *QH* and *QHA* in the utility function in equation (26) with the LES demand functions (29) and (30). This yields:

$$V(PQ, PXAC, EH) = \prod_c \left[\frac{\beta_{ch}^m}{PQ_c}\left(EH_c - \sum_c PQ_c\gamma_{ch}^m - \sum_a\sum_c PXAC_{ac}\gamma_{ach}^h\right)\right]^{\beta_{ch}^m}$$

$$\cdot \prod_a \prod_c \left[\frac{\beta_{ach}^h}{PXAC}\left(EH_c - \sum_c PQ_c\gamma_{ch}^m - \sum_a\sum_c PXAC_{ac}\gamma_{ach}^h\right)\right]^{\beta_{ach}^h} \quad (49)$$

Solving equation (49) for consumption expenditure, *EH* gives the money metric indirect utility function, $m(PQ, PXAC, V)$. This is a measure of the consumption expenditure needed to attain utility level V at vector of prices *PQ* and *PXAC*.

$$m(PQ, PXAC, V) = \prod_c \left(\frac{PQ_c}{\beta_{ch}^m}\right)^{\beta_{ch}^m} \cdot \prod_a \prod_c \left(\frac{PXAC_{ac}}{\beta_{ach}^h}\right)^{\beta_{ach}^h} \cdot V(PQ, PXAC, EH)$$

$$+ \sum_c PQ_c\gamma_{ac}^m + \sum_a\sum_c PXAC_{ac}\gamma_{ach}^h \quad (50)$$

Suppose the initial prices are denoted by $\left(PQ^0, PXAC^0\right)$. After a policy change, new prices, $\left(PQ^1, PXAC^1\right)$ are observed. Formally, the EV is given by:

$$EV = m\left(PQ^0, PXAC^0, V(PQ^1, PXAC^1, EH^1)\right) - m\left(PQ^0, PXAC^0, V(PQ^0, PXAC^0, EH^0)\right)$$

$$EV = m\left(PQ^0, PXAC^0, V(PQ^1, PXAC^1, EH^1)\right) - EH^0 \quad (51)$$

The EV for the LES specification is obtained by substituting equation (50) into (51) as follows:

$$EV_h = \left(EH_h^1 - \sum_c PQ_c^1 \gamma_{ch}^m - \sum_a \sum_c PXAC_c^1 \gamma_{ach}^h \right)$$

$$\cdot \prod_c \left(\frac{PQ_c^0}{PQ_c^1} \right)^{\beta_{ch}^m} \cdot \prod_a \prod_c \left(\frac{PXAC_{ac}^0}{PXAC_{ac}^1} \right)^{\beta_{ach}^h}$$

$$-\left(EH_h^0 - \sum_c PQ_c^0 \gamma_{ch}^m - \sum_a \sum_c PXAC_{ac}^0 \gamma_{ach}^h \right) \quad (52)$$

Equation (52) is the consumption expenditure change that, at base prices, would yield the same utility as observed in the simulation. In the model, it is reported as a percent of base year consumption, with a positive value indicating a welfare gain and vice versa.

3.3 Implementing the Zambia CGE VAT Model

The Zambia CGE VAT model is calibrated to the 2001 social accounting matrix (SAM) prepared by Thurlow et al (2004). It is written as a set of linear and non-linear simultaneous equations arising from the structure presented in Section 3.2 and its sub-sections. The entire list of equations of the model is presented in Appendix A. In the following sections I describe the steps I take in order to implement the model.

3.3.1 The Social Accounting Matrix (SAM)

The Zambia SAM for 2001 has 28 sectors. I employ a small-scale disaggregation by aggregating the 28 sectors into 11 sectors. The aggregated sectors are presented in Table 4.1 below and the mapping from the 28 sectors to 11 sectors is presented in Appendix B.

The basis for this small-scale disaggregation is from Bovernberg (1986), who argues that it makes results easier to interpret. However, he further argues that more specific tax policy questions call for large-scale multi-sector models. Therefore, the disaggregation in this study has been chosen such that it makes results easier to interpret and at the same time does not sacrifice so much on the interactions that a large scale disaggregation may capture. The disaggregation has been done such that

activities with homogenous production and trading structures are drawn into one sector, akin to Schürenberg (2007), to minimise aggregation bias.

The model distinguishes among three agriculture sectors (staple food, cash crop and other agriculture), six industrial sectors (processed food, mining, heavy machinery, other manufacturing, construction, and energy) and two services sectors (private and public services). In the sectors, a distinction is made between activities and commodities. In this regard, activities can be thought of as factories and farms while commodities as markets

The households in the SAM are classified into 11 representative categories. The categorisation is based on location and type of work of the household head. In order to capture the welfare consequences of the tax policy on different socio-economic groups, I maintain the 11 representative households. The definitions of the households in the SAM are shown in Table 3.1.

Table 3.1: Households' Definitions in the Model

Rural households
HRRS: Remote rural small scale farmer
HRRM: Remote rural medium scale farmer
HRRN: Remote rural non-farmer
HRS: Non-remote rural small scale farmer
HRM: Non-remote rural medium scale farmer
HRL: Non-remote rural large scale farmer
HRN: Non-remote rural non-farmer
Urban Households
HUSE: Self employed
HUPR: Private sector employment
HUPU: Public sector employment
HUEM: Employer

The SAM inherited the categorisation of households in Table 3.1 from the Living Conditions Monitoring Survey (LCMS). In a number of studies, representative households are categorised by income ranges (see Go et al, 2005; Kearney, 2003) rather than socio-economic groups as in the Zambia case.

However, the socio-economic group categorisation does have its own merits. As pointed out by Chia et. al. (1992), categorisation by socio-economic groups rather

than income ranges is a better reflection of characteristic features of most developing economies. With regards to taxation, most developing economies are characterised by narrow tax bases for their key taxes. The narrow base of key taxes in developing economies implies a more specificity of tax effects than in economies with broad tax bases. Therefore, in the former, taxes primarily affect narrowly defined socio-economic groups (public employees, large scale farmers, etc) rather than income ranges. Thus, the household categorisation in my model is adequate for this study.

Given that the classification in my model only crudely ranks households from rich to poor (both rich and poor are distributed in all categories), questions of tax incidence are not answered in this chapter.

The 2001 SAM comprises of indirect taxes on production, direct taxes on income of institutions (households and enterprises) indirect taxes on commodities and tariffs. In the original SAM, commodity taxes are in an aggregate form and therefore do not distinguish among the different commodity taxes in the Zambia tax system. In order to simulate different scenarios of a VAT reform, a disaggregated commodity tax account which isolates VAT is needed. Therefore, for my model I disaggregate commodity taxes in the SAM to capture the main types of commodity taxes that are in the Zambia tax structure. Specifically, I disaggregate the tax account to make it reflect the tax system in 2001 as much as possible.[2] I make use of data on revenue collection from ZRA to determine the proportions of revenue on each tax and apply these proportions to disaggregate commodity tax revenue in the original SAM. The resulting disaggregated commodity taxes are VAT and Excise tax. The excise tax also includes a fuel levy.

There is no rebate account in the original SAM. Taxes paid on production are net of the subsidy. To use rebates explicitly in the model, a rebate account is created in the SAM based on the calculation in the "REBATE" equation (45). Specifically, a rebate row and column is created with each activity paying a negative tax (receiving a rebate) to the rebate row and in turn the rebate column paying the same tax (deducting

[2] The SAM was prepared by IFPRI to conduct poverty-focused studies and not tax policy studies (see Lofgren, 2004; Thurlow and Wobst, 2005). Therefore, the commodity tax account of the SAM was not disaggregated.

rebate) to the government account. To re-balance the SAM the tax payment from the activity to the government is adjusted upward to add back in the subsidy payment. This entails re-calculating the indirect tax rate, *ta*, to take into account this adjustment.

3.3.2 Model Calibration and Specification of Parameters

The SAM as a benchmark data set is in value terms. To obtain separate price and quantity observations, I adopt the Harberger (1962) 'units convention'. Under this procedure prices for units of both goods and factors are set equal to unity or to their relevant tax inclusive prices in the benchmark equilibrium. The values in the SAM can now be interpreted as quantity indices of output or simply physical units. Values for exogenous prices are also set to unity in the base year. In this way, the bench mark solution represents the state of the economy in real terms.

All parameter and variable values are obtained from the SAM. Details on the calibration of the model to the Zambia SAM are presented in Appendix C. The SAM provides initial values for the model's endogenous variables (except factor quantities which are obtained from country statistics), which are in turn used to estimate the model parameters. Calibration of the behavioural functions, the CES, CET and LES in the model requires additional non-SAM-based data in terms of elasticity values. Ideally, these non-SAM-based parameters should come from country econometric estimates. However, in most cases these are not available and therefore, they are guessed or borrowed from other studies or models for other countries. This is far from ideal and is essentially induced by data limitations. Where guesstimates are used, Sanchez and Vos (2007) advise that, they should be educated guesses; thinking well about the nature of the elasticity and the reality of the country whose economy is being modelled. Given that there are no econometrically estimated elasticities for Zambia, elasticity values for this model are borrowed. However, most of the elasticities are borrowed from an existing Zambia dataset embedded in the IFPRI CGE model, implying that they have already been used before in the Zambia context. The remaining elasticities are obtained from developing country context literature. A number of developing country elasticities are documented by Annabi et al (2006).

The values for the elasticities have been selected from these various sources using personal judgement. In Table 3.2 I present the elasticities of substitution between factors in the CES value-added function, σ^{va}, the Armington elasticities of substitution between imports and domestic output in domestic demand, σ^{q} , and the elasticities of substitution in the CET function for the allocation of export supply and domestic market supply, σ^{t}.

Table 3.2: Production and Trade Elasticities

	CES Value-added (σ^{va})	**CES Armington (σ^{q})**	**CET (σ^{t})**
Staple food agriculture	0.75	-	-
Cash crop agriculture	0.75	3.0	2.5
Other agriculture	0.75	3.0	2.5
Mining	0.5	0.75	2.5
Processed food, beverages & tobacco	1.5	1.25	4.0
Capital goods	0.5	0.83	4.0
Other manufacturing	0.5	0.5	4.0
Electricity and Water	0.5	3.0	2.5
Construction	0.5	-	-
Public services	1.19	-	-
Private services	1.19	0.5	1.0

Source: Zamdata.dat (from applied CGE model programmed by Lofgren (1999) and (2003).

The elasticity associated with the CES value added function, $\sigma^{va} = 1/(1 + \rho_a^{va})$, measures the ease with which factors can be substituted for each other in the production process. It is used in the model to calibrate the substitution parameter ρ_a^{va}, which appears as an exponent in the CES value-added function. The ease with which factors can be substituted for one another reduces as $\sigma^{va} \to 0$.The opposite is true when $\sigma^{va} \to \infty$. In the model, the values of σ^{va} used are generally small implying that while substitution possibilities between the factors exist, it is to a small extent due to complementariness of capital and labour in the production process.

The industrial sectors with the exception of processed food, beverages and tobacco sectors have value added elasticities close to zero. The highest value-added elasticities are associated with processed food followed by the services sectors. This means that these sectors have greater possibilities for producing a given level of output with different factor combinations. According to Rahmah and Idris (2002), consumption-oriented industries tend to have relatively higher elasticities of substutition between factors than investment-oriented industries.

The Armington elasticity of substitution, $\sigma^q = 1/(1 + \rho_c^q)$, specify the degree of substitution in demand between commodities of the same industry produced in different countries. In this model, this refers to similar commodities which are both imported and locally produced. The Armington elasticity is essential in the calibration of ρ_c^q, an exponent in the CES Armington function. Under the Armington specification, an industry's imports or locally produced commodities are assumed to be imperfect substitutes for each other. In Table 3.2, the Armington elasticities are highest for the agricultural and energy sectors. Thus, the degree of substitution in demand is highest for commodities of these sectors. This is plausible given that quality differences between imports and domestic commodities of these sectors are generally low and hence they will tend towards perfect substitutes. The opposite holds for the sectors with low Armington elasticities.

The elasticity of substitution in the CET function, $\sigma^t = 1/(1 - \rho_c^t)$, measures the degree of transformability between commodities produced essentially by the same conglomerate of resources. In the model, the transformability is between exports and domestic output. The elasticity of substitution in the CET function is used to calibrate ρ_c^t, an exponent in the CET function. The elasticities in Table 3.2 show a higher degree of transformability in the industrial than in the agricultural sectors.

All the above elasticities are treated as the central elasticity case. Results on the model are checked for robustness by conducting experiments for low elasticity and high elasticity cases. The low (high) elasticity case is obtained by reducing (augmenting) the values of the central elasticities by 20 percent.

In Table 3.3 I present expenditure (income) elasticities of demand used to calibrate the LES demand functions of the households in the model. All the expenditure elasticities are positive. This is an indication that all the commodities are normal goods and therefore demand is also normal. This is plausible given that all the commodities in Table 3.3 are large aggregates. If they were much disaggregated, substitution to higher quality goods as income increases would cause some commodities to become inferior goods at some level of income.

Table 3.3: Expenditure Elasticities for Commodities by Household Group

	HRRS	**HRRM**	**HRRN**	**HRS**	**HRM**	**HRL**	**HRN**	**HUSE**	**HUPR**	**HUPU**	**HUEM**
CSFA	0.925	0.873	0.860	1.020	0.962	0.815	0.983	0.882	0.863	0.885	0.823
COAG	0.885	0.834	0.822	0.936	0.883	0.835	0.902	0.903	0.884	0.907	0.844
CFBT	1.026	0.967	0.953	0.909	0.858	0.744	0.876	0.805	0.788	0.808	0.752
COMA	1.347	1.270	1.251	1.117	1.054	0.934	1.076	1.010	0.988	1.013	0.943
CEAW	1.200	-	1.115	0.979	0.924	0.736	0.944	0.797	0.779	0.799	0.744
CCON	1.746	-	1.622	1.349	1.272	0.930	1.300	1.006	0.984	1.010	0.939
CPUB	0.836	0.788	0.777	0.785	0.740	0.680	0.756	0.735	0.720	0.738	0.687
CPVT	2.033	1.917	1.889	1.862	1.756	1.575	1.794	1.704	1.667	1.710	1.591

Source: Zamdata.dat (from Applied CGE model programmed by Lofgren (1999) and (2003), Nganou (2004).

CSFA= staple food agriculture, COAG = other agriculture, CFBT = processed food, beverages and tobacco, COMA= manufacturing, CEAW = Electricity and water, CCON = construction, CPUB = public services, CPVT = private services

All essential commodities such as agricultural commodities and public services (CSFA, COAG, CPUB) are associated with expenditure elasticities less than unity. Expenditure elasticities are greater than unity for commodities which are luxury goods given the type of household. For poorer rural households, manufactured goods, energy and construction have expenditure elasticities greater than unity. This also holds for poorer urban households with the exception of the expenditure elasticity of demand associated with energy. The expenditure elasticity of demand for private services is greater than unity for all the households. This is because private services mostly comprise of items such as financial and insurance services whose demand is very responsive to income changes. The model is implemented and solved for benchmark equilibrium as a mixed complimentary problem (MCP) in the General algebraic modelling system (GAMS). The MCP is chosen as a solver because it accommodates

equilibrium models which are not natural optimization problems as in the case of this study.[3]

3.3.3 Benchmark Statistics

The structure of the economy as captured by the benchmark data set is an important determinant of tax effects, as noted by Bovenberg (1986). Therefore, it is useful to make a brief comment on the accounts in the SAM. In this section I describe the structure of production, pattern of foreign trade, household consumption pattern, and the tax structure as obtaining in the SAM.

