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Impact of Tax Reforms on Household Welfare

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Abstract

The Uganda government has since 1987 initiated a sequence of tax reforms to address the fiscal challenges facing the country. This paper uses a Computable General Equilibrium (CGE) model to analyze the welfare effects of tax reforms on households and the impact of these changes on production and firm activities. The findings are consistent with previous studies which found that the introduction of VAT was indeed a progressive policy reform. Zero rating all food items and agricultural products mainly benefit the low income households whose consumption basket is mainly food items. In a quest for further sources of revenue by overtaxing the rich, this could generate further revenues albeit lower savings and investments by this group. Finally, over-reliance on excise duties especially on petroleum and alcoholic drinks affects the transportation sectors which are also used by the poor. In our results we find that taxation of petrol and rising excise duties indeed is a regressive policy stance.

Section 1: Introduction

The Uganda government has since 1987 initiated a sequence of tax reforms to address the fiscal challenges facing the country. Fiscal policy has focused on stimulating economic growth, strengthening tax administration and raising tax revenue. From a historical performance of 12.6 percent of GDP in 1970-71, revenue from tax declined to a dismal 6.5 percent in 1989/90 which led to large deficits and a budget mainly funded by external financing. However, revenue performance improved between 1991/92 and 1996/97, to a tax/GDP ratio of 12.2 percent in 1996/97. The remarkable growth in tax revenue was a result of policy measures that included restructuring the tax system/administration, particularly the establishment of the Uganda Revenue Authority (URA) in 1991.

Among the main tax changes introduced since 1990 include; the replacement of sales tax with VAT in 1996, introduction of the new income tax structure in 1997 coupled with a reduction of the personal income tax and abolishing of the tax holidays in 1999 which were replaced with tax concessions.

The natural question to ask is the extent to which all these changes have affected the welfare of households and the performance of firms. Studies have showed that with the exception of some excise taxes and graduated personal tax, tax reforms have largely been progressive (Chen et al, 2001). It was found that excise tax on kerosene which is highly consumed by the poor was highly regressive and that the tax burden incurred by large and medium-size regular taxable firms was significantly reduced due to the 1997 income tax reform.

While these studies have focused on the micro incidence of taxes, the literature does not address the general equilibrium effects of these reforms. For instance, while at the micro level increasing the income taxes would hurt the middle income class, the collected revenues could be used by the government to improve infrastructure and thereby indirectly improve the overall welfare of individuals. This paper uses a Computable General Equilibrium (CGE) model to analyze the welfare

effects of tax reforms on households and the impact of these changes on production and firm activities.

Using a similar approach as Devarajan and Hossain (1995) we assess the incidence of VAT by removing it and replacing it with other forms of taxes that were used earlier. The findings are consistent with previous studies which found that the introduction of VAT was indeed a progressive policy reform. Households in lower income groups are better off now than the previous tax system prior to the reforms. In addition, to make VAT even more regressive, we run a simulation where all food items and agricultural products are zero rated. This policy reform would mainly benefit the low income households whose consumption basket is mainly food items. For Uganda's case, the main problem is to identify further sources of revenues without necessarily affecting the low income households. We describe alternative tax structures that are revenue neutral and that shift the tax burden away from low-income households; in particular we increase income taxes on high-income households. While this policy change is progressive, it could also affect the savings and investment of high income households and hence the overall macroeconomic performance.

In addition, for the case of Uganda there has been an over-reliance on excise duties especially on petroleum and alcoholic drinks. As for petroleum an argument could be made that it's mainly consumed by rich households. However, by over taxing petrol this could also affect the transportation sectors which are also used by the poor. In our results we find that taxation of petrol and rising excise duties indeed is a regressive policy stance. This affects both the urban consumers and rural consumers who indirectly use it through transport services.

Key policy conclusions from this paper are as follows. Uganda should continue strengthening the VAT and further streamline it so that VAT can be captured both at the production and consumption stage. At the moment, its only formally registered companies which are paying VAT at the retail stage. This narrows the scope of

collection and provides some room to widen the tax base. Second, to stimulate production in the agricultural sector, all agricultural activities should be fully exempted from VAT. This would make the tax system more progressive as most of the low income households depend on the agricultural sector. Third, excessive excise taxes indirectly impact poor households through other intermediary sectors like transport. Therefore, there should be a balance between excessive taxation of a few commodities considered to be luxury goods and the quest for revenue.

The rest of the paper will be organized as follows: section II outlines the salient features of the tax reforms with specific changes in rates; section III focuses on the tax yields as a result of changes in tax reforms; section IV covers the literature review; the methodological issues will be outlined in section V and lastly section VI will have results and conclusion.

Section 2: Tax reforms with specific changes in quantity

Excise Duties especially on fuel have been increasing over the years. This affects transport services since it's a main source of fuel for public and produces transport and could have a negative impact on household and firms. In addition, due to the shortages in electricity, many firms have resorted to the use of diesel for generators and changes in rates affect their profitability. Because of this fact, the government has recently reduced tax rates on diesel for manufactures.

The Income Tax Decree of 1974 (Kelvin Holmes, 1997) with extensive amendments in the subsequent annual financial statutes remained the main income tax law until the major reforms in income tax of 1997, which saw the enactment of Income Tax Act 1997. The Income Tax Act 1997 and its subsequent amendments are the basis of income tax to date. The components of the income tax are:

(a) PAYE**.** Its brackets was in 1992/93 reduced from five to four and the maximum marginal rate reduced from 50 percent to 40 percent on income exceeding shs.3.6 million.