The structure of production and pattern of foreign trade are presented in Table 3.4. The private services sector contributes about 40 percent to GDP, employs 36 percent of the workers and uses just about more than half of the country's capital stock.

Table 3.4: Production Structure and Trade in Zambia (SAM 2001)

Sector	GDP (%)	Labour (%)	Capital (%)	Inter-mediates	Imports (%)	Exports (%)
Staple food Agriculture	6.2	12.4	0.7	2.2	0	0
Cash crop Agriculture	2.1	2.9	1.1	0.8	2.3	8.5
Other Agriculture	12.3	23.2	4.4	6.2	3.3	3.7
Processed food, beverages & tobacco	4.2	4.7	2.5	10.6	3.8	0.8
Capital goods	4.3	2.3	1.6	1.9	30.3	0.7
Other manufacturing	8.7	3.3	7.9	12.0	37.3	15.8
Mining	8.5	0.7	15.9	6.0	1.4	59.0
Energy	4.1	0.5	7.9	3.3	0	5.6
Construction	1.4	1.4	1.4	9.1	0	0
Private services	40.2	36.0	50.7	38.1	21.6	6.0
Public services	8.2	12.6	5.9	10.0	0	0
All	100	100	100	100	100	100

Source: Author's calculations based on SAM 2001

The private services sector also has the highest demand for intermediate commodities. Mining contributes 8.5 percent to GDP but is the source of almost 60 percent of

[3] See Rutherford (1995).

Zambia's total exports. The agriculture sector contributes about 21 percent to GDP and within the sector, staple food agriculture contributes 6.2 percent to GDP.

In terms of value-added composition, labour is relatively important for the agriculture, food processing and public service sectors. While capital is relatively important for the mining sector comprising 96 percent of its total value-added. This is closely followed by the energy sector. The agriculture sectors are the only sectors employing land in their production.

Table 3.5: Value-added Composition (SAM 2001)

	Labour share	**Capital share**	**Land share**	**Total**
Staple food Agric	84.2	5.7	10.1	100
Cash crop Agric	61.6	26.8	11.6	100
Other Agric	80.7	17.6	16.7	100
Processed food, beverages & tobacco	62.2	37.8		100
Capital goods	54.8	45.2		100
Other manufacturing	26.8	73.2		100
Mining	3.9	96.1		100
Energy	5.0	95.0		100
Construction	47.0	53.0		100
Private services	38.2	61.8		100
Public services	65.1	34.9		100

Source: Author's calculations based on SAM 2001

The household accounts in the SAM as summarised in Table 3.6 show that the rural farming households spend a relatively large proportion of their budget on home or non-marketed agriculture and food commodities. On the other hand, urban households spend a relatively higher proportion of their budget on marketed agriculture and food commodities.

While the classification of households in the SAM allows that the poor are found in all categories, poverty levels are higher in the rural area compared to the urban area. Thus, there is an indication that the policy of exempting agriculture and food products from VAT may be disproportionately benefiting the richer expenditure groups.

Table 3.6: Household Consumption Spending by Broad Commodities

Household	Agric & food (own)	Agric & food (market)	Manu. goods	Utilities	Private services	Public services	All
Rural							
Remote							
Small	64.7	20.1	9.1	0.0	3.6	2.6	100
Medium	55.4	19.7	15.2	0.0	6.3	3.4	100
Non-farm	29.9	51.2	14.8	0.2	4.7	2.3	100
Non-remote							
Small	60.4	22.8	9.4	0.2	4.0	3.2	100
Medium	41.8	21.2	21.3	0.5	9.5	5.7	100
Large	43.2	4.8	26.7	2.0	21.5	1.8	100
Non-farm	16.0	50.4	20.3	0.6	7.5	5.2	100
Urban							
Self-employ.	11.5	42.1	20.5	3.1	16.1	6.8	100
Private employ.	1.8	47.2	22.1	3.0	18.4	7.5	100
Public employ.	5.3	43.4	21.6	3.7	15.9	10.0	100
Employer	3.2	32.6	26.2	5.7	23.3	9.0	100
All households	23.3	36.3	18.4	2.4	13.1	6.5	100

Source: Thurlow and Robinson (2004) from calculations based on 2001 SAM.

Urban households also relatively consume more of private services which comprise a large component of services not covered under VAT. Thus, there could be some gains in VAT revenue in broadening the VAT base into these sectors with minimal adverse effect on welfare.

The tax account in the SAM is summarized in Table 3.7. Total tax revenue comprises of about 17 percent of GDP. In terms of contribution to total tax revenue, VAT is the second largest contributor to total revenue after personal income tax. Thus, changes in VAT are expected to have significant effects on the economy.

Table 3.7: Taxes in the Zambia CGE VAT Model

Category	Model parameter	Percent of total revenue	Percent of GDP
Institutional taxes (direct taxes)			
Company tax	*tins(i)*	9.5	1.7
Personal Income tax	*tins(h)*	42.2	7.3
Commodity taxes (indirect taxes)			
VAT	*tvat(c)*	18.2	3.8
Excise	*tq(c)*	9.0	0.9
Import tariffs	*tm(c)*	11.8	2.1
Activity taxes			
Taxes on production	*ta(a)*	9.3	1.6
Total		100	17.4

Source: Author's calculation based on adjusted SAM 2001

Table 3.8 shows the sectoral pattern of VAT rates. The model VAT rates are based on actual VAT rates and not the statutory rate, this means that the rates will differ across sectors. This is a reflection of differing coverage, measurement errors and leakages in the various sectors.

Table 3.8: Base Vat Rates

Sector	**Actual VAT rate (%)**	**Rebate/Qinta (%)**
Staple food Agric	0.1	1.6
Cash crop Agric	2.1	2.5
Other Agric	0.8	2.3
Processed food, beverages & tobacco	2.0	3.5
Capital goods	4.5	1.2
Other manufacturing	3.5	3.9
Mining	5.3	2.8
Energy	0.0	0
Construction	0.2	2.8
Private services	0.0	0
Public services	0.0	0

Source: Author's calculations based on adjusted SAM (2001).

According to Table 3.8, the widest VAT coverage is in the mining sector followed by capital goods sector. The least VAT covered sectors are the services sectors followed by the agricultural sectors. The proportion of rebates per aggregate intermediate input demand in each sector is highest in the manufacturing sector followed by the processed food, beverages and tobacco sectors. This is in line with their high level of demand for intermediate inputs in total intermediate input demand as well as VAT coverage.

3.3.4 Definition of Model Simulations

On the basis of the benchmark equilibrium obtained from implementing and solving the Zambia CGE VAT model, I conduct two broad experiments on VAT reform. These simulations are taken to be a form of broadening the VAT base. The first one is a full VAT reform and I denote it as FULLVAT. The FULLVAT is the ultimate in VAT reform. In this reform, the VAT system generally covers all sectors with only few exceptions. According to Bye et al (2003), a number of developed countries by 2001 were already a step in this direction. While this reform provides indications as to short-term effects of such a policy in Zambia, I use it more as a check on whether the model responds in a consistent manner to the simulations.

Under FULLVAT, I employ two variants of the reform. In the first variant, I simulate a uniform VAT rate in all sectors by increasing the actual VAT rate in each sector to be equal to the highest actual VAT rate in the benchmark. The resulting increase in revenue is absorbed by a uniform percentage point reduction in income tax rates. I denote this sub-experiment FULLVAT1.

In the second variant of FULLVAT, I simulate a uniform VAT rate in all sectors that keeps total revenue constant. In other words, an endogenously determined uniform VAT rate absorbs changes in VAT revenue arising from this shock. This simulation portrays a situation where all sectors are brought under VAT coverage while raising the same amount of revenue as before the reform. This entails that on average, the actual VAT rate by sector will fall. The significance or otherwise of the effects of this simulation should render an insight into the traditional argument that low tax rates applied to a broad base are associated with less welfare costs than higher tax rates on a narrow base that yield the same total revenue. The simulation will thus throw light

on the argument by the government (Budget Speech, 2007) that a substantial reduction in the statutory VAT rate is only sustainable with a broader VAT base in Zambia. I denote this experiment FULLVAT2.

In the second broad experiment, I simulate an increase in the agriculture sectors except the staple food sector. This experiment mimics the decision by government in 2006 to standard rate all agriculture, which was previously VAT exempt, with the exception of maize, maize meal and infant food. This decision was amended before it came into effect due to an outcry from various quarters of the economy on its likely impact. I denote this experiment AGRIVAT.

The resulting change in revenue from this experiment is absorbed by a change in direct tax rates on domestic institutions on order to close the government balance. In all the simulations, government consumption is held fixed in order to avoid a 'free lunch' on welfare. The simulations are conducted under a scenario of an imperfect rebate system ($\varphi_c^{vat} = 0.5$). However, in order to assess the impacts of the rebate system on the economy, I run experiments under a perfect rebate system ($\varphi_c^{vat} = 1$) and compare the welfare effects of this scenario to those obtained under the imperfect rebate scenario.

3.3.5 Overview of Transmission Mechanism of the Simulations

Changes in VAT coverage alter the relative prices of composite goods impacting on both production and consumption. The direct impact on production is channelled through intermediate goods used as inputs into the production process. Broadening VAT coverage to sectors with limited or no ex ante coverage alters relative prices of aggregate intermediate goods in production. This engenders a resource re-allocation within value-added favourable to the ex ante limited VAT covered sector. Hence returns to factors are affected and this ultimately impact on household welfare. Household welfare is also impacted directly by changes in relative prices of the composite commodity because it enters into the household utility function. However, how all these forces interact to determine the final impact on the economy is dependent on the underlying economic structure as captured by the general equilibrium model.

3.4 Simulation Results

In this section I discuss results from the static Zambia CGE VAT model. Results are presented on macroeconomic effects, sectoral effects and household welfare effects. These results are presented as comparative statics from the benchmark equilibrium scenario.

3.4.1 Macroeconomic Effects

The short-run effects of all the options on broadening the VAT base cause real GDP at market prices to decline[4]. The decline is largest in the FULLVAT1 reform in which the VAT rate in all sectors is raised to a maximum rate in the benchmark. Raising the VAT rate increases the wedge between producer and consumer prices. The price wedge is larger for FULLVAT1, compared to other reform options, given its larger downward push on the producer price index (PDIND) relative to the model *numéraire*, the CPI.

Table 3.9: Changes in Real GDP and other Macroeconomic Variables

	BASE	FULLVAT1	FULLVAT2	AGRIVAT
GDP	8597.1	-3.3	-0.2	-0.4
Private Cons.	8241.1	-3.7	-0.3	-0.5
Exports	3119.7	-1.8	-0.1	-0.2
Imports	7094.4	-1.1	-0.1	-0.2
REXR	74.9	-3.3	-0.3	-0.3
PDIND	133.5	-4.2	-0.2	-0.9
IMPTAXGDP	2.1	-0.1		
VATTAXGDP	3.8	9.3	0.5	0.8
DIRTAXGDP	9.0	-6.3		-0.6

Non-BASE columns show percentage change from base. Base column shows base year quantities.

[4] The Real GDP resulting from the simulation and its components are calculated using base prices (with base taxes)

The effect of this price wedge is mainly absorbed by consumers and hence the fall in private consumption. It is this fall in private consumption that drives the fall in GDP.

Broadening the VAT base causes an appreciation in the real exchange rate (REXR). The real exchange rate appreciates by 3.3 percent under FULLVAT1 and by 0.3 percent for both FULLVAT2 and AGRIVAT. This is because of a decline in imports due to an increase in their domestic prices given that imports attract VAT. Imports fall by 1.1% under FULLVAT1, by 0.1% under FULLVAT2 and by 0.2% under AGRIVAT. The appreciation in the real exchange rate leads to exports losing competitiveness on the international market and hence total exports decline as well.

Comparing the two variants of FULLVAT, it can be seen that effects of FULLVAT2 are moderated unlike in the case of FULLVAT1. This is because the actual tax rate falls in order to maintain constant revenue, leading to a fall in relative prices in those sectors initially with more VAT coverage and vice-versa. Therefore, a decline in private consumption is dampened. The muted impact of AGRIVAT on the macro-economy can also be explained in the same light. The consumer prices for agriculture commodities increase relative to the CPI while prices for commodities not directly or indirectly affected by increased VAT coverage in the agriculture sector fall. Hence, private consumption does not drop that much.

The revenue boost from FULLVAT1 increases VAT revenue as a percentage of GDP by 9.3 percentage points. This is offset by a 6.3 percentage point decline in direct tax as a percentage of GDP in accordance with the selected neutral closure on government. VAT revenue to GDP under FULLVAT2 increases only by 0.5 percentage points. This is because the VAT itself is being used as a recycling instrument of the revenue arising from the reform. The VAT revenue boost from AGRIVAT increases the VAT to GDP ratio by 0.8 percentage points. This result is more than the anticipated gain of 0.1 percentage points from standard rating agriculture as estimated by government in the 2006 National budget. This underscores

the importance of indirect effects that a general equilibrium framework is able to account for.

3.4.2 Sectoral Impacts

In order to see what could possibly drive the macro shifts that are observed in the earlier section, I now consider the sectoral impacts of the simulations. The first port of call is to look at the impact on relative prices.

Figure 4.4 shows relative changes of prices for composite commodities or simply final market prices of commodities. For a FULLVAT1 and FULLVAT2, the final market prices of commodity groups that had relatively low VAT coverage, ex ante, such as staple food agriculture, other agriculture and public services, increase relative to the CPI.

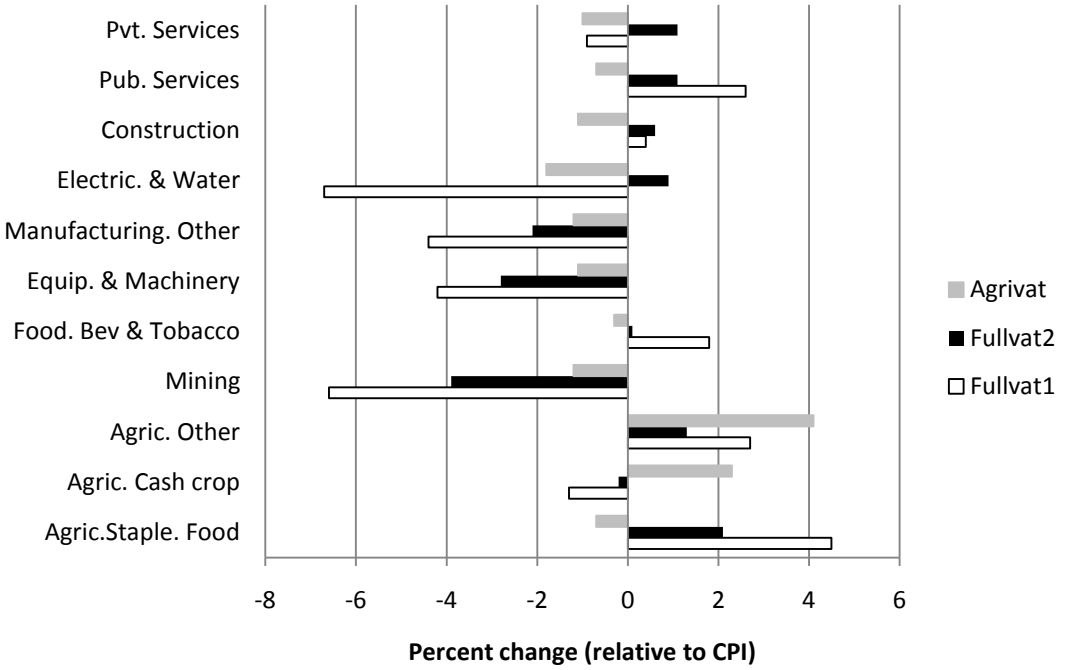


Figure 3.4: Relative Changes to Purchaser Prices of Composite Commodities

For AGRIVAT, all prices of all commodity groups decrease relative to the CPI, except for commercial and other agriculture which are directly affected by the reform. Changes in prices of final market commodities filter into prices for intermediate inputs depending on the extent of VAT rebates. According to Figure 3.5, the higher

the increase in actual VAT rate (the broader the VAT coverage) associated with the reform, the higher the reduction in the price of aggregate intermediate inputs relative to the CPI. In particular, the FULLVAT1 reform is associated with the highest increase in the actual VAT rate and it experiences a higher reduction in prices of aggregate intermediate inputs. The price reduction for aggregate intermediate inputs is smaller or absent for sectors whose use is intensive of intermediate inputs from sectors with increased purchaser prices as shown in Fig. 3.4 above.

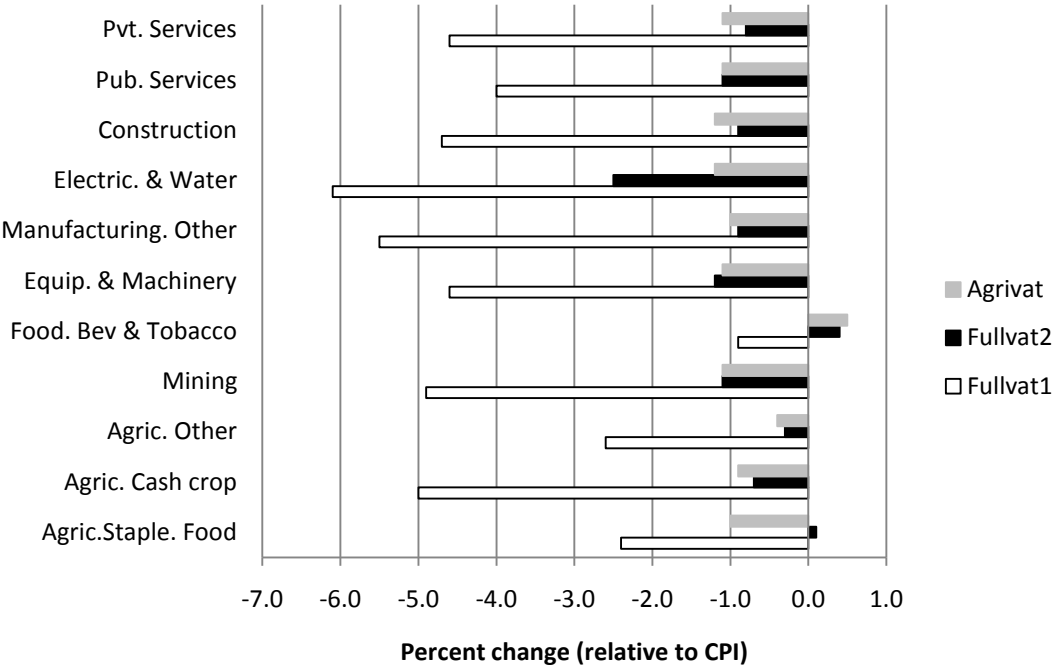


Figure 3.5: Relative Changes in Prices of Aggregate Intermediate Inputs

Under FULLVAT2, the processed food, beverages and tobacco sector experience an increase in the price for its intermediate inputs relative to the CPI. This sector uses relatively higher intermediate inputs from the agriculture sectors which have experienced a higher relative increase in prices for final commodities. Given an imperfect rebates system assumed, the two sectors experience a higher retention of input VAT in their total cost of intermediate inputs. The same explanation applies for the behaviour of the price of intermediate inputs for the food, beverages and tobacco sector under AGRIVAT.

Given that intermediate input prices decline for most of the sectors while production output prices decline (see Fig. 3.6), the overall return to factors (price of value added) for various sectors may have also declined. Under a VAT with a functioning rebate system, an increase in VAT coverage is expected to engender a reallocation of factors within value-added, beneficial to the mobile factor, in this case labour. Thus, the relative return to labour is expected to rise. However, the relative impact of this increase on the overall return to factors depends on the level of substitution between factors in value-added.

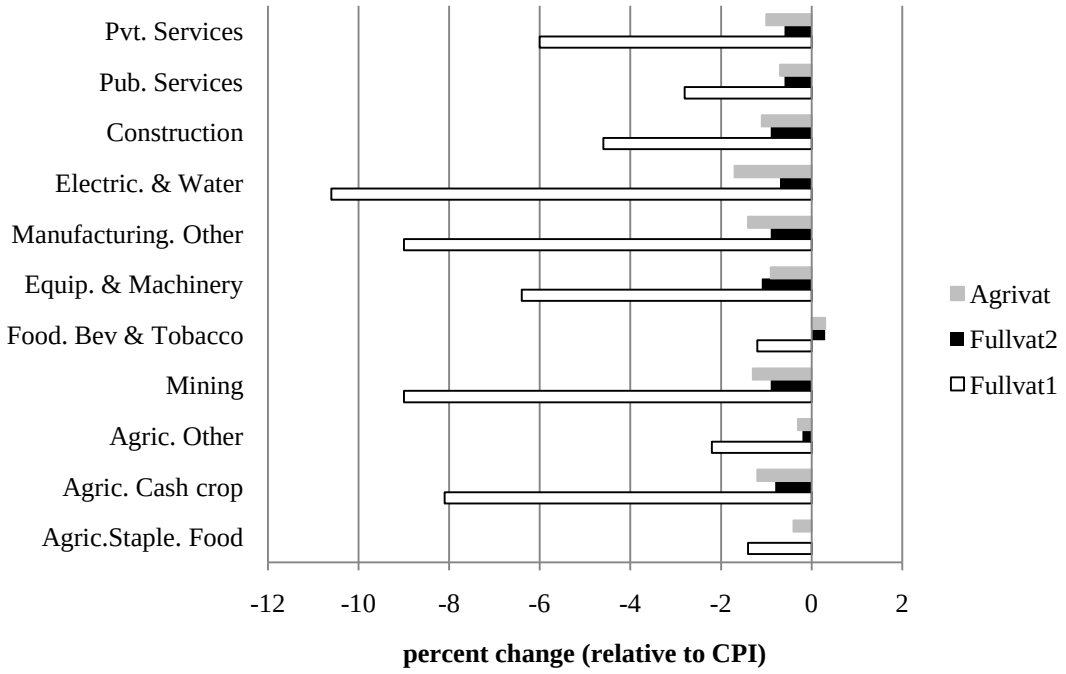


Figure 3.6: Relative Changes in Prices of Production Output

According to Figure 3.7, the overall return to factors for sectors, captured by the price of value added has fallen. The highest fall in the price of value added is recorded for sectors with a high intensity of capital in its total value-added. These are mining, manufacturing and energy (electricity and water).

The overall return to factors may have declined as Figure 3.7 indicates; however, a further analysis of specific changes in income received by factors gives a more informed picture. Table 3.10 shows percentage shares of base factor income and their deviations from base under the different shocks. In general, there is a re-distribution

of factor income from capital towards labour. This can be seen clearly from the FULLVAT1 and AGRIVAT reforms (effect under FULLVAT2 is negligible).

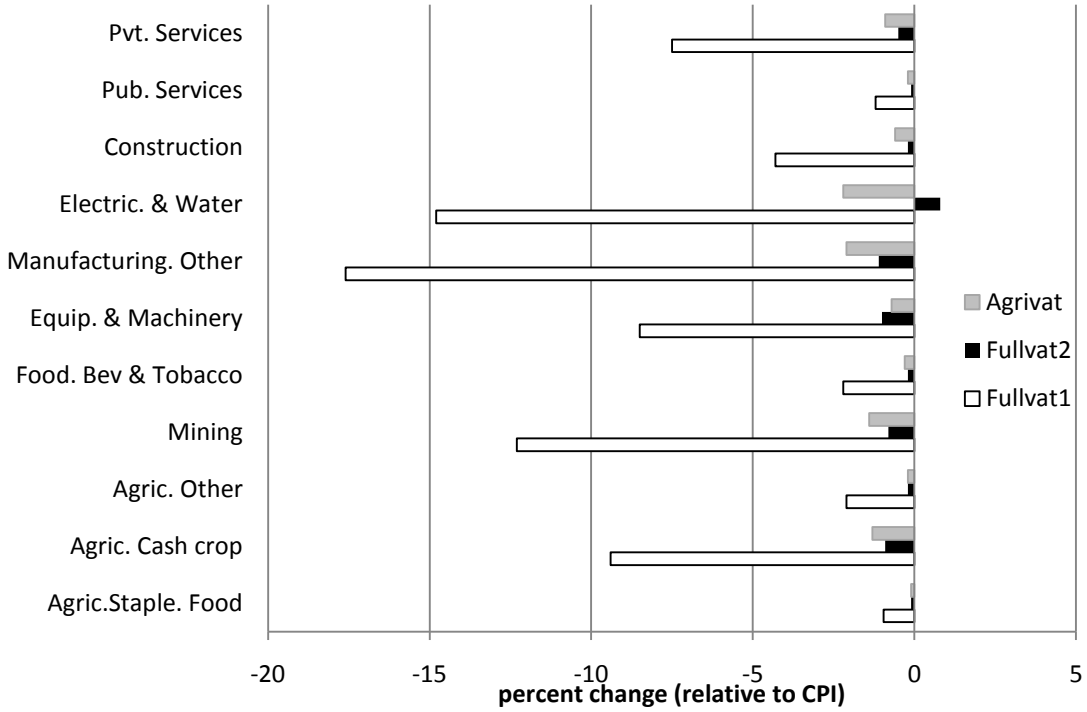


Figure 3.7: Relative Changes in Prices of Value Added

All labour categories increase their share in factor income while both mining and other capital experience a decline. This confirms the effect of VAT with rebates on resource allocation as advanced by the heuristic analysis in Emini (2000).

Table 3.10: Disaggregated Factor Income Distribution

	BASE	FULLVAT1	FULLVAT2	AGRIVAT
LNONE	12.8	0.4	0.1	
LPRIM	15.0	0.2		
LSECD	8.9	0.1		
LPOST	9.3	0.2		
KAPAGR	3.3			
KAPMIN	6.6	-0.2		
KAPOTH	42.9	-0.7	-0.1	
LAND	1.2			
TOTAL	100.0			

Note: missing values imply zero impact.
The base column show %-age shares of base factor incomes. Non-base columns show deviation from base.

This implies that moving towards a broader VAT coverage in the short-run reduces the cascading of input tax in the system and induces a resource allocation towards the mobile factor, which is labour in this instance. Hence, the returns to labour increase in contrast to returns on the immobile factor, capital. Appendix E presents more results on impacts on the supply of the mobile factor labour as well as the disaggregated activity levels by sector.

3.4.3 Household Welfare Effects

To analyse current-period household welfare effects, I focus on household consumption effects. While household welfare is also dependent on government consumption, this is held fixed in the model. This is because the model does not provide for how to assess the impact of government consumption on welfare. The level of household consumption is linked to incomes received by households. In turn, incomes of households are affected primarily by the relative returns on the factors of production that they own. The household level results therefore, are a logical culmination of sectoral effects I have discussed in the previous section.

Figure 3.8 presents changes in nominal and real household expenditure for FULLVAT1. The use of the term ‘nominal’ here is rather a misnomer since these values do not contain the influence of general price inflation since the CPI is held constant (see McDonald et al., 2006). In this case the difference between nominal and income expenditure is due to household-specific price changes for consumption commodities.

According to Figure 3.8, all rural households, with the exception of the medium and large scale farmers, experience an adverse price effect following a full VAT reform in which actual VAT rates in all sectors is raised to be uniform to the maximum rate in the baseline. Their real household consumption expenditure dips more than their nominal consumption expenditure.

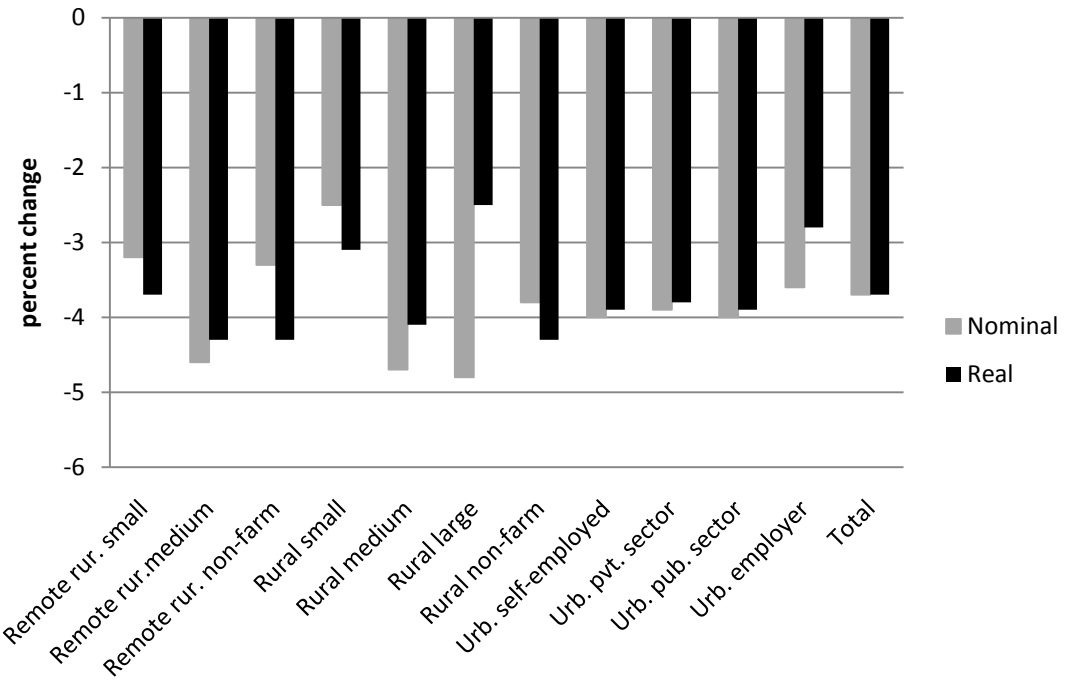


Figure 3.8: Household Consumption Effects from a full VAT Reform (1)

Under the second variant of a full VAT reform, in Figure 3.9 a similar picture is painted as that of the first variant in terms of who suffers an adverse price effect among rural households. However, among urban households, a different scenario occurs. All urban households, apart from the urban employer household, now experience an adverse price effect. This is because the attenuating effect from reduced income tax rate, which was used as a tax recycling instrument in variant (1) is now absent. The other significant difference is that the effects are less pronounced in the second variant than the first variant. This owes to the type of tax recycling instrument. VAT has a broader tax base in Zambia compared to income tax. Thus, an endogenous reduction in the VAT rate to recycle revenue from a full vat is likely to have a wider and stronger positive effect on household consumption outcomes.