Other reforms in the income tax was the 1993 increase in the threshold for personal income from Shs 600,000 to Shs 840,000 and the reduction of the income tax brackets from four to three and the top marginal rate from 40 percent to 30 percent for income above shs.4.2 million. Then there was an introduction of the New Income Tax Law in December 1997, which was to replace tax holidays with accelerated depreciation allowances. This was to improve the performance of PAYE and non-PAYE component. The new threshold for PAYE is as follows.

Table 2.1: PAYE bracket trends

Bracket	from	to	rate
1st	0	130000	0
2nd	130001	235000	10%
3rd	235001	410000	20%
4th >410000	410000		30%

Source: MFPED (2002)

The above threshold was revised in 1997. An analysis of the threshold from an income point of view shows that the rates depend on an income bracket. Majority of the salaried Ugandans are within the 1st and third bracket, and therefore the rates applicable to them are not as regressive as those in the 4th bracket. This perhaps explains why PAYE is one of the taxes where government collects a lot of revenue.

(b) Corporation tax or Company tax. This is a tax on company's net profits. The rate of company tax in Uganda is 30 percent and is normally paid twice a year, depending on the taxpayers' year of income. Companies file returns of income to URA, which highlights the operations of the company specifically the income and expenses, gross profits and deductions, and net profits. The corporation tax rate on company's net profits was reduced from 35 percent to 30 percent in 1997 and has not changed since.

The performance of company tax has been poor since 1997 when income tax was overhauled (Table 2). This is attributed to the number of weaknesses in the Income Tax Act (ITA) 1997. For instance, section 39 of the ITA allows companies to indefinitely carry forward losses, section 23 specifies a number of deductions allowed and some companies still have certificates of incentives.

Under corporation tax, the major reform was the abolition of all tax exemptions, tax holidays (however this change did not affect investors who had already received tax holidays), suspension of all running investment incentives other than those specifically re-confirmed on fresh application and privatization of state owned enterprises, which brought all corporations into the tax net. The act repealed Section 25 of the Investment Code 1991, which provided a basis for tax holidays (Budget Speech June 1997).

(b) VAT. This was introduced in 1997 to replace Certificate of Tax Liability (CTL) and sales tax in order to boost non-trade related taxes that were also disappointing in the tax collection effort. The rate was established at 17 percent but was revised in 2005/2006 to 18 percent.

(c) Withholding tax. The major reform in this tax (1997) was the imposition of withholding tax on non-residents who earn income in form of interest, dividends, management fees, and loyalty in Uganda. Effective July 1997, non-residents were required to pay the withholding tax of 15 percent. The rate on supplies and procurement is 6 percent

(c) Presumptive taxes. This is a tax that is levied on a turnover of less than or equal to 50 million Uganda shillings. It mainly covers small businesses, because any business with a turnover of above 50 million is considered a corporation. These small businesses are associated with inability to keeping proper records, hence unlike corporate taxes; these firms are taxed without adjusting for deductions of

expenditures and losses. This tax could have larger implications on low income earners who are largely involved in small scale production.

Table 2.2: Presumptive tax

Income Tax on MOF Schedule		
From	To	Rate(Ug.Shs)
-	5,000,000.00	0
5,000,001.00	20,000,000.00	100,000.00
20,000,001.00	30,000,000.00	250,000.00
30,000,001.00	40,000,000.00	350,000.00
40,000,001.00	50,000,000.00	450,000.00

Source: URA (various issues)

(d) Rental income tax. This is categorized as either limited company earnings or individual rental earnings. With respect to limited company earnings of rent, this is income that is considered as part of the company's turnover. As for individual rental incomes, it's not considered as part of the turnover, since we are dealing with individuals, so it's imposed separately from actual incomes, payable after 12 months. For companies, a 20 percent deduction is made to cater for expense on maintenance of the building and the remaining 80 percent is what is taxed. However the other characteristics of this tax are that no deductions are made on withholding tax and this tax applies to only immovable properties (land and buildings).

(e) Import duty which is the second largest source of government revenue in Uganda, contributing 3 percent of GDP in 2003/04, representing 23.8 percent of total tax revenue. Excise duty was the biggest contributor bringing in 10.5 percent of Uganda's total tax revenue (1.4 percent of GDP) in 2003/2004. The tariff structure in Uganda (is basically ad valorem for most items) - comprising three tariff bands: 0, 10, and 15 percent. The zero rate applies to capital goods and some socially important imports such as medicines, fertilizers and pesticides. Tariff reform have involved (among others) reduction in tariff rates, simplification of the structure, reduction of exemptions and phasing out import bans, import license requirements and pre-shipment inspection. To compensate for the reduction in tariff, government introduced excises of 10 percent on the imports (applied on an ad valorem basis

across about 400 tariff lines). For example, sugar benefited from high duties on sugar imports (15 percent), and hence, preferential access to imported sugar as a raw material for other production (beer and soft drinks) led to the domestic market price of sugar in Uganda to exceed US$600 per ton (much higher than the cost of sugar on world markets) – thus imposing a burden on the consumers.

Section 3: Tax performance after reforms

Total taxes have been increasing since 1997 from10.7 percent to 19.7 of GDP. This increase has largely been attributed to improved revenue collection and enforcement of the tax code. While trade taxes used to dominate the overall tax revenue, these have been replaced by other taxes including VAT, presumptive taxes, and withholding taxes among other taxes (Table 3).

Table 3: Fiscal Operations of Central Government

	Uganda Government Revenue, 1997-2006(in billion of Uganda shillings)		
	1997-2000	**2001-2003**	**2003-2006**
Taxes on international trade	93.3	130.7	112
Income Tax	159	286	222.5
Excise tax	318.3	358.3	338.3
VAT	286.3	399.3	342.8

	Uganda Government Revenue, 1997-2006(as GDP percentage)		
	1997-2000	**2001-2003**	**2003-2006**
Revenue	11.23	11.7	20.7
International trade taxes	1.08	1.36	1.22
IncomeTax	1.83	2.79	3.6
Excise Tax	3.64	3.54	3.33
VAT	3.29	3.9	4.07

Source: IMF Staff Reports (Various Issues)

Section 4: Literature review

To assess the effectiveness of a tax system, it's always worthwhile to understand how the tax system impacts the welfare of households and performance of firms.
Under the current tax code most basic goods and services which accounts for disproportionately high percentage of low-income household spending are exempted or zero-rated (e.g. basic foodstuffs). In addition to equity concerns, certain sales are exempt or zero-rated for especially educational and health services and passenger transport services. Generally, a number of VAT exemptions appear pro-poor.

Chen et al. (2001) showed that, with the exception of some excise taxes and graduated personal tax, which is an income tax levied by local governments, most tax reforms had been progressive. The excise tax on kerosene, which is heavily consumed by the poor, was found to be highly regressive. Graduated personal tax also turned out to hit the poor relatively hard as its threshold was about half the lower threshold of the central government income tax on individuals. Since it was levied on formal sector employees and hence on the better-off, Pay-As-You Earn (PAYE) income tax was the most progressive tax.

The impact of tax reforms on regular taxable firms was such that the tax burden incurred by large and medium-size regular taxable firms was significantly reduced following the 1997 income tax reform (Chen et al., 2001). This was mainly due to the generous initial allowance for investment in machinery and equipment (except vehicles) available to all tax-paying firms under the new system. The other contributor was the zero rated import duty for imported machinery. The corporate tax holidays were abolished in 1997 and replaced mainly by an initial investment allowance for machinery. As a result, the Marginal Effective Tax Rate (METR) on machinery was significantly reduced. This indicated that, given the generous allowances, profitable firms that invest heavily in machinery could benefit from opting from the tax reform, reflecting the policy makers' desire to provide incentives for acquisition on new technologies.

The findings indicated that the tax reforms made excise taxes more progressive and import duties more regressive. The latter finding was most likely due to the introduction of duty-free treatment of imported capital goods for all firms in 1995. The excise tax on petroleum was found to be particularly progressive. As the authors pointed out, this finding should be treated with caution. If the indirect effects of the petroleum taxes were taken into account, excise taxes might turn out to be more regressive. Since taxing petroleum consumption affects transport prices and hence final consumer prices of all types of goods, people in rural areas and thus the poor are likely to be hurt disproportionately.

This study points to the limitations of this type of tax incidence analysis. In addition, it is based on the formal tax structure only. If the analysis were instead based on taxes actually paid, the above findings could change substantially. In an economy with a large rural and informal sector like Uganda, there is good reason to believe that numerous businesses and individuals do not pay taxes at all. For example, there is evidence that tax exemptions and tax evasion are widespread among firms. While tax exemptions appear to be more common among larger firms, tax evasion is especially prevalent among smaller firms (Gauthier and Reinikka, 2001). If this were taken into account, the resulting tax incidence could move in either direction depending on the extent of the tax burden resting on smaller firms.

Kayizzi-Mugerwa, 2002, points out that the budget's financing options also implied trade-offs. Earlier, trade taxes, notably those on coffee exports, were popular, mostly for their ease of collection. Commodity taxation has a high incidence on the poor, however, with the countryside in effect subsidizing the cities. There were followed by fuel taxation, which seemed more equitable, since cities are transport-intensive. However, fuel enters directly into the cost of transporting exports to the sea as well as the price of the 'wage goods' to producers in the countryside, including the remotest regions. Intent on private sector development, such as Uganda, tax policies have assumed a central place in the economic debate not least since the level of

taxation ultimately defines the business environment. Pressure groups representing the manufacturing sector have argued that taxes are among the most important obstacles to the expansion of industrial activities. The government has argued, however, that at only 11.5 of GDP total taxation is much lower than in many other African countries. The problem is that the tax base is still quite shallow.

Section 5: Incidence of Taxes 1992-2005

In examining the welfare impact of tax policy reforms, we adopt a number of strong assumptions. For direct taxes, we assume that the factors that produce the associated incomes pay the taxes. For indirect taxes, we assume that households that consume the taxed items pay the associated taxes. Thus, smokers pay taxes on tobacco, households that use paraffin for lamps pay the taxes on paraffin, etc. Import duties are more difficult to capture from a household survey given that there is no differentiation of consumer goods which are domestically produced and those which are imported. We therefore assume that the prices of all goods for which imports are a large share of the market go up by the amount of the tariff when it is imposed. Finally, most of the analysis relies on statutory tax rates rather than any estimates of taxes actually paid.

In the figures below, we present results showing the incidence of taxes on Households over the period 1992-2005. The data used to analyze the effects of tax reforms for both 1992 and 1994/95 are from the Integrated Households Survey (1992) and the 2005 Integrated Household Survey.

We first compare two different tax regimes by presenting results for the incidence of taxes in 1992 before major reforms took place and 1994/95 after the tax reforms. We compare these results to the 2005 data. Two important results can be derived from this exercise. Figure 1 clearly shows that tax reforms did not have an immediate impact on the overall distribution of taxes paid by households. As noted from the figures below, all taxes have concentration curves that are lower than the household

per-capita expenditures an indication that they are generally progressive. The exception is graduated tax which was later abolished.[1]

The key interest in this paper is mainly on how the tax incidence has evolved overtime. From the Lorenz curves, its revealed that the coverage of taxes has greatly improved compared to 1992-94. For instance, in figure 2 its very clear that income tax during that period was only paid by a few individuals. Since then if we compare this chart to figure 3, we find that more individuals are now being captured in the distribution. This also applied to excise duties which in 1992 the distribution of the Lorenz curve was mainly skewed to the rich. Compared to the 2005 distribution, more households are being captured for this income tax category. The intuition behind the changes in the distribution of these curves could be two fold: first its possible that there has been a growth in incomes by households which has resulted into being captured especially for taxes like excise which are levied on goods consumed largely by the rich. Second, its also possible that there has been a general improvement in tax collection effort.