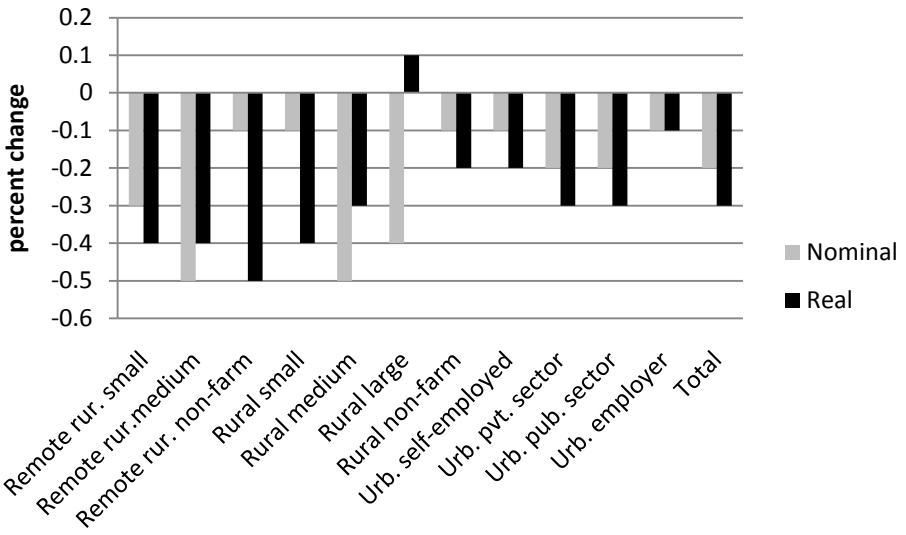


Figure 3.9: Household Consumption Effects from a full VAT Reform (2)

Figure 3.10, shows household consumption expenditure effects following a reform that increases VAT coverage in the agriculture sector. A snapshot on these effects indicates that no household experiences an adverse price effect. Real household consumption expenditure for all households declines much less than nominal household consumption expenditure.

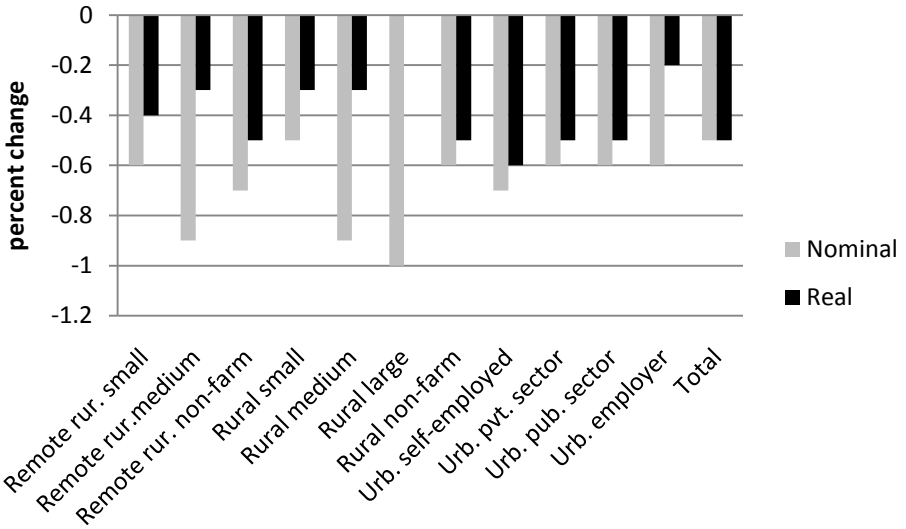


Figure 3.10: Household Expenditure Effects from an Agriculture VAT Reform

However, urban households experience a larger fall in their real consumption expenditures than rural household. When compared to the total change in real household consumption expenditure, changes for rural households are much smaller. In order to get a deeper insight into the actual losses or gains in welfare resulting from the reforms, Table 3.11 presents the equivalent variation calculations.

Table 3.11: Disaggregated Equivalent Variation on Consumption

	BASE	FULLVAT1	FULLVAT2	AGRIVAT
Rural				
Remote				
Small scale	1259.1	-3.4	-0.4	-0.3
Medium scale	96.7	-3.8	-0.3	-0.2
Non-farm	137.5	-4.3	-0.4	-0.5
Non-Remote				
Small scale	1568.3	-3.2	-0.4	-0.3
Medium scale	165.8	-3.9	-0.3	-0.2
Large scale	121.3	-2.2	0.1	0.0
Non-farm	340.9	-4.3	-0.2	-0.5
Urban				
Self-employed	2528.9	-3.9	-0.1	-0.6
Pvt. employed	1253.0	-3.8	-0.3	-0.5
Pub. employed	2434.8	-3.9	-0.3	-0.5
Employer	834.4	-2.8	-0.1	-0.2

Non-BASE columns show percentage change from base. Base column shows base year quantities.

Under FULLVAT1, all households experience losses in their welfare. The most distinct result is that of rural non-farm households and urban-employer households. The rural non-farm households experience the worst loss in welfare while the urban-employer households are least affected. The explanation for this is straight forward.

The rural non-farm households spend disproportionately large amounts of their income, *inter alia*, on commodities whose relative price changes are largest such as agriculture commodities. The opposite is true for the least affected urban employer households. For the second variant of moving towards a full VAT, the effects are moderated and therefore all households experience smaller losses compared to the first variant. The difference between these two variants of a full vat reform lies in how the resulting VAT revenues are recycled. The inference from these results is that a full VAT reform which is associated with a reduced VAT rate other than reduced income tax rates has smaller adverse effects on household welfare in the short-run.

Overall, the most worse off households under the reform towards a full VAT are the rural ones. Rural households are predominantly poor compared to urban households. This is a rough indication of the regressive nature of a VAT levied on a broad base without any exceptions. According to Steenkamp (2005), this is because consumption as a percentage of income decreases as individuals move up the income ladder given that high income earners tend to save proportionally more, leaving them with a proportionally lower tax burden. The notion of VAT regressiveness in this analysis is however subject to the caveat mentioned earlier on regarding answering incidence questions. Consequently, this result is treated as a rough indication.

The welfare losses from broadening VAT to the agriculture sector are higher for urban households compared to rural households. This is because rural households, with the exception of non-farm households, consume relatively small proportions of marketed agriculture commodities. Most of their consumption of agriculture commodities is from home or own consumption. Thus, the existing policy of exempting agriculture commodities disproportionately benefits the urban households compared to the rural ones.

As alluded to earlier, the value added tax exhibit economic neutrality in that it does not distort resource allocation decisions due to its system of rebating VAT paid by producers on their intermediate input purchases. Thus, the extent to which the rebate system is applied has an impact on production and ultimately on welfare. In order to

assess this notion I run experiments on the three reforms assuming a perfect rebate system. The results are presented in Table 3.12.

It is clear from the results that the efficiency of the rebate system has an impact on welfare. When the rebate system is operating at 100 percent, the welfare losses are attenuated. Under an AGRIVAT with a perfect rebate system most rural households do not experience welfare losses. However, an interesting finding is that of FULLVAT2.

Table 3.12: VAT Rebates and Household Welfare

	50 PERCENT REBATES			**100 PERCENT REBATES**		
	FULLVAT1	**FULLVAT2**	**AGRIVAT**	**FULLVAT1**	**FULLVAT2**	**AGRIVAT**
HRRS	**-3.4**	**-0.4**	**-0.3**	-2.2	-0.3	0.0
HRRM	**-3.8**	**-0.3**	**-0.3**	-2.5	-0.2	0.0
HRRN	**-4.3**	**-0.4**	**-0.5**	**-3.0**	**-0.3**	**-0.2**
HRS	**-3.2**	**-0.4**	**-0.3**	**-2.1**	**-0.3**	**-0.1**
HRM	**-3.9**	**-0.3**	**-0.2**	**-2.6**	**-0.2**	**0.0**
HRL	**-2.2**	**0.0**	**0.0**	**-1.3**	**0.1**	**0.1**
HRN	**-4.3**	**-0.2**	**-0.5**	**-3.1**	**-0.2**	**-0.3**
HUSE	**-3.9**	**-0.2**	**-0.6**	**-2.7**	**0.0**	**-0.3**
HUPR	**-3.8**	**-0.3**	**-0.5**	**-2.9**	**-0.3**	**-0.4**
HUPU	**-3.9**	**-0.3**	**-0.5**	**-2.9**	**-0.3**	**-0.4**
HUEM	**-2.8**	**-0.1**	**-0.2**	**-2.2**	**-0.2**	**-0.2**

While the welfare losses for rural households are attenuated by the efficiency in the rebates system, the losses for urban households are not. In fact for the urban-employer household, the loss in welfare dips a bit. The explanation for this seemingly queer result goes back to the effect that VAT with rebates engenders on resource allocation. In the short-run, the effect of increasing rebates on input VAT induces a resource re-allocation towards the mobile factor, which is labour in this case. An examination of income factor distribution under a FULLVAT2 with 100 percent rebates shows that the share of income going to mining capital declines. The decreased return to mining capital must be primarily responsible for the increasing loss in welfare, via income, for the urban-employer households and to an extent, for the un-attenuated loss for the public and private employee households. These households are the beneficiaries of dividends on capital. At the same time FULLVAT2 uses a reduction in the VAT rate for recycling revenue from the experiment and not a reduction in the income tax rate from which these households would have benefited more relative to other households.

3.5 Sensitivity Analysis

To get a good insight of the impacts of the parameter values on the model results, I conduct a sensitivity analysis. The parameters that I subject to sensitivity analysis are the production and the trade elasticities in relation to household welfare effects. The production elasticities refer to the factor substitution in value-added (capital and labour). The trade elasticities refer to the import (Armington) and export (CET) elasticities.

The elasticities in the baseline are augmented by 20 percent and reduced by 20 percent to yield high and low elasticity values, respectively. The baseline elasticities make up the central elasticity values. The results of the sensitivity analysis are presented in Appendix D. On the overall, the changes in welfare as a result of elasticity changes are very small and not drastic. All the negative EV results remain negative and the positive EV results remain positive. From the foregoing, therefore, I can conclude that the results are stable and thus are not merely an outcome of the parameters selected for the model.

3.6 Limitations of the Zambia VAT CGE Model

The Zambia VAT CGE model used in the analysis in this Chapter is a static CGE model. This means that capital (as well as land) is fixed and sector-specific. Therefore, the model is only suited to capture short-run or transitional effects of changes in VAT. In the medium to long term, all production factors would be variable and mobile across sectors. This would induce additional effects such that probably the short-run welfare deterioration observed in all simulations would disappear or turn into gains. Emini (2005) identified differential effects of a VAT between the short-run and long-run in his study on Cameroun. Nevertheless, Zambia VAT CGE model has provided some enlightening results for the transitional period and the conclusions should be restricted to and viewed within this context.

3.7 Discussion and Conclusions

In this Chapter I develop a static CGE model with explicit specification of VAT with rebates. I use the CGE model to analyse the effects of reforming VAT in Zambia under two options. The first option, with two variants, is the move towards a full VAT. The second option is the move towards bringing agriculture into the VAT net. The results shed some light on the short-run effects of these reforms on the macro level, the sectoral level and most importantly on the welfare of the households. Furthermore, a sensitivity analysis is conducted on the production and trade elasticities. The overall results of the sensitivity analysis reveal that the model is robust.

The simulation results reveal that a move towards a full VAT that raises the actual VAT rate in all sectors to be uniform to that of the highest covered sector has the ability to increase VAT revenue to GDP by 9.3 percentage points in the short-run. However, this is likely to induce a recession largely due to a contraction in private consumption. At sectoral level, the final market prices of sectors that had relatively low VAT coverage *ex ante* increase relative to the CPI. Changes in relative prices of final market prices filter into prices for intermediate inputs. Sectors which used intermediate inputs which initially attracted no or minimal VAT rebates experience the lowest fall in relative intermediate prices. The changes in intermediate prices due to the presence of VAT rebates appear to have a re-allocation effect, within value-added, beneficial to labour as predicted. The short-run redistribution of factor income from capital towards labour is observed. Thus, the model was able to capture the rebate system well. The household welfare effects of this reform are negative. The welfare effects tend to be uniform across the small to medium scale farm households in rural areas and the 'low to medium' income households in the urban areas. The non-farm rural households experience the worst loss in welfare while the urban employer household and the large scale farmers experience the least loss.

A move towards a full VAT that allows the actual VAT rate in all sectors to be uniform to the rate that maintains total government revenue constant has less adverse effects on the short-run economy. However, it raises only half a percent of VAT revenue to GDP. This variant of a full VAT reform uses an endogenously determined VAT rate, which falls so as to maintain constant total revenue. The sectoral impacts are on similar lines as those observed in the first variant but the re-distribution of factor income from the immobile factor to the mobile factor is negligible. The household welfare losses under this variant of the reform are minimal compared to the first variant above which uses a reduction in income tax rate as a revenue re-cycling instrument. This indicates that a move towards a full VAT that is associated with a reduced VAT rate than reduced income rates would have less adverse welfare consequences in the short-run. This is because VAT has a broader base than income tax. Thus a lower rate on a wider base is likely to be associated with lower welfare costs. The implication of this for tax policy is that any policy aimed at reducing the VAT rate should be accompanied by a widening of the VAT base so as to preserve revenue.

An increase in VAT coverage in the agriculture sectors apart from the staple food sectors shows minimal adverse impacts on the macro economy and generates close to a percentage of VAT revenue to GDP. At sectoral level, an increase in VAT coverage to the agricultural sectors causes an increase in relative final market prices in these sectors and this filters into relative prices of intermediate inputs engendering a re-allocation within value-added beneficial to labour. This is confirmed by a re-distribution of factor income from capital to labour. The loss in welfare arising from this reform is more pronounced among urban households than rural households. Therefore, the indication from this is that the policy of exempting agriculture is more beneficial to urban households, who are relatively better off, than he rural households. This means that bringing in more agriculture supplies under the VAT net than is currently the case, offers a possibility of reforming VAT in Zambia with minimal welfare losses.

The model experiments also show the importance of a well functioning rebate system on the economy. The imperfections in the rebate system are likely to affect the welfare implications of changes to VAT. Model results showed that welfare losses fell with an improvement in the functioning of the rebate system. This being the case, if Zambia were to reduce further the distortions caused by input VAT on production decisions by bringing the activities of the informal sector under VAT, the welfare cost of extending the VAT base to more sectors such as the agricultural sector would be minimised.

The overall conclusions from the foregoing are as follows. Extending the VAT coverage to all sectors with very minimal or no exclusions should be accompanied with reductions in the VAT rate, given that a full VAT reform with income tax as a recycling instrument proved to be the most welfare worsening scenario in the short run. In the same vein, calls for further reductions in the VAT rate as observed in the on-going debate on VAT reform in Zambia, should be made bearing in mind that if revenue has to be preserved, more sectors should be brought under the VAT net. Important to note however, is that the study is not able to establish by how much the reduction in the VAT rate should be as the model used actual VAT rates which deviate from the standard VAT rate.

The second and final conclusion is that contrary to the widely held view in the debate on VAT reform in Zambia, extending the VAT coverage to agricultural sectors apart from maize sector is not likely to hurt the worse-off socio-economic groups. The short-run welfare losses of such a reform appear to be more disproportionately borne by the urban households whose incidence of poverty is low compared to the rural households. Therefore, bringing more agricultural commodities under VAT coverage provides one of the viable options to reforming VAT in Zambia.

CHAPTER 4 : SUMMARY AND CONCLUDING REMARKS

4.1 Introduction

In this thesis I have attempted to contribute to the ongoing debate about how to reform the value added tax (VAT) in Zambia in the wake of the realisation that the country has to depend more on its tax system to finance its economic developmental agenda in a predictable manner. The VAT was central to the tax reform process initiated in the early 1990s and it still continues to dominate tax policy in Zambia being one of the major contributors to tax revenue.

In order to establish a basis for the selection of options on reforming VAT, I conducted a tax incidence analysis using welfare dominance. As a methodological enhancement, I applied compliance coefficients to the calculation of VAT paid by each household. This methodological enhancement was aimed at taking into account differences in VAT compliance across households (in rural and urban) and across commodities.

The selected options on VAT reform were simulated within a general equilibrium framework. A CGE model with capabilities of capturing VAT with rebates on intermediate purchases was developed and was called the Zambia CGE VAT model. On the basis of the Zambia CGE VAT model, two simulation experiments with respect to extending the VAT base to all sectors and extending the VAT base to the agriculture sector minus the maize sector were carried out. The imacts of these simulations on macro-economic variables, sectoral variables and household level variables were indentified.

The thesis was presented in four chapters. The first chapter introduced the research problem, specified the objectives of the study and reviewed the characteristics of VAT and performance of VAT revenue in Zambia. In the second chapter, I empirically determined who paid VAT in Zambia with an eye on possibilities for reforming the tax. In the third chapter, I adjusted the standard CGE model by IFPRI in order to model VAT with rebates on intermediate purchases. On the basis of the resulting

model, I carried out two simulations on reforming VAT in Zambia. The objective of this final chapter is to summarise the main findings and shed some light on future directions of research. The chapter is organised as follows. Section 4.2 presents the summary of the research findings, Section 4.3 highlight suggestions for future research

4.2 Summary of Research Findings

In this section I summarise the major findings of the study starting from the descriptive aspects on characteristics of VAT and its performance, through the empirical analysis of who pays the VAT, to the impacts of reforming VAT within a CGE framework.

The descriptive analysis of characteristics of VAT in Zambia reveals that while VAT largely conforms to what is referred to as "best practice" in VAT design, it has exemptions beyond the core exemptions and zero-rating other than for exports. Basic food and agriculture is one of the key exemptions. The rationale for exempting most of the items beyond the core exemptions largely lies in the notion that doing so will ameliorate the distributional consequences of the tax. The explanations behind the existing zero-rated items are varied ranging from distributional concerns to production and consumption incentives.

While all the non-standard VAT zero-rated and exempted supplies in Zambia can be rationalized, they are likely to have an impact on revenue yield. Zero-rating other than that of exports reduces VAT revenue because while no tax is paid on output, VAT paid on inputs is reclaimable. Exemptions on the other hand can have many effects and some of them quite complex. Notably, exemptions break the VAT chain and depending on where the break occurs, they may increase or reduce revenue; exemptions of items used as inputs in other production processes distorts production choices, thereby eliminating one of the merit key features a well-functioning VAT renders; the tax cascading that an exemption introduces induces some firms to self-supply; exemptions 'feed on one another', thereby creating an exemption creep. Consequently, shedding some of the exemptions is one of the possible ways in which VAT in Zambia can be reformed.

Descriptive analysis on the performance of VAT revenue shows that on the basis of both the efficiency and 'C-efficiency' ratios, revenue performance has been weakening since 2001. On average VAT in Zambia generates 0.3 percentage points of GDP in revenue for every one percentage point of the standard rate. This falls below the average of 0.4 percentage points to GDP that a VAT with few exemptions can generate. The 'C-efficiency' ratio has remained around 0.4 (40 percent), which deviates significantly from unity (100 percent).

The results on the analysis of who pays VAT, review that VAT in Zambia is mildly regressive as the top expenditure households face lower effective VAT rates, relative to their expenditure levels than the remainder of the households. This is confirmed by a result of dominance of the concentration curve for VAT over the Lorenz curve of expenditure. A rural-urban split indicates that VAT is more regressive for urban households compared to rural households. VAT on food is found to dominate VAT on non-food. In terms of rural and urban, VAT on food for urban households dominates VAT on food for rural households. Hence, urban households bear a heavier burden of VAT on food than rural households. Results also show that for the rural households, non-food VAT is more regressive than food VAT.

The conclusion from the above findings is that the burden of VAT is largely borne by urban households who are relatively better off compared to the rural households. This indicates that VAT can be extended to cover some of the currently exempted items at low welfare cost. This would create fiscal space to undertake more activities as envisaged in the Fifth National Development Plan (FNDP) 2006-2011.

The simulation results reveal that a move towards a full VAT that raises the actual VAT rate in all sectors to be uniform to that of the highest covered sector has the ability to increase VAT revenue to GDP by 9.3 percentage points in the short-run. However, this is likely to induce a recession largely due to a contraction in private consumption. At sectoral level, the final market prices of sectors that had relatively low VAT coverage *ex ante* increase relative to the CPI. Changes in relative prices of

final market prices filter into prices for intermediate inputs. Sectors which used intermediate inputs which initially attracted no or minimal VAT rebates experience the lowest fall in relative intermediate prices. The changes in intermediate prices due to the presence of VAT rebates appear to have a re-allocation effect, within value-added, beneficial to labour as predicted. The short-run redistribution of factor income from capital towards labour is observed. Thus, the model was able to capture the rebate system well. The household welfare effects of this reform are negative. The welfare effects tend to be uniform across the small to medium scale farm households in rural areas and the 'low to medium' income households in the urban areas. The non-farm rural households experience the worst loss in welfare while the urban employer household and the large scale farmers experience the least loss.

A move towards a full VAT that allows the actual VAT rate in all sectors to be uniform to the rate that maintains total government revenue constant has less adverse effects on the short-run economy. However, it raises only half a percent of VAT revenue to GDP. This variant of a full VAT reform uses an endogenously determined VAT rate, which falls so as to maintain constant total revenue. The sectoral impacts are on similar lines as those observed in the first variant but the re-distribution of factor income from the immobile factor to the mobile factor is negligible. The household welfare losses under this variant of the reform are minimal compared to the first variant above which uses a reduction in income tax rate as a revenue re-cycling instrument. This indicates that a move towards a full VAT that is associated with a reduced VAT rate than reduced income rates would have less adverse welfare consequences in the short-run. This is because VAT has a broader base than income tax. Thus a lower rate on a wider base is likely to be associated with lower welfare costs. The implication of this for tax policy is that any policy aimed at reducing the VAT rate should be accompanied by a widening of the VAT base so as to preserve revenue.

An increase in VAT coverage in the agriculture sectors apart from the staple food sectors shows minimal adverse impacts on the macro economy and generates close to a percentage of VAT revenue to GDP. At sectoral level, an increase in VAT coverage

to the agricultural sectors causes an increase in relative final market prices in these sectors and this filters into relative prices of intermediate inputs engendering a re-allocation within value-added beneficial to labour. This is confirmed by a re-distribution of factor income from capital to labour. The loss in welfare arising from this reform is more pronounced among urban households than rural households. Therefore, the indication from this is that the policy of exempting agriculture is more beneficial to urban households, who are relatively better off, than he rural households. This means that bringing in more agriculture supplies under the VAT net than is currently the case, offers a possibility of reforming VAT in Zambia with minimal welfare losses.

The model experiments also show the importance of a well functioning rebate system on the economy. The imperfections in the rebate system are likely to affect the welfare implications of changes to VAT. Simulation results showed that welfare losses fell with an improvement in the functioning of the rebate system. This being the case, if Zambia were to reduce further the distortions caused by input VAT on production decisions by bringing the activities of the informal sector under VAT, the welfare cost of extending the VAT base to more agricultural activities would be minimised.

The overall conclusions from the foregoing are as follows. Extending the VAT coverage to all sectors with very minimal or no exclusions should be accompanied with reductions in the VAT rate, given that a full VAT reform with income tax as a recycling instrument proved to be the most welfare worsening scenario in the short run. In the same vein, calls for further reductions in the VAT rate as observed in the on-going debate on VAT reform in Zambia, should be made bearing in mind that if revenue has to be preserved, more sectors should be brought under the VAT net. Important to note however, is that the study is not able to establish by how much the reduction in the VAT rate should be as the model used actual VAT rates which deviate from the standard VAT rate.

The second and final conclusion is that contrary to the widely held view in the debate on VAT reform in Zambia, extending the VAT coverage to agricultural sectors apart from maize sector is not likely to hurt the worse-off socio-economic groups. The short-run welfare losses of such a reform appear to be more disproportionately borne by the urban households whose incidence of poverty is low compared to the rural households. Therefore, bringing more agricultural commodities under VAT coverage provides one of the viable options to reforming VAT in Zambia.

4.3 Suggestions for Further Research

My suggested area for further research is directly and indirectly linked to the limitations of the Zambia CGE VAT model indentified in Chapter 3. Firstly, it would be important to study how the tax to GDP ratio evolves over time assuming no changes in the tax structure. This would allow for revenue to grow at the same rate as GDP and it would be important in determining whether a growing economy alone would increase the tax to GDP ratio. The significance or otherwise of the findings of such an analysis would provide justification for strategies that aim to broaden the tax base such as the one carried out in my study as these presumes that additional revenue can only arise from such. It would also be ideal to study the medium to long-run impacts of VAT broadening. In order to carry out all these analyses, it would be ideal to extend the Zambia CGE VAT model to incorporate recursive dynamics whereby investment is allowed to add to capital stock in each period. It would also be important to direct some resources towards constructing a more comprehensive SAM for a more recent base year. This SAM should incorporate a more disaggregated tax account which includes VAT rebates. The disaggregation at activity and commodity levels should also be comprehensive enough to isolate sectors with different status for VAT purposes.

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Appendix A: The Mathematical Model

Notation Principles

Endogenous variables	upper-case Latin letters without a bar
Exogenous variables	upper-case Latin letters with a bar
Parameters	lower-case Latin letters (with or without a bar) or lower-case Greek letters (with or without superscripts)
Set indices	lower-case Latin letters as subscripts to variables and parameters

Sets

A	Set of activities
C	set of commodities
CD	set of commodities with domestic sales of domestic output
CDN	set of commodities without domestic market sales of domestic output
CE	set of exported commodities
CEN	set of non-exported commodities (complement of CE)
CM	set of imported commodities
CMN	set of non-imported commodities
CT	set of domestic trade inputs
CX	set of commodities with domestic output
F	set of factors
FLAB	set of labour categories
H	set of households
INS	set of institutions (domestic and rest of the world)
INSD	set of domestic institutions
INSDNG	set of domestic non-government institutions

Parameters

α_c^{ac}	shift parameter for domestic commodity aggregation function
α_c^{q}	CES (Armington) function shift parameter
α_c^{t}	CET function shift parameter
α_a^{va}	efficiency parameter in the CES value-added function
β_{ch}^{m}	marginal share of consumption spending on marketed commodity c for household h
β_{ach}^{h}	marginal share of consumption spending on home commodity c from activity a for household h
δ_{ac}^{ac}	share parameter for domestic commodity aggregation
δ_c^{q}	CES (Armington) function share parameter
δ_c^{t}	CET function share parameter
δ_{fa}^{va}	CES value-added function share parameter for factor f in activity a
ρ_a^{ac}	domestic commodity aggregation function exponent
ρ_c^{q}	CES (Armington) function exponent
ρ_c^{t}	CET function exponent
ρ_a^{va}	CES value-added function exponent

γ_{ch}^{m} subsistence consumption of marketed commodity c for household *h*

γ_{ach}^{h} subsistence consumption of home commodity *c* from activity *a* for household *h*

φ_c^{vat} rebate efficiency parameter

$cwts_c$ weight of commodity c in the consumer price index

$dwts_c$ weight of commodity c in the producer price index

ica_{ca} quantity of c per unit of aggregate intermediate a

mps_i base savings rate for domestic institutions i

$mps01_i$ 0-1 parameter with 1 for institutions with potentially flexed direct tax rates

pwe_c f.o.b export price in foreign currency units

pwm_c c.i.f import price in foreign currency units

$qdst_c$ quantity of stock change

$\overline{qg}_c$ base-year quantity of government demand

$\overline{qinv}_c$ base-year quantity of fixed investment demand

$Shif_{if}$ share of domestic institution *I* in income factor f

$Shii_{ii`}$ share of net income to i' to i (i` Є INSDNG' and i Є INSDNG)

ta_a tax rate for activity

$\overline{tins}_i$ exogenous direct tax rate for domestic institution i.

$Tins01_i$ 0-1 parameter with 1 for institutions with potentially flexed direct tax rates

tm_c import tariff rate

tq_c rate of excise tax

$tvat_c$ rate of value-added tax

$trnsfr_{if}$ transfer from factor f to institution i

Variables

DMPS change in domestic institution savings rates (=0 for base; exogenous)

DPI producer price index for domestically marketed ouput

EG government expenditures

EH_h household consumption expenditure

EXR exchange rate (local currency unit per foreign currency unit)

GSAV government savings

MPSi domestic propensity to save for domestic non-government institutions (exogenous)

PAa activity price (gross revenue per activity unit)

PDDc demand price for commodities produced and sold domestically

PDSc supply price for commodities produced and sold domestically

PEc export price in local currency units

PINTAa aggregate intermediate input price for activity a

PMc import price in local currency units

PQc composite commodity market price

PVAa price of aggregate value-added

PXc aggregate producer price for commodity

PXACac producer price of commodity c for activity a

QAc quantity (level) of activity

QD_c quantity sold domestically of domestic output

QE_c quantity of exports

QF_{fa} quantity demanded of factor f for activity a

QG_c government consumption demanded for commodity c
QH_{ch} quantity of consumption demand for marketed commodity c
QHA_{ach} quantity of consumption demand for home commodity c
$QINT_{ca}$ quantity of commodity c as intermediate input into activity a
$QINV_c$ quantity of fixed investment demand for commodity c
QM_c quantity of imports of commodity
QQ_c quantity of goods supplied to domestic market (composite)
QVA_a quantity of aggregate value-added
QX_c aggregate quantity of domestic output of commodity c
$QXAC_{ac}$ marketed output of commodity c from activity a
$REBATE_a$' VAT rebates on intermediate input purchases to activity a
$TINS_i$ rate of direct taxes on domestic institutions
$TABS$ total nominal absorption
$TRII_{ii`}$ transfers from institutions i` to i
$VATREV$ total VAT revenue to government
WF_f average factor price
YG government revenue
YI_i income of institution i (in set INSDNG)
YIF_{if} income to domestic institution from factor f

Exogenous Variables

$\overline{CPI}$ consumer price index
$\overline{DTINS}$ change in domestic institution tax share
$\overline{FSAV}$ foreign savings in foreign currency
$\overline{GADJ}$ government consumption adjustment factor
$\overline{MPSADJ}$ savings rate scaling factor

$\overline{IADJ}$ investment adjustment factor
$\overline{QFS}_f$ quantity supplied of factor *f*
$\overline{TINSADJ}$ direct tax scaling factor
$\overline{WFDIST}_{fa}$ wage distortion factor for factor *f* in activity *a*

EQUATIONS

Price Block

Import price

$$PM_c = pwm_c \cdot (1 + tm_c) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c} \quad (1)$$

Export price

$$PE_c = pwe_c \cdot EXR - \sum_{c' \in CT} PQ_{c'} \cdot ice_{c'c} \quad (2)$$

Demand price of domestic non-traded goods

$$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c} \quad (3)$$

Absorption

$$PQ_c \cdot (1 - tvat_c - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c \quad (4)$$

Marketed output value

$$PX_c \cdot QX_c = PDS_c \cdot QD_c + PE_c \cdot QE_c \quad (5)$$

Activity Price

$$PA_c = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac} \quad (6)$$

Aggregate intermediate input price

$$PINTA_a = \sum_c PQ_c ica_{ca} - REBATE_a / QINTA_a \quad (7)$$

Activity revenue and costs

$$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a \quad (8)$$

Consumer price Index

$$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c \quad (9)$$

Producer price Index

$$DPI = \sum_{c \in C} PDS_c \cdot dwts_c \quad (10)$$

Production and Trade Block

Leontief Technology – Demand for Aggregate Value-added

$$QVA_a = iva_a \cdot QA_a \quad (11)$$

Leontief Technology - Demand for Aggregate intermediate input.