[1] Graduated tax is a form of a poll tax which is compulsory for all individuals above 18 years of age and not engaged in schooling. This tax is levied irrespective of whether an individual holds a job or some taxable assets. The incidence of this tax is mainly on the poor given that it is effectively collected in
rural areas.

Figure 1: Incidence of Tax Reforms on Households 1992-94

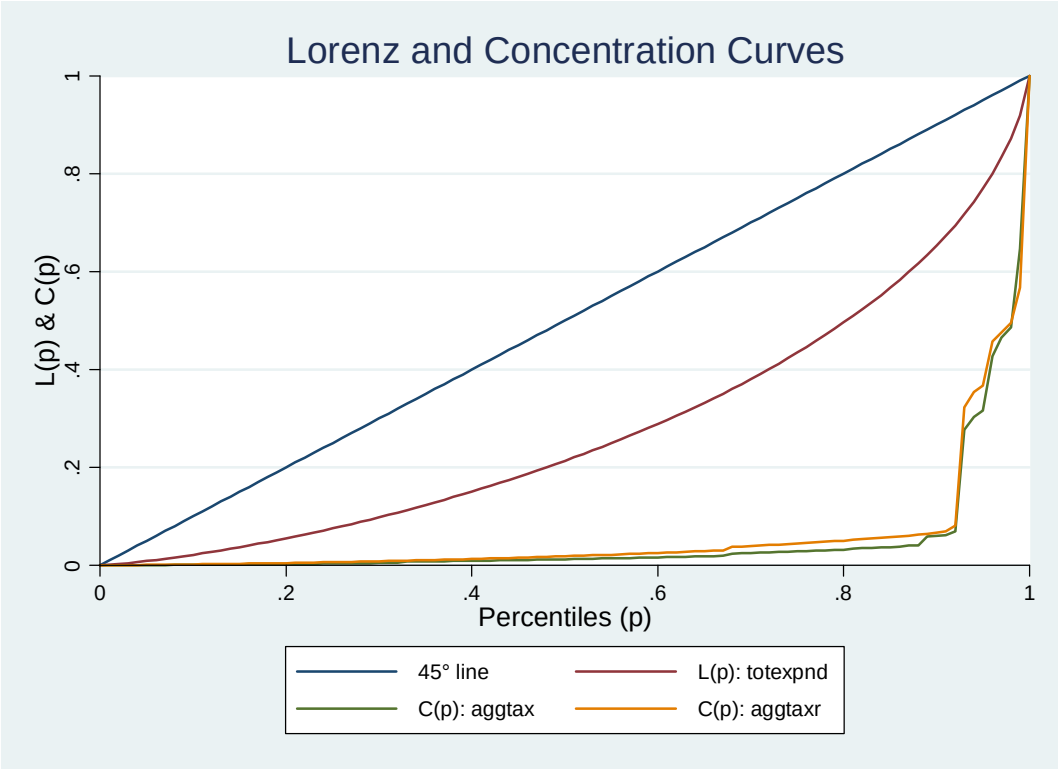


Figure 2: Incidence of Income Taxes before and After Reforms in 1992-94

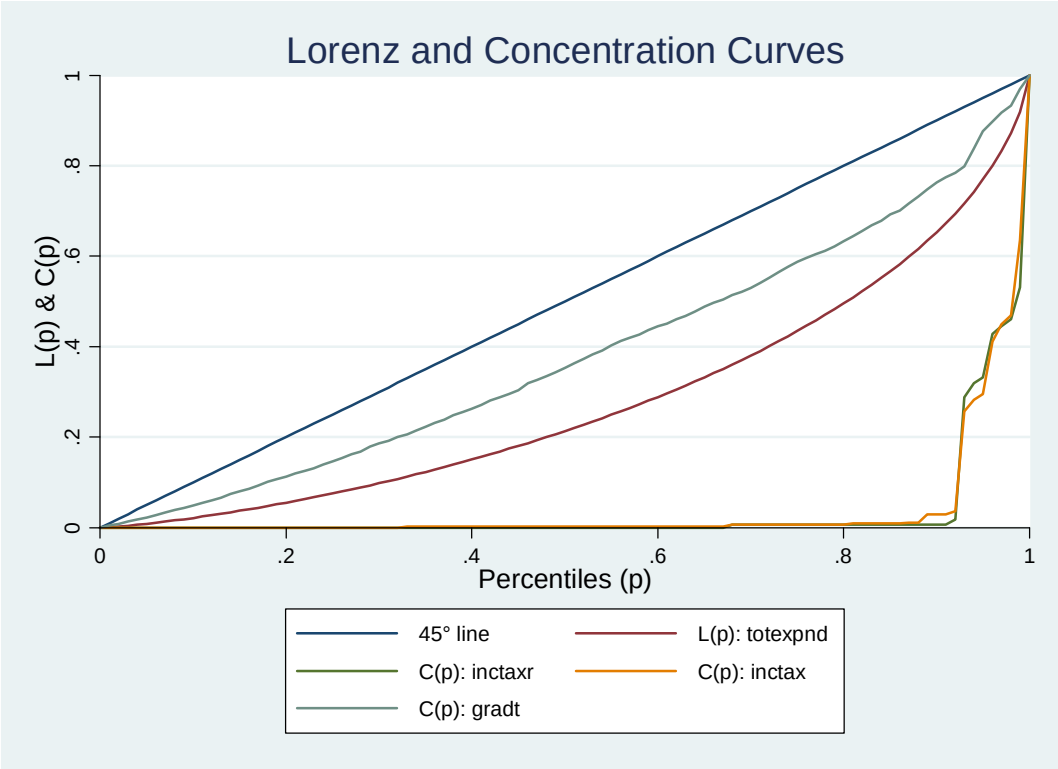


Figure 3: Incidence of Income Taxes in 2005

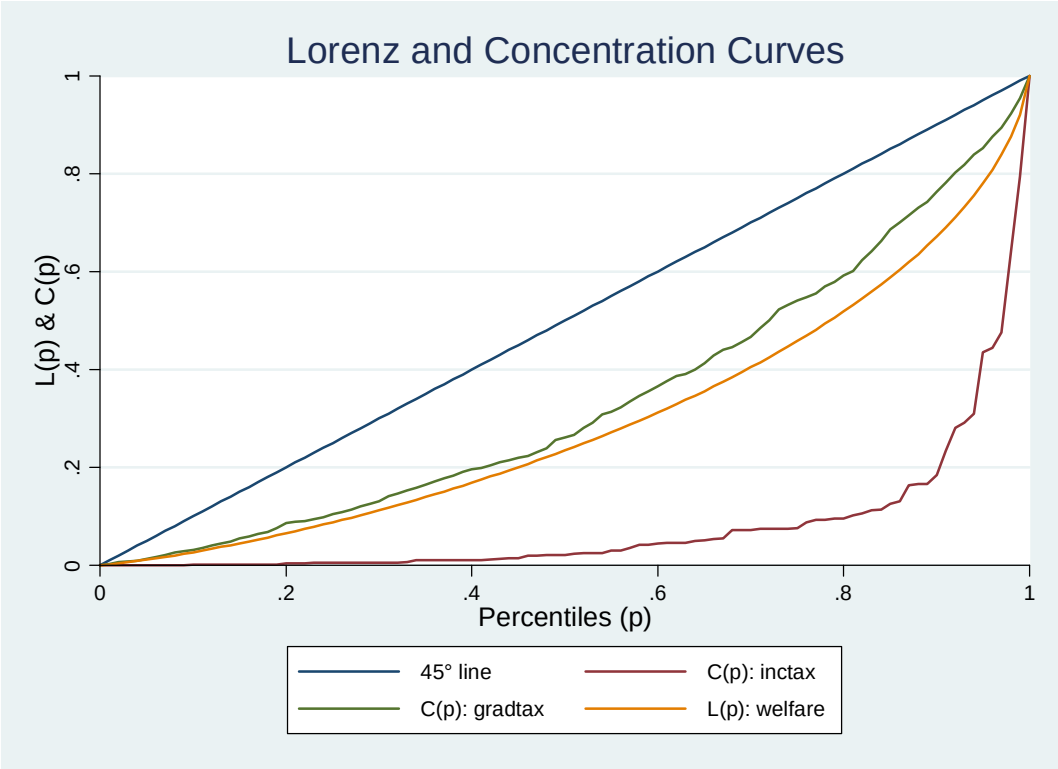


Figure 4: Incidence of excise taxes before and after reforms in 1992-94.