$$QINTA_a = inta_a \cdot QA_a \quad (12)$$

Value-added and factor demands

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-\rho_a^{va}} \quad (13)$$

Factor Demand

$$WF_f \cdot \overline{WFDIST}_{fa} = PVA_a \cdot QVA_a \cdot \left(\sum_{f \in F'} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}-1} \quad (14)$$

Disaggregated intermediate input demand

$$QINT_a = ica_{ca} \cdot QINTA_a \quad (15)$$

Commodity production and allocation

$$QXAC_{ac} + \sum_{h \in H} QHA_{ach} = \theta_{ac} \cdot QA_a \quad (16)$$

Output aggregation function

$$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}-1}} \quad (17)$$

First-order condition for output aggregation function

$$PXAC_{ac} = PX_c QX_c \left(\sum_{a \in A} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}-1} \quad (18)$$

Output transformation function

$$QX_c = \alpha_c^t \left(\delta_c^t \cdot QE_c^{\rho_c^t} + (1 - \delta_c^t) QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \quad (19)$$

Export-Domestic supply ratio

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1-\delta_c^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t-1}} \quad (20)$$

Output transformation for domestically sold outputs without exports and for exports without domestic sales

$$QX_c = QD_c + QE_c \quad (21)$$

Composite supply (Armington function)

$$QQ_c = \alpha_c^q \left(\delta_c^q \cdot QM_c^{-\rho_c^q} + \left(1 - \delta_c^q\right) QD_c^{-\rho_c^q}\right)^{-\frac{1}{\rho_c^q}} \quad (22)$$

Import-domestic demand ratio

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1-\delta_c^q}\right)^{\frac{1}{1+\rho_c^q}} \quad (23)$$

Composite supply for non-imported outputs and non-produced imports

$$QQ_c = QD_c + QM_c \quad (24)$$

Demand for transaction services

$$QT_c = \sum_{c' \in C'} (icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'}) \quad (25)$$

Institutional Block

Factor income

$$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa} \quad (26)$$

Institutional factor incomes

$$YIF_{if} = shif_{if} \cdot \left[\left(1 - tf_f\right) YF_f - trnsfr_{row\ f} \cdot EXR\right] \quad (27)$$

Income of domestic, non-government institutions

$$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i \in INSDNG} TRII_{ii} + trnsfr_{i\ gov} \cdot \overline{CPI} + trnsfr_{i\ row} \cdot EXR \quad (28)$$

Intra-Institution transfers

$$TRII_{ii} = shii_{ii} \cdot (1 - MPS_i) \cdot (1 - TINS_i) \cdot YI_i \quad (29)$$

Household consumption expenditures

$$EH_i = (1 - \sum_{i \in INSDNG} shii_{ih}) \cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot TI_h \quad (30)$$

Household consumption spending on marketed commodities

$$PQ_c \cdot QH_{ch} = PQ_c \gamma_{ch}^m + \beta_{ch}^m \left(EH_h - \sum_{c\prime \in C} PQ_{c\prime} \cdot \gamma_{c\prime h}^m - \sum_{a \in A} \sum_{c\prime \in C} PXAC_{ac\prime} \cdot \gamma_{ac\prime h}^m\right) \quad (31)$$

Household consumption spending on home commodities

$$PXAC_{ac} QHA_{ch} = PXAC_{ac} \gamma_{c\prime h}^h + \beta_{ac\prime h}^h \left(EH_h - \sum_{c\prime \in C} PQ_{c\prime} \gamma_{c\prime h}^m - \sum_{a \in A} \sum_{c\prime \in C} PXAC_{ac\prime} \gamma_{ac\prime h}^h\right) \quad (32)$$

Investment demand

$$QINV_c = \overline{IADJ} \cdot \overline{qinv_c} \quad (33)$$

Government consumption demand

$$QG_c = \overline{GADJ} \cdot \overline{qg_c} \quad (34)$$

Government revenue

$$YG = \sum_i TINS_i \cdot YI_i + \sum_a ta_a \cdot PA_a \cdot QA_a + \sum_c tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_c tq_c \cdot PQ_c \cdot QQ_c + VATREV \quad (35)$$

Government expenditure

$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum \quad trnsfr_{i\ gov} \cdot \overline{CPI} \quad (36)$$

VAT Rebates

$$REBATE'_a = \varphi_c^{vat} \sum_c tvat_c \, PQ'_C QINT_{ac} \quad (37)$$

VAT Revenue

$$VATREV = \sum_C tvat_c \cdot PQ_C \cdot QQ_c - \sum_a REBATE'_a \quad (38)$$

System constraint block

Factor markets

$$\sum_{a \in A} QF_{fa} = \overline{QFS}_f \quad (39)$$

Composite commodity markets

$$QQ_c = \sum_{a \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + QG_c + QINV_c + QT_c \quad (40)$$

Current account balance

$$\sum_{c \in CM} pwm_c QM_c + \sum_{f \in F} trnsfr_{row\ f} = \sum_{c \in CE} pwe_c QE_c + \sum_{i \in INSD} trnsfr_{i\ row} + FSAV \quad (41)$$

Government balance

$$YG = EG + GSAV \quad (42)$$

Direct institutional tax rates

$$TINS_i = \overline{tins}_i\ (1 + \overline{TINSADJ} \cdot tins01_i) + \overline{DTINS} \cdot tins01_i \quad (43)$$

Institutional savings rates

$$MPS_i = \overline{mps}_i\ (1 + \overline{MPSADJ} \cdot mps01_i) + \overline{DMPS} \cdot mps01_i \quad (44)$$

Savings-investment balance

$$\sum_{i \in INSDNG} MPS_i (1 - TINS_i) YI_i + GSAV + EXR \cdot \overline{FSAV} = \sum_{c \in C} PQ_c QINV_c \quad (45)$$

Total absorption

$$TABS = \sum_{c \in C} \sum_{h \in H} PQ_c QH_{ch} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} PXAC_{ac} QHA_{ach} + \sum_{c \in C} PQ_c QG_c + \sum_{c \in C} PQ_c QINV_c \quad (46)$$

Ratio of investment to absorption

$$INVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QINV_c \quad (47)$$

Ratio of government consumption to absorption

$$GOVSHR \cdot TABS = \sum_{c \in C} PQ_c \cdot QG_c \quad (48)$$

Appendix B: Mapping of sectors in the Zambia CGE VAT model

Code	Original sector	New sector
CMAI	Maize (small holder)	Staple food agriculture
CMAI	Maize (large-scale)	
CSTA	Drought tolerant staples	
CGNT	Groundnuts	
CSUG	Sugar	Cash crop agriculture
CCOT	Cotton	
CTOB	Tobacco	
CCOF	Coffee	
CWHE	Wheat	
CHCR	Horticulture	Other agriculture
CLIV	Livestock	
CFIS	Fishing	
CFOY	Forestry	
COCR	Other crops	
CMIN	Mining	Mining
CFBT	Food, beverages & processed tobacco	Food, beverages & processed tobacco
CCAG	Capital goods	Capital goods
CTAG	Textiles and garments	Manufacturing
CWAF	Wood and furniture	
CFER	Fertilizer and industrial chemicals	
COMA	Other manufacturing	
CEAW	Electricity and water	Electricity and water
CCON	Construction	Construction
CPUB	Public services	Public services
CTSV	Trade and transport services	Private services
CTOU	Tourism	
CFIN	Financial services	
CSER	Other private and community services	

Appendix C: Parameter, Variable Definition and Model Calibration

These computations are based on the Zambia CGE VAT model adapted from MOD100.gms the IFPRI/TMD Standard CGE Model, documented in Lofgren et al. (2001):

1. SET DECLARATIONS

In this section, all sets are declared. They are divided into the following groups:

(a) model sets (appearing in the model equations)

(b) calibration sets (used to initialize variables and define model parameters)

(c) report sets (used in report files)

SETS

(a) Model sets (appearing in model equations)

AC	global set for model accounts - aggregated microsam accounts
ACNT(AC)	all elements in AC except TOTAL
A(AC)	activities
ACES(A)	activities with CES fn at top of technology nest
ALEO(A)	activities with Leontief fn at top of technology nest
C(AC)	commodities
CD(C)	commodities with domestic sales of output
CDN(C)	commodities without domestic sales of output
CE(C)	exported commodities
CEN(C)	non-export commodities
CM(C)	imported commodities
CMN(C)	non-imported commodities
CX(C)	commodities with output
F(AC)	factors
INS(AC)	institutions
INSD(INS)	domestic institutions
INSDNG(INSD)	domestic non-government institutions

H(INSDNG) households

(b) Calibration sets (used to initialize variables and define model parameters)

CINV(C) fixed investment goods

CT(C) transaction service commodities

CTD(AC) domestic transactions cost account

CTE(AC) export transactions cost account

CTM(AC) import transactions cost account

(c) Report sets (used in report files)

AAGR(A) agricultural activities

ANAGR(A) non-agricultural activities

AVAT(A) vatable activities

ANVAT(A) non-vatable activities

CAGR(C) agricultural commodities

CNAGR(C) non-agricultural commodities

CVAT(C) vatable commodities

CNVAT(C) non-vatable commodities

EN(INSDNG) enterprises

FLAB(F) labor

FLND(F) land

FCAP(F) capital

ALIAS statement to create identical sets:

(AC,ACP) , (ACNT,ACNTP), (A,AP)

(C,CP) , (CE,CEP) , (CM,CMP)

(F,FP) , (FLAB,FLABP), (FCAP,FCAPP) , (FLND,FLNDP)

(INS,INSP), (INSD,INSDP), (INSDNG,INSDNGP), (H,HP)

2. DATABASE

Defining data parameters:

SET

AC global set for model accounts-aggregated microsam accounts comprising of the following:

*Activities

ASFA	Staple food agriculture
ACEA	cash crop agriculture
AOAG	Other agriculture
AMIN	Mining
AFBT	Processed food beverages and tobacco
ACAG	Capital goods
AOMA	other manufacturing
AEAW	Electricity and Water
ACON	construction
APUB	public services
APVT	private services

*Commodities

CSFA	Staple food agriculture
CCEA	cash crop agriculture
COAG	Other agriculture
CMIN	Mining
CFBT	Processed food beverages tobacco
CCAG	Capital goods
COMA	other manufacturing
CEAW	Electricity and Water
CCON	construction
CPUB	public services

CPVT	private services
*Factors	
LNONE	no school
LPRIM	primary school
LSECD	secondary school
LPOST	post secondary
KAPAGR	Agriculture capital
KAPMIN	mining capital
KAPOTH	other capital
LAND	Land
*Domestic Institutions	
HRRS	Rural remote small-scale
HRRM	Rural remote medium-scale
HRRN	Rural remote non-farm
HRS	Rural non-remote small-scale
HRM	Rural non-remote medium-scale
HRL	Rural non-remote large scale
HRN	Rural non-remote non-farm
HUSE	Urban low-skilled self-employed
HUPR	Urban private sector employee
HUPU	Urban public sector employee
HUEM	Urban high-skilled employers
ENTMIN	Mining enterprises
ENTOTH	Non-mining enterprises
*Taxes	
IMPTAX	tax on imports(tariffs)
EXCISE	excise tax on commodities
ACTTAX	activity tax on producers

INSTAX direct tax on institutions

VATTAX value added tax on commodities

*Other accounts

GOV government

S-I Savings-investment

ROW rest of the world

REBATE VAT rebates on intermediate commodity purchases

*Transaction costs

CMMD domestic transaction costs

CMME export transaction costs

CMMI import transaction costs

DUM dummy

TOTAL total

SAM(AC,ACP) standard SAM

SAM includes home consumption but NO data were provided for SHRHOME. Thus, data are generated assuming that the value shares for home consumption are identical to activity output value shares:

SHRHOME(A,C,H)$SAM(A,H) = SAM(A,C)/SUM(CP, SAM(A,CP))

QFSBASE(F) total physical factor supplies

QFBASE(F,A) demand for factor F by A

QF2BASE(F,A) quantity of factor f employed by activity a (extracted data)

Given that there is a SAM payment from A to F and supply (but not demand) quantities have been defined in the country data file, the supply values are used to compute demand quantities:

QF2BASE(F,A)$(SAM(F,A)$((NOT QFBASE(F,A))$QFSBASE(F)))

= QFSBASE(F)*SAM(F,A)/SUM(AP, SAM(F,AP))

Elasticities for trade, production and household consumption:

TRADELAS trade elasticities

SIGMAQ	Armington elasticity
SIGMAT	CET elasticity
ELASAC(C)	output aggregation elasticity for commodity C
LESELAS1(C,H)	expenditure elasticity of market demand for C by household H
LESELAS2(A,C,H)	expenditure elasticity of home demand by H for C from A
FRISCH(H)	Frisch parameter for household LES demand

Initialization of Tax data

TX	taxes in the model
INSTAX	direct taxes on domestic institutions
ACTTAX	indirect production taxes
VATTAX	value added tax on commodities
EXCISE	excise taxes on commodities
IMPTAX	import taxes
REBATE	subsidy on input vat

Defining tax parameters:

TAXPAR(TX,AC) payment of account AC to tax account TX

```
ALIAS(TX,TXP)
        TAXPAR('INSTAX',INSD) = SAM('INSTAX',INSD)
        TAXPAR('ACTTAX',A) = SAM('ACTTAX',A)
        TAXPAR('VATTAX',C) = SAM('VATTAX',C)
        TAXPAR('EXCISE',C) = SAM('EXCISE',C)
        TAXPAR('IMPTAX',C) = SAM('IMPTAX',C)
        TAXPAR('REBATE',A) = SAM('REBATE',A);
```

3. PARAMETER DECLARATION

(a) Parameters appearing in model equations other than tax rates

alphaa(A)	shift parameter for top level CES function
alphaac(C)	shift parameter for domestic commodity aggregation function
alphaq(C)	shift parameter for Armington function
alphat(C)	shift parameter for CET function
alphava(A)	shift parameter for CES activity production function
betah(A,C,H)	marginal share of household consumption on home commodity from activity
betam(C,H)	marg share of hhd cons on marketed commodity c
cwts(C)	consumer price index weights
deltaa(A)	share parameter for top level CES function
deltaac(A,C)	share parameter for domestic commodity aggregation function
deltaq(C)	share parameter for Armington function
deltat(C)	share parameter for CET function
deltava(F,A)	share parameter for CES activity production function
dwts(C)	domestic sales price weights
gammah(A,C,H)	per-cap subsistence consumption for h/hold h on home com c fr act a
gammam(C,H)	per-cap subsist consumption of marketed com c for hhd h
ica(C,A)	intermediate input c per unit of aggregate intermediate
inta(A)	aggregate intermediate input coefficient
iva(A)	aggregate value added coefficient
icd(C,CP)	trade input of c per unit of commodity cp produced & sold domestically
ice(C,CP)	trade input of c per unit of commodity cp exported
icm(C,CP)	trade input of c per unit of commodity cp imported
mps01(INS)	0-1 par for potential flexing of savings rates
mpsbar(INS)	marginal propensity to save for domestic non-gov institutions (exog. part)
qdst(C)	inventory investment by sector of origin
qbarg(C)	exogenous (unscaled) government demand
qbarinv(C)	exogenous (unscaled) investment demand
rhoa(A)	CES top level function exponent
rhoac(C)	domestic commodity aggregation function exponent

rhoq(C)	Armington function exponent
rhot(C)	CET function exponent
rhova(A)	CES activity production function exponent
shif(INS,F)	share of dom. inst'on i in income of factor f
shii(INS,INSP)	share of inst'on i in post-tax post-sav income of inst ip
supernum(H)	LES supernumerary income
theta(A,C)	yield of commodity C per unit of activity A
tins01(INS)	0-1 par for potential flexing of dir tax rates
trnsfr(INS,AC)	transfers from inst. or factor ac to institution ins

Tax rates

ta(A)	rate of tax on producer gross output value
te(C)	rate of tax on exports
tinsbar(INS)	rate of (exog part of) direct tax on domestic institution ins
tm(C)	rate of import tariff
tq(C)	rate of excise tax
tvat(C)	rate of vat on commodities
phi0(A)	proportion of intermediate consumptions covered by VAT

(b) Parameters used for model calibration

For model calibration, one parameter is created for each model variable with the suffix "0" added to the variable name. 0 is also added to the names of parameters whose values are changed in experiments.

Parameters for definition of model parameters

alphava0(A)	shift parameter for CES activity production function
qdst0(C)	stock change
qbarg0(C)	exogenous (unscaled) government demand
ta0(A)	rate of tax on producer gross output value
tins0(INS)	rate of direct tax on domestic institutions ins
tm0(C)	rate of import tariff

tq0(C)	rate of excise tax
tvat0(C)	rate of vat on commodities

Parameters for variable initialization

CPI0	consumer price index (PQ-based)
DPI0	index for domestic producer prices (PDS-based)
DMPS0	change in marginal propensity to save for selected inst
DTINS0	change in domestic institution tax share
EG0	total current government expenditure
EH0(H)	household consumption expenditure
EXR0	exchange rate
FSAV0	foreign savings
GADJ0	government demand scaling factor
GOVSHR0	govt consumption share of absorption
GSAV0	government savings
IADJ0	investment scaling factor (for fixed capital formation)
INVSHR0	investment share of absorption
MPS0(INS)	marginal propensity to save for dom non-gov inst ins
MPSADJ0	savings rate scaling factor
PA0(A)	output price of activity a
PDD0(C)	demand price for commodity c produced & sold domestically
PDS0(C)	supply price for commodity c produced & sold domestically
PE0(C)	price of exports
PINTA0(A)	price of intermediate aggregate
PM0(C)	price of imports
PQ0(C)	price of composite good c
PVA0(A)	value added price
PWE0(C)	world price of exports

PWM0(C) world price of imports

PX0(C) average output price

PXAC0(A,C) price of commodity c from activity a

QA0(A) level of domestic activity

QD0(C) quantity of domestic sales

QE0(C) quantity of exports

QF0(F,A) quantity demanded of factor f from activity a

QFS0(F) quantity of factor supply

QG0(C) quantity of government consumption

QH0(C,H) quantity consumed of marketed commodity c by h/hold h

QHA0(A,C,H) quantity consumed of home commodity c from activity a by h/hold h

QINT0(C,A) quantity of intermediate demand for c from activity a

QINTA0(A) quantity of aggregate intermediate input

QINV0(C) quantity of fixed investment demand

QM0(C) quantity of imports

QQ0(C) quantity of composite goods supply

QT0(C) quantity of trade and transport demand for commodity c

QVA0(A) quantity of aggregate value added

QX0(C) quantity of aggregate marketed commodity output

QXAC0(A,C) quantity of ouput of commodity c from activity a

TABS0 total absorption

TINS0(INS) rate of direct tax on domestic institutions ins

TINSADJ0 direct tax scaling factor

TRII0(INS,INSP) transfers to dom. inst. insdng from insdngp

WALRAS0 savings-investment imbalance (should be zero)

WF0(F) economy-wide wage (rent) for factor f

WFDIST0(f,A) factor wage distortion variable

YF0(f) factor income

YG0 total current government income

YIF0(INS,F) income of institution ins from factor f

YI0(INS) income of (domestic non-governmental) institution ins

*Additional variable for VAT reform simulation

REBATES0(A) vat rebate to activity a

VATREV0 total vat revenue

4 PARAMETER DEFINITIONS

(a) Price block

The prices PDS, PX, and PE are initialized at unity. For any given commodity, these three prices should be identical. The remaining supply-side price, PXAC, and the non-commodity prices, EXR and PA may be initialized at any desired level. In this model they are initialized at unity.

PARAMETER

PSUP(C) initial supply-side market price for commodity c

PSUP(C) = 1

PE0(C)$CE(C) = PSUP(C);

PX0(C)$CX(C) = PSUP(C);

PDS0(C)$CD(C) = PSUP(C);

PXAC0(A,C)$SAM(A,C) = PSUP(C);

PA0(A) = 1

EXR0 = 1

Activity quantity = payment to activity divided by activity price. QA covers both on-farm consumption and marketed output. Output is GROSS of tax.

QA0(A) = SAM('TOTAL',A)/PA0(A)

Unit value-added price = total value-added / activity quantity

QVA0(A) = (SUM(F, SAM(F,A))

PVA0(A) = (SUM(F, SAM(F,A))/QVA0(A)

iva(A) = QVA0(A)/QA0(A)

QXAC0(A,C)$SAM(A,C) = SAM(A,C) / PXAC0(A,C)

QHA0(A,C,H)$SHRHOME(A,C,H) = SHRHOME(A,C,H)*SAM(A,H)/PXAC0(A,C)

Output quantity = value received by producers divided by producer price. QX covers only marketed output:

QX0(C)$SUM(A, SAM(A,C)) = SUM(A, SAM(A,C)) / PX0(C)

Export quantity = export revenue received by producers minus transactions cost divided by export price:

QE0(C)$SAM(C,'ROW') = (SAM(C,'ROW') - SUM(CTE, SAM(CTE,C)))/PE0(C)

RoW export price = RoW export payment (in foreign currency) / export quantity:

PWE0(C)$QE0(C) = (SAM(C,'ROW')/EXR0) / QE0(C)

Quantity of output sold domestically = output quantity less quantity exported = value of domestic sales divided by domestic supply price:

QD0(C)$CD(C) = QX0(C) - QE0(C)

QD0 covers only marketed output. Domestic demander price = demander payment divided by quantity bought:

PDD0(C)$QD0(C)= (PDS0(C)*QD0(C) + SUM(CTD, SAM(CTD,C)))/QD0(C);

Import price is defined to equal domestic price so that import and domestic units are the same to the purchaser. If no domestic good, PM is set equal to 1.

PM0(C) = PDD0(C)

PM0(C)$(QD0(C) EQ 0) = 1

Import quantity = demander payment for imports (including tariffs and marketing cost) divided by demander price:

QM0(C)$CM(C) = (SAM('ROW',C) + TAXPAR('IMPTAX',C)

+ SUM(CTM, SAM(CTM,C)))/PM0(C)

World price = import value (in foreign currency / import quantity:

PWM0(C)$QM0(C) = (SAM('ROW',C)/EXR0) / QM0(C)

tm0(C)$SAM('ROW',C) = TAXPAR('IMPTAX',C) / SAM('ROW',C);

tm(C) = tm0(C);

Composite supply is the sum of domestic market sales and imports (since they are initialized at the same price):

QQ0(C)$(CD(C) OR CM(C)) = QD0(C) + QM0(C)

PQ0(C)$QQ0(C) = (SAM(C,'TOTAL') - SAM(C,'ROW'))/QQ0(C)

tvat0(C)$QQ0(C) = TAXPAR('VATTAX',C)/(PQ0(C)*QQ0(C))

tvat(C) = tvat0(C)

tq0(C)$QQ0(C) = TAXPAR('EXCISE',C)/(PQ0(C)*QQ0(C)) ;

tq(C) = TQ0(C)

Defining additional parameters:

SHCTD(C)	share of commodity ct in transaction services for domestic sales
SHCTM(C)	share of commodity ct in transaction services for imports
SHCTE(C)	share of commodity ct in transaction services for exports

SHCTD(CT) = SUM(CTD, SAM(CT,CTD)/SAM('TOTAL',CTD))

SHCTM(CT) = SUM(CTM, SAM(CT,CTM)/SAM('TOTAL',CTM))

SHCTE(CT) = SUM(CTE, SAM(CT,CTE)/SAM('TOTAL',CTE))

Transactions input coefficients:

icd(CT,C)$QD0(c) = (shctd(ct)*SUM(CTD, SAM(CTD,C))/PQ0(ct)) / QD0(C)

icm(CT,C)$QM0(C) = (shctm(ct)*SUM(CTM, SAM(CTM,C))/PQ0(ct)) / QM0(C)

ice(CT,C)$QE0(C) = (shcte(ct)*SUM(CTE, SAM(CTE,C))/PQ0(ct)) / QE0(C)

Indirect activity tax rate = tax payment / output value

Tax is here applied to total output value (incl. on-farm cons.). QA is GROSS of tax, so base for ta is as well:

ta0(A) = TAXPAR('ACTTAX',A) / (SAM(A,'TOTAL'))

ta(A) = ta0(A).

Yield coefficient = quantity produced (including home-consumed output)/activity quantity

theta(A,C)$PXAC0(A,C) = ((SAM(A,C) +
SUM(H,SHRHOME(A,C,H)*SAM(A,H))) / PXAC0(A,C)) / QA0(A).

Intermediate demand:

QINT0(C,A)$PQ0(C) = SAM(C,A) / PQ0(C)

Embedding Rebates in the model, assuming a 50 percent rebate efficiency:

phi0('ASFA') = 0.5

phi0('ACEA') = 0.5

phi0('AOAG') = 0.5

phi0('AMIN') = 0.5

phi0('AFBT') = 0.5

phi0('ACAG') = 0.5

phi0('AOMA') = 0.5

phi0('AEAW') = 0

phi0('ACON') = 0.5

phi0('APUB') = 0

phi0('APVT') = 0

phi(A) = phi0(A)

REBATES0(A) = -(phi0(A)*SUM(C, TVAT0(C)*PQ0(C)*QINT0(C,A)))

Intermediate input coefficient = input use / output quantity:

QINTA0(A) = SUM(C$PQ0(C), SAM(C,A) / PQ0(C))

ica(C,A)$(QINTA0(A)$PQ0(C)) = SAM(C,A)/PQ0(C) / QINTA0(A)

inta(A) = QINTA0(A) / QA0(A)

PINTA0(A) = SUM(C, ica(C,A)*PQ0(C))+ REBATES0(A)/QINTA0(A);

VAT revenue:

VATREV0 = SUM(C, tvat0(c)*PQ0(C)*QQ0(C))+ SUM(A, REBATES0(A))

CPI weight by commodity = household consumption value for commodity / total household consumption value. CPI does not consider on-farm consumption.

```
cwts(C)      = SUM(H, SAM(C,H)) / SUM((CP,H), SAM(CP,H))
```

Domestic sales price index weight = domestic sales value for commodity/ total domestic sales value. Domestic sales price index does not consider on-farm consumption.

```
dwts(C)      = (SUM(A, SAM(A,C)) - (SAM(C,'ROW') -  SUM(cte, SAM(cte,C))))
                  /SUM(CP, SUM(A, SAM(A,CP)) - (SAM(CP,'ROW')
                  - SUM(cte, SAM(cte,CP))))

CPI0         = SUM(C, cwts(C)*PQ0(C))
DPI0         = SUM(CD, dwts(CD)*PDS0(CD))
```

(b) Production and trade block

Computing exponents from elasticities

```
rhoq(C)$(CM(C) AND CD(C)) = (1/TRADELAS(C,'SIGMAQ')) - 1;
rhot(C)$(CE(C) AND CD(C))  = (1/TRADELAS(C,'SIGMAT')) + 1;
rhova(A)       = (1/PRODELAS(A)) - 1;
rhoa(A)$ACES(A) = (1/PRODELAS2(A)) - 1;
```

Aggregation of domestic output from different activities

```
RHOAC(C)$ELASAC(C) = 1/ELASAC(C) - 1

deltaac(A,C)$ (SAM(A,C)$ELASAC(C))
                  = (PXAC0(A,C)*QXAC0(A,C)**(1/ELASAC(C)))
                  / SUM(AP, PXAC0(AP,C)*QXAC0(AP,C)**(1/ELASAC(C)))

alphaac(C)$SUM(A,deltaac(A,C))   = QX0(C)
                        / (SUM(A$deltaac(A,C), deltaac(A,C) * QXAC0(A,C)
                        **(-RHOAC(C))) )**(-1/RHOAC(C))
```

PARAMETERS

WFA(F,A) wage for factor f in activity a (used for calibration)

Defining factor employment and supply:

QF0(F,A) = QF2BASE(F,A)

QFS0(F) = SUM(A, QF0(F,A))

Activity-specific wage is activity labour payment over employment

WFA(F,A)$SAM(F,A) = SAM(F,A)/QF0(F,A);

Economy-wide wage average is total factor income over employment

WF0(F) = SUM(A, SAM(F,A))/SUM(A, QF0(F,A));

Wage distortion factor:

WFDIST0(F,A)$SAM(F,A) = WFA(F,A)/WF0(F)

CES activity production function:

deltava(F,A)$SAM(F,A)

= (WFDIST 0(F,A) * WF0(F)

* (QF0(F,A))**(1+rhova(A)))

/ SUM(FP, WFDIST 0(FP,A) * WF0(FP)*(QF0(FP,A))**(1+rhova(A)))

alphava0(A) = QVA0(A)/(SUM(F$(QF0(F,A)), deltava(F,A)*QF0(F,A)

(-rhova(A))))(-1/rhova(A))

alphava(A) = alphava0(A)

CES top level production function:

Defining parameter:

predeltaa(A) dummy used to estimate deltaa

predeltaa(A) = 0

predeltaa(A)$(ACES(A) AND QINTA0(A))

= (PVA0(A)/PINTA0(A))*(QVA0(A)/QINTA0(A))**(1+rhoa(A))

deltaa(A)$ACES(A) = predeltaa(A)/(1 + predeltaa(A))

alphaa(A)$deltaa(A)

= QA0(A)/((deltaa(A)*QVA0(A)**(-rhoa(A))

+(1-deltaa(A))*QINTA0(A)**(-rhoa(A)))**(-1/rhoa(A)))

Intermediate demand:

QINT0(C,A)$PQ0(C) = SAM(C,A) / PQ0(C)

Transactions demand

QT0(CT) = (SUM(CTD, SAM(CT,CTD)) + SUM(CTE, SAM(CT,CTE))

+ SUM(CTM, SAM(CT,CTM))) / PQ0(CT)

CET transformation:

deltat(C)$(CE(C) AND CD(C))

= 1 / (1 + PDS0(C)/PE0(C)*(QE0(C)/QD0(C))**(rhot(C)-1))

alphat(C)$(CE(C) AND CD(C))

= QX0(C) / (deltat(C)*QE0(C)**rhot(C) + (1-deltat(C))

*QD0(C)**rhot(C))**(1/rhot(C));

Armington aggregation:

Defining an additional parameter:

predelta(C) dummy used to estimate deltaq

predelta(C)$(CM(C) AND CD(C))

= (PM0(C)/(PDD0(C)))*(QM0(C)/QD0(C))**(1+rhoq(C))

deltaq(C)$(CM(C) AND CD(C)) = predelta(C)/(1 + predelta(C))

alphaq(C)$(CM(C) AND CD(C))

= QQ0(C)/(deltaq(C)*QM0(C)**(-rhoq(C))

+(1-deltaq(C))*QD0(C)**(-rhoq(C)))**(-1/rhoq(C))

(c) Institution block

Institutional income:

YI0(INSDNG) = SAM('TOTAL',INSDNG)

Factor income by factor category:

YF0(F) = SUM(A, SAM(F,A))