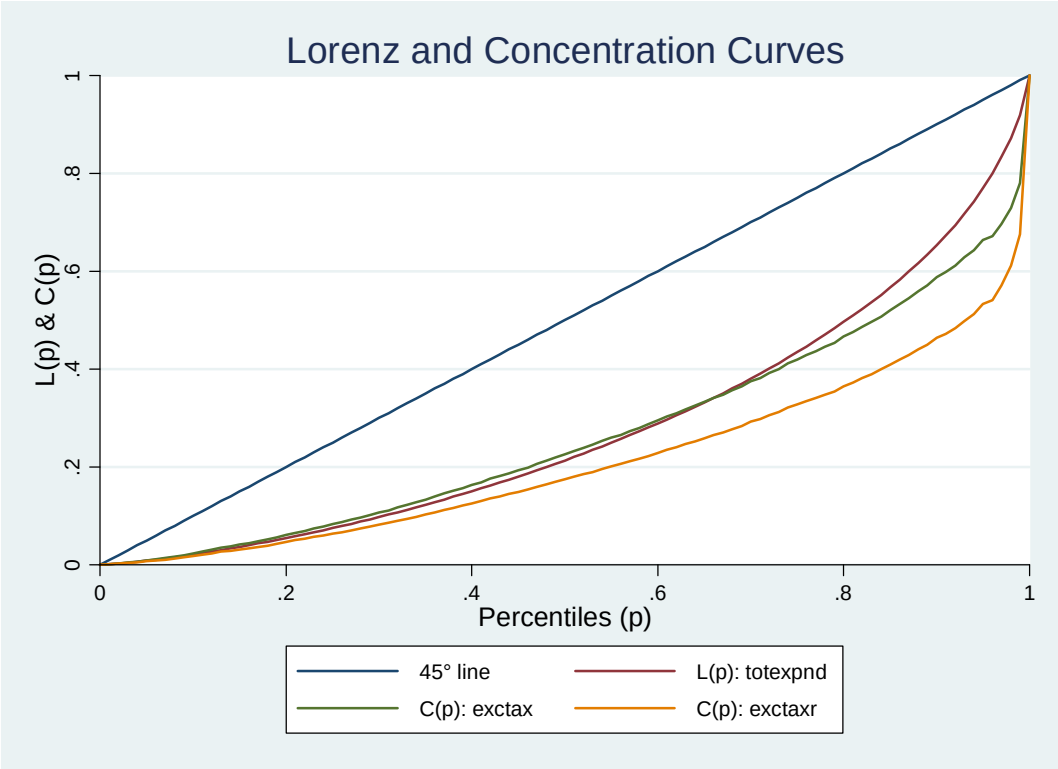


Figure 5: Incidence of Sales and VAT taxes before and after reforms in 1992-94

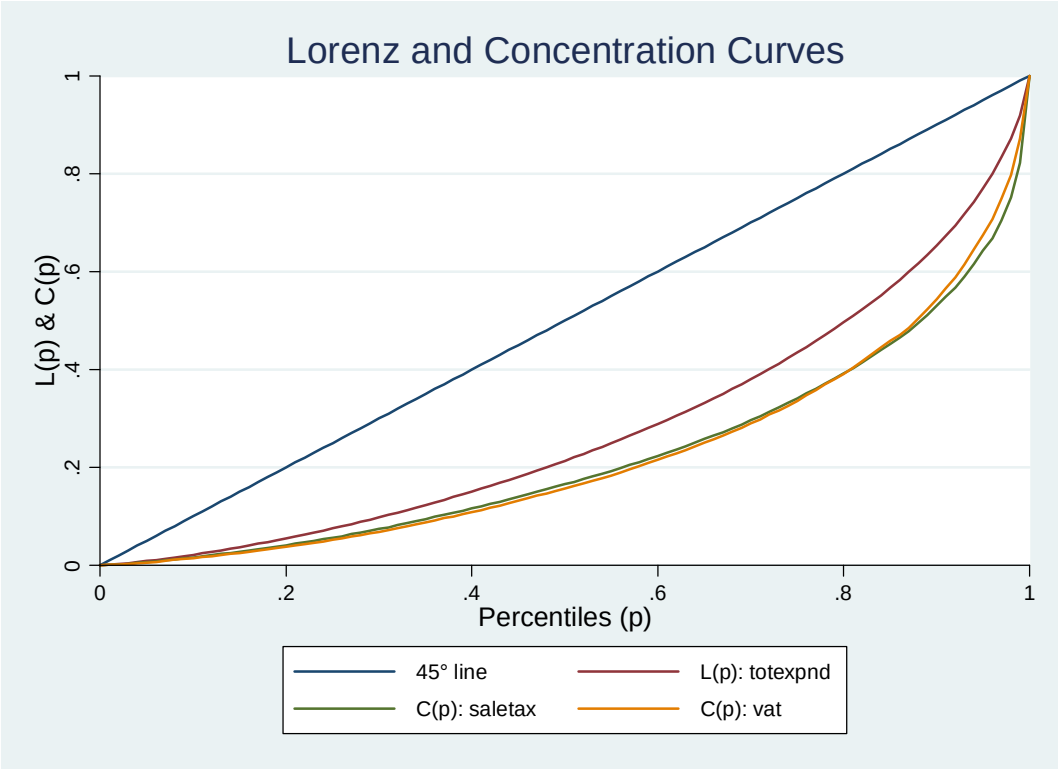
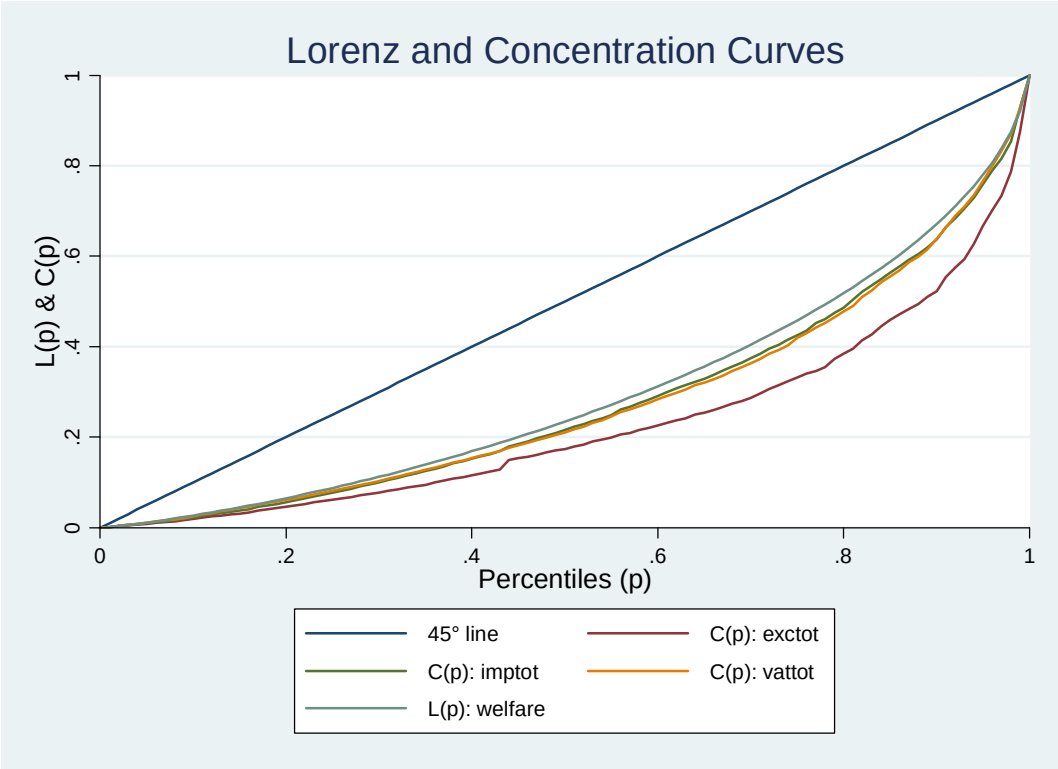