Institution income from factors:

YIF0(INSD,F) = SAM(INSD,F)

Transfers to RoW from factors:

trnsfr('ROW',F) = SAM('ROW',F)/EXR0

Transfers from RoW to institutions:

trnsfr(INSD,'ROW') = SAM(INSD,'ROW')/EXR0

Government transfers

trnsfr(INSD,'GOV') = SAM(INSD,'GOV')/CPI0

Shares of domestic institutions in factor income (net of transfers to RoW).

shif(INSD,F) = SAM(INSD,F)/(SAM(F,'TOTAL') - SAM('ROW',F))

Inter-institution transfers

TRII0(INSDNG,INSDNGP) = SAM(INSDNG,INSDNGP)

Share of domestic non-governmental institution in income of other domestic non-governmental institutions (net of direct taxes and savings):

shii(INSDNG,INSDNGP)

= SAM(INSDNG,INSDNGP) /(SAM('TOTAL',INSDNGP)

- TAXPAR('INSTAX',INSDNGP) - SAM('S-I',INSDNGP))

Scaling factors for savings and direct tax shares

MPSADJ0 = 0

TINSADJ0 = 0

Savings rates

MPS0(INSDNG)= SAM('S-I',INSDNG)/(SAM('TOTAL',INSDNG)

-TAXPAR('INSTAX',INSDNG))

mpsbar(INSDNG) = MPS0(INSDNG)

Direct tax rates

TINS0(INSDNG) = TAXPAR('INSTAX',INSDNG) / SAM('TOTAL',INSDNG)

tinsbar(INSDNG) = TINS0(INSDNG)

Point change in savings and direct tax shares

DMPS0 = 0;

DTINS0 = 0;

Selecting institutions for potential "point" change in savings and tax rates: If DMPS is flexible, institutions with a value of 1 for mps01 change their savings rate:

mps01(INSDNG) = 1

If DTINS is flexible, institutions with a value of 1 for tins01 change their savings rates.

tins01(INSDNG) = 1

Household consumption spending and consumption quantities:

EH0(H) = SUM(C, SAM(C,H)) + SUM(A, SAM(A,H))

QH0(C,H)$PQ0(C) = SAM(C,H)/PQ0(C)

Government indicators

YG0 = SAM('TOTAL','GOV')

EG0 = SAM('TOTAL','GOV') - SAM('S-I','GOV')

QG0(C)$PQ0(C) = SAM(C,'GOV')/PQ0(C)

qbarg0(C) = QG0(C)

qbarg(C) = qbarg0(C)

GADJ0 = 1

GSAV0 = SAM('S-I','GOV')

LES calibration

Defining parameters:

BUDSHR(C,H)	budget share for marketed commodity c and household h
BUDSHR2(A,C,H)	budget share for home commodity c - act a - hhd h
BUDSHRCHK(H)	check that budget shares some to unity
ELASCHK(H)	check that expenditure elasticities satisfy Engel aggregation

BUDSHR(C,H) = SAM(C,H)/(SUM(CP, SAM(CP,H)) + SUM(AP, SAM(AP,H)))

BUDSHR2(A,C,H) = SAM(A,H)*SHRHOME(A,C,H)/(SUM(CP, SAM(CP,H))
+ SUM(AP, SAM(AP,H)))

BUDSHRCHK(H) = SUM(C, BUDSHR(C,H)) + SUM((A,C), BUDSHR2(A,C,H))

ELASCHK(H) = SUM(C, BUDSHR(C,H)*LESELAS1(C,H))
+ SUM((A,C), BUDSHR2(A,C,H)*LESELAS2(A,C,H))

LESELAS1(C,H) = LESELAS1(C,H)/ELASCHK(H)

LESELAS2(A,C,H) = LESELAS2(A,C,H)/ELASCHK(H)

ELASCHK(H) = SUM(C, BUDSHR(C,H)*LESELAS1(C,H))
+ SUM((A,C), BUDSHR2(A,C,H)*LESELAS2(A,C,H))

betam(C,H) = BUDSHR(C,H)*LESELAS1(C,H)

betah(A,C,H) = BUDSHR2(A,C,H)*LESELAS2(A,C,H)

gammam(C,H)$BUDSHR(C,H)

= ((SUM(CP, SAM(CP,H)) + SUM(AP, SAM(AP,H))) / PQ0(C))

* (BUDSHR(C,H) + betam(C,H)/FRISCH(H))

gammah(A,C,H)$BUDSHR2(A,C,H)

= ((SUM(CP, SAM(CP,H)) + SUM(AP, SAM(AP,H))) / PXAC0(A,C))

* (BUDSHR2(A,C,H) + betah(A,C,H)/FRISCH(H))

Defining additional parameters for LES:

SUBSIST(H) subsistence spending

FRISCH2(H) alternative definition of Frisch -- ratio of consumption to supernumerary consumption

SUPERNUM(H) = SUM((A,C), gammah(A,C,H)*PXAC0(A,C))

+ SUM(C, gammam(C,H)*PQ0(C))

FRISCH2(H) = -EH0(H)/(EH0(H) - SUPERNUM(H))

(d) System-constraint block

Fixed investment:

qbarinv(c)$CINV(C) = SAM(C,'S-I')/PQ0(C)

QINV0(C) = qbarinv(C)

IADJ0 = 1

FSAV0 = SAM('S-I','ROW')/EXR0

TABS0 = SUM((C,H), SAM(C,H)) + SUM((A,H), SAM(A,H))

+ SUM(C, SAM(C,'GOV')) + SUM(C, SAM(C,'S-I'))

+ SUM(C, SAM(C,'DSTK'))

INVSHR0 = SAM('TOTAL','S-I')/TABS0

GOVSHR0 = SUM(C, SAM(C,'GOV'))/TABS0

WALRAS0 = 0

Appendix D: Macro SAM for Zambia for 2001 (Billions of Current Kwacha)

	Activities	Commodities	Factors	Households	Enterprises	Government	Taxes	Investment	Rest of World	Total
Activities		23,670		2,500						26,170
Commodities	14,118	5,897		8,241		1,704		2,627	3,760	36,346
Factors	11,844									11,844
Households			5,987	169	5,365	453			7	11,972
Enterprises			5,866			106				5,972
Government					83		2,245			2,328
Taxes	208	877		947	213					2,245
Savings				115	311	-428			2,629	2,627
Rest of World		5,902				493				6,395
Total	26,170	36,346	11,844	11,972	5,972	2,327	2,245	2,627	6,395	

APPENDIX E: Additional Simulation Summary Reports

Disaggregated activity production levels

	BASE	PUREVAT1	PUREVAT2	AGRIVAT
ASFA	1117.1	-3.3	-0.1	-0.4
ACEA	365.7	-10.4	-0.5	-1.4
AOAG	2440.4	-4.8	-0.2	-0.4
AMIN	1920.8	-0.2		
AFBT	1908.9	-3.8	-0.2	-0.5
ACAG	535.5	-3.1	-0.2	-0.2
AOMA	2429.1	-2.6		-0.3
AEAW	985.6	-0.3		
ACON	1452.8	-1.0		-0.1
APUB	2471.2	-0.7		-0.1
APVT	10543.0	-3.6		-0.4
TOTAL	26170.0	-2.9	-0.1	-0.3

In the BASE column, quantities are measured at base-year prices.

The non-BASE columns show % change from BASE.

Quantity of factor supply (percent change)

	BASE	PUREVAT1	PUREVAT2	AGRIVAT
LNONE	2071.902	-6.879	-0.259	-0.783
LPRIM	1501.976	-8.750	-0.206	-1.069
LSECD	254.951	-8.937	-0.132	-1.127

In the BASE column, quantities are measured at base-year prices.

The non-BASE columns show % change from BASE.

Appendix F: Sensitivity Analysis

Figure 3.11: Welfare Sensitivity to Production (sigma_va) Elasticities

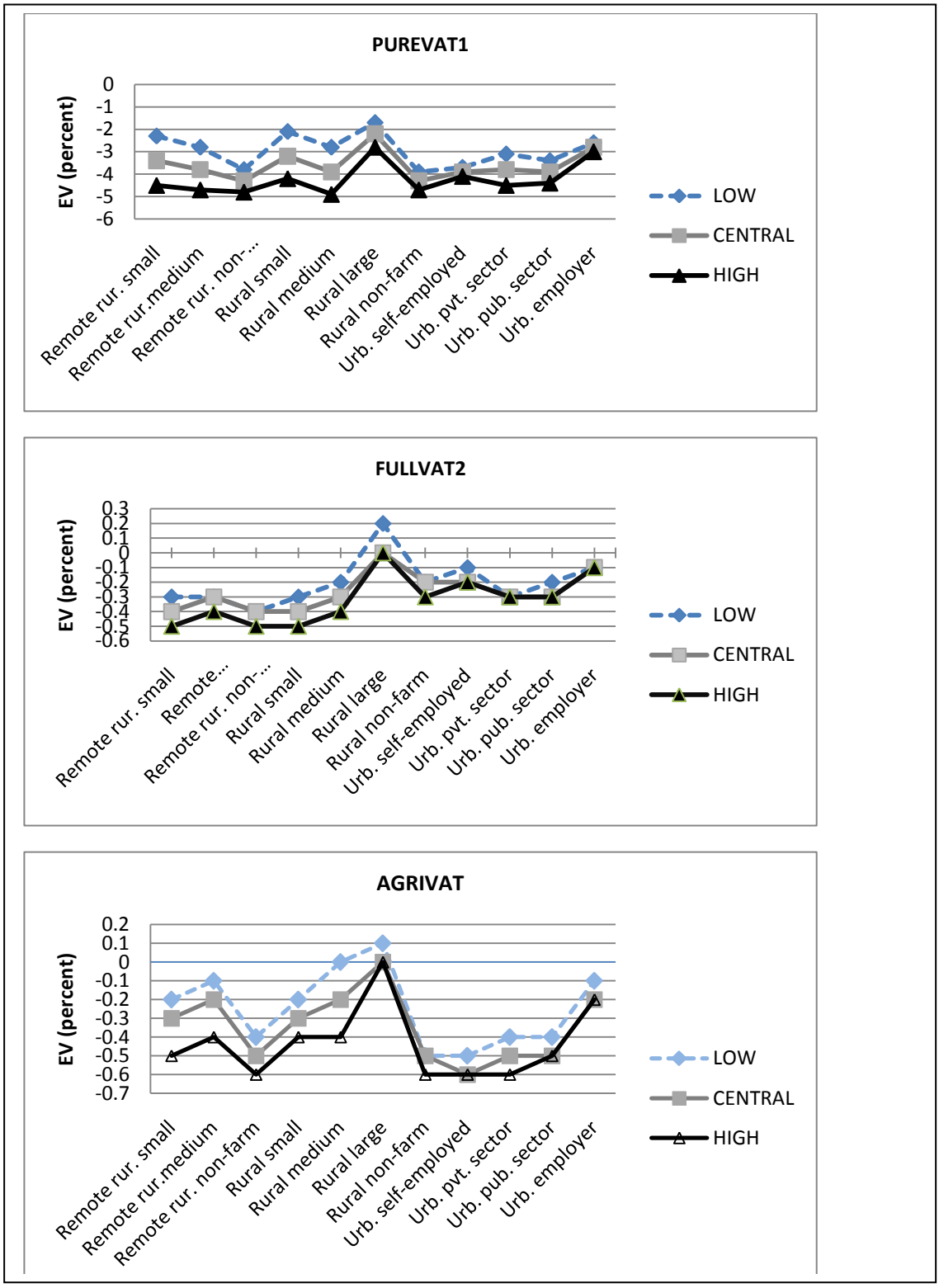


Figure 3.12: Welfare Sensitivity to Import (sigma_q) Elasticities

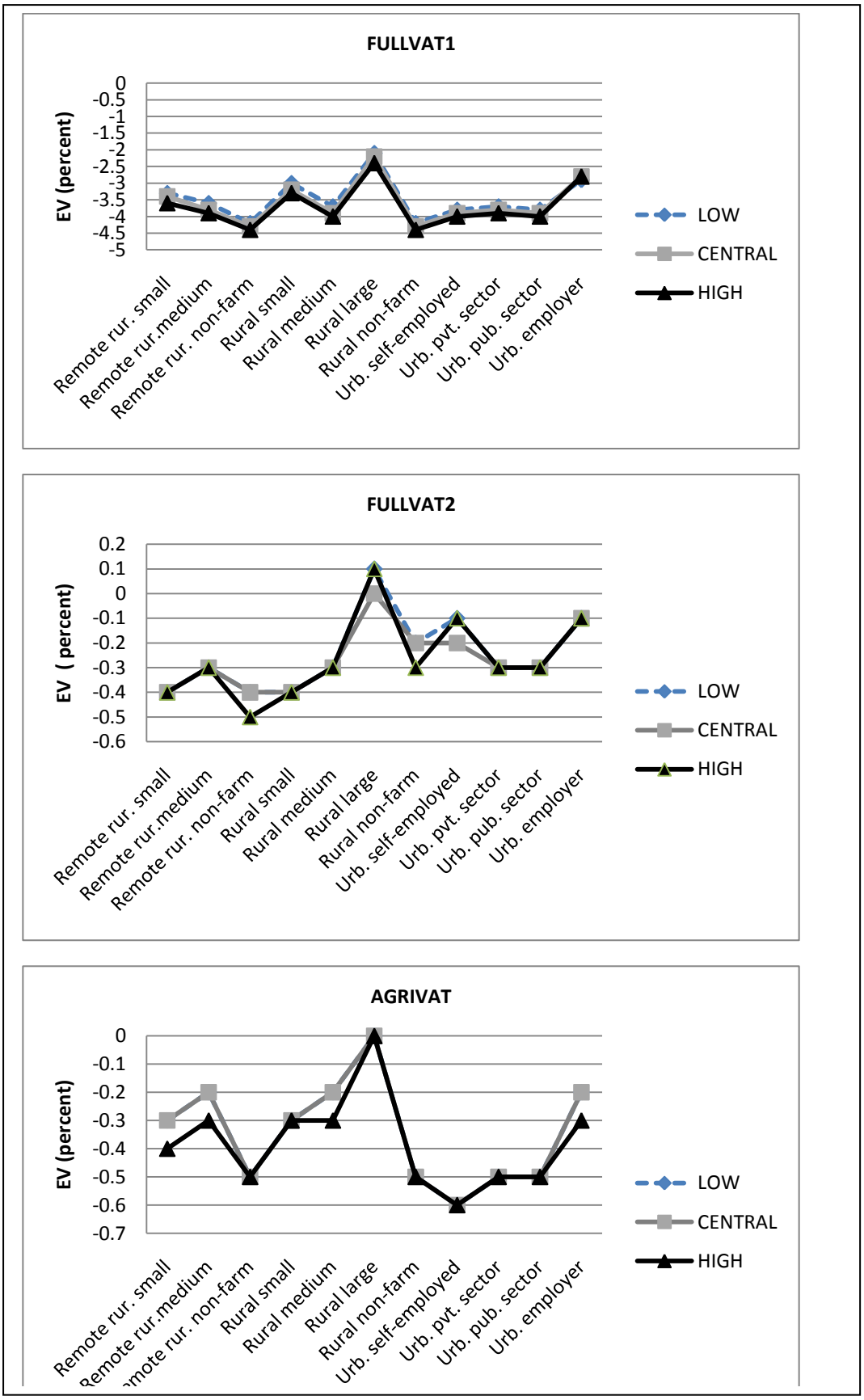


Figure 3.13: Welfare Sensitivity to Export (sigma_t) Elasticities