Figure 6: Incidence of Excise, VAT and Import Duties in 2005



Section 6: The Uganda Social Accounting Matrix (SAM) 2007

A Social Accounting Matrix (SAM) is a table which summarizes the economic activities of all agents in the economy. These agents typically include households, enterprises, government, and the rest of the world (ROW). The relationships included in the SAM include purchase of inputs (goods and services, imports, labour, land, capital etc.); production of commodities; payment of wages, interest rent and taxes; and savings and investment. Like other conventional SAMs, the Uganda SAM is based on a block of production activities, involving factors of production, households, government, stocks and the rest of the world.

The Uganda SAM is a 120 by 120 matrix. The various commodities (domestic production) supplied are purchased and used by households for final consumption (42 per cent of the total), but also a considerable proportion (34 per cent) is demanded and used by producers as intermediate inputs. Only 7 percent of domestic production is exported, while 11 per cent is used for investment and stocks and the remaining 7 percent is used by government for final consumption. Households derive 64 per cent of their income from factor income payments, while the rest accrues from government, inter-household transfers, corporations and the rest of the world. The government earns 32 percent of its income from import tariffs – a relatively high proportion, but a characteristic typical of developing countries. It derives 42 percent of its income from the ROW, which includes international aid and interest. The remainder of government's income is derived from taxes on products (14 percent), income taxes paid by households (6 percent) and corporate taxes (5 percent).

Investment finance is sourced more or less equally from government (26 per cent), domestic producers (27 per cent) and households (26 per cent), with enterprises providing only 21 per cent. Imports of goods and services account for 87 percent of total expenditure to the ROW. The rest is paid to ROW by domestic household sectors in form of remittances; wage labour from domestic production activity;

domestic corporations payments of dividends; income transfers paid by government; and net lending and external debt related payments.

The extent of household dis-aggregation is very important for policy analysis, and involves representative household groups as opposed to individual households. Pyatt and Thorbecke (1976) argue persuasively for a household dis-aggregation that minimizes within-group heterogeneity. This is achieved in the Uganda SAM through the disaggregating of households by rural and urban, and whether households are involved in farming or non farming activities.

The Uganda SAM identifies three labour categories disaggregated by skilled, unskilled and self employed. Land and capital are distributed accordingly to the various household groups.

Section 7: Salient Features of the CGE Model

The CGE model used in the present study is based on a standard CGE model developed by Lofgren, Harris, and Robinson (2002). The CGE model is calibrated to the 2002 SAM database. GAMS software is used to calibrate the model and perform the simulations.

Productions and commodities

For all activities, producers maximize profits given their technology and the prices of inputs and output. The production technology is a two-step nested structure. At the bottom level, primary inputs are combined to produce value-added using a CES (constant elasticity of substitution) function. At the top level, aggregated value added is then combined with intermediate input within a fixed coefficient (Leontief) function to give the output. The profit maximization gives the demand for intermediate goods, labor and capital demand.

The allocation of domestic output between exports and domestic sales is determined using the assumption that domestic producers maximize profits subject to imperfect transformability between these two alternatives. The production possibility frontier of the economy is defined by a constant elasticity of transformation (CET) function between domestic supply and export.

On the demand side, a composite commodity is made up of domestic demand and final imports and it is consumed by households, enterprises, and government. The Armington assumption is used here to distinguish between domestically produced goods and imports. For each good, the model assumes imperfect substitutability (CES function) between imports and the corresponding composite domestic goods. The parameter for CET and CES elasticity used to calibrate the functions used in the CGE model are exogenously determined and are taken from Chung-I Li (1999).

Factor of production

There are 18 primary inputs: 16 labour types, capital and land. Wages and returns to capital are assumed to adjust so as to clear all the factor markets. Both types of labor are mobile across sectors while capital is assumed to be sector-specific.

Institutions

There are six institutions in the model: 32 households, 1 enterprises and government. Households receive their income from primary factor payments. They also receive transfers from government and the rest of the world. Households pay income taxes and these are proportional to their incomes. Savings and total consumption are assumed to be a fixed proportion of household's disposable income (income after income taxes). Consumption demand is determined by a Linear Expenditure System (LES) function. Firms received their income from remuneration of capital; transfers from government and the rest of the world; and net capital transfers from households. Firms pay corporate tax to government and these are proportional to their incomes.

Government revenue is composed of direct taxes collected from households and firms, indirect taxes on domestic activities, domestic value added tax, tariff revenue on imports, factor income to the government, and transfers from the rest of the world. The government also saves and consumes.

Macro closure

Equilibrium in a CGE model is captured by a set of macro closures in a model. Aside from the supply-demand balances in product and factor markets, three macroeconomic balances are specified in the model: (i) fiscal balance, (ii) the external trade balance, and (iii) savings-investment balance. For fiscal balance, government savings is assumed to adjust to equate the different between government revenue and spending. For external balance, foreign savings are fixed with exchange rate adjustment to clear foreign exchange markets. For savings-investment balance, the model assumes that savings are investment driven and adjust through flexible saving rate for firms. Alternative closures, described later, are used in a subset of the model simulations.

Section 8: Simulations and Results

First to make an assessment as to whether the current tax regime is progressive, we undertake a simulation where we assume that VAT is removed and the budget is mainly financed by the former sales tax and direct income taxes. In all cases, we remove VAT while at the same time considering the following revenue tax changes. First, we assume that the revenue losses are not compensated for by adjusting any other forms of taxes. We also consider scenarios where the revenue loss after the removal of VAT is compensated for by increasing direct taxes on households uniformly. The third scenario is where the revenue loss is mainly compensated for by households in the fourth quartile (richer households). We also assess the progressiveness of the tax system if all food items and agricultural commodities were zero rated.

8.1 Macroeconomic Effects of Tax Reforms

The analysis used to assess the progressiveness of VAT is similar to Devarajan and Hossain who analyze sales taxes rather than a VAT. As noted in Devarajan and Hossain, this allows us to examine the “true” price-distorting effect of the tax. In the analysis, we are mainly interested in the macroeconomic effects, the sectoral effects and the welfare implications on households. A policy of a 100 percent reduction in VAT is expected to impact generally positively on the macro economy. The outturn is as expected under both fixed and flexible tax deficits with a greater impact on the trade balance since the increase in exports (0.1 percent) is greater than the increase in imports (0.04 percent). The intuition is that the exports become cheaper as such they are now more competitive in the international markets. Overall GDP increased due to increased domestic activities as the elimination of VAT reduces both cost of production and prices of the product for the domestic consumers. The positive net indirect taxes are due to increases in the GDP and the higher disposable incomes that have resulted from the VAT cuts.

For the case where the reduction of VAT is financed by richer households, the trade balance is negatively affected (exports decreased by about 0.3 percent while the imports decreased by about 0.2 percent). On top of the VAT, they are burdened by indirect taxes, which make the trade balance suffer. However, the effects on other macroeconomic variables are marginal. The reduction of VAT on food items has a positive though small effect on the macro economy (this tax is however regressive since all rural quartiles households are negatively affected). The intuition here is that these rural quartile households are the ones engaged in the production of food items, removing taxes on these items results in low tax revenues which revenues would otherwise be used to provide social infrastructure for these groups.

Removing excise tax on manufactured goods impacts negatively on the macro economy under both the flexible and fixed tax deficit regimes. The trade balance is also negatively affected (exports decrease by about 0.24 percent while the imports

decreased by about 0.16 percent). The negative net indirect taxes may be due to a decrease in the excise tax itself. The negative impact on the macro economy and the trade balance may be because the removal of excise duty which is a major source of government revenue impacts negatively the government expenditure and economic development.

Increasing excise tax on petrol products impacts negatively on the macro economy and the trade balance is also slightly affected. Whereas taxation of petrol (which is considered to be consumed mainly by the rich), may be considered to be a progressive move, its effects can also be felt in the overall transport sector thereby affecting the whole macroeconomy.

Table: 8.1: Simulations on the Impact of Tax Reforms on the Macroeconomy

	Baseline	VATTAX1	VATTAX2	VATTAX3	VATTAX4	VATTAX5
Absorption	12703	0.03	0.04	0.00	0.00	0.00
Private Consumption	8513	0.05	0.05	0.01	0.00	0.00
Fixed Investment	2424	..	..	..	..	..
Government Consumption	1766	..	..	..	..	..
Exports	1854	0.06	0.07	-0.03	0.13	0.13
Imports	-2821	0.04	0.05	-0.02	0.09	0.09
GDP at Market Price	11736	0.04	0.04	0.00	0.00	0.00
Net Indirect Taxes	1163	0.51	0.52	0.04	0.02	0.02

	INCTAX1	INCTAX2	PTRTAX1	VATTAX6	VATTAX7	EXCISE3	EXCISE4
Absorption	0.00	-0.01	0.00	0.03	0.04	-0.01	-0.01
Private Consumption	0.00	-0.01	-0.01	0.05	0.05	-0.02	-0.02
Fixed Investment	..	..	..	..	..	..	..
Government Consumption	..	..	..	..	..	..	..
Exports	-0.05	-0.09	-0.02	0.06	0.07	-0.24	-0.24
Imports	-0.03	-0.06	-0.01	0.04	0.05	-0.16	-0.16
GDP at Market Price	0.00	-0.01	0.00	0.04	0.04	-0.01	-0.01
Net Indirect Taxes	-0.03	-0.06	-0.04	0.51	0.52	-0.13	-0.13

8.2 Welfare Effects

Removal of VAT across the board

With the removal of VAT, the welfare of richer households improves. These are households who mainly consume manufactured commodities on which VAT is levied. The rural household's welfare generally declined. This policy stance clearly shows that implementation of VAT was indeed good for the poor and made the tax system more progressive. The arguments that were fronted at the time that VAT would make the poor poorer are not supported in this analysis. This result is consistent with the study done by Chen et.al. (200x), which suggests that replacement of sales tax with VAT did not make the poor worse off. The welfare measures also show a worse off scenario where the loss in revenues is mainly compensated for by a uniform increase in direct taxes.

Table 8.2: Simulations on the Impact of Tax Reforms on Household Welfare

	VATTAX1	VATTAX2	VATTAX3	VATTAX4	VATTAX5	INCTAX1
CRURQ1	-0.96	-1.12	0.24	-0.07	-0.08	1.09
CRURQ2	-2.11	-2.42	0.57	-0.09	-0.11	2.09
CRURQ3	-1.93	-2.20	1.04	-0.17	-0.19	0.78
CRURQ4	-1.73	-1.65	2.16	-0.12	-0.11	-5.32
CURBQ1	0.22	0.20	0.07	-0.02	-0.02	0.22
CURQ2	0.65	0.61	0.22	-0.03	-0.03	0.15
CURQ3	0.77	0.74	0.44	-0.06	-0.06	-0.32
CURQ4	14.97	18.45	-12.37	0.08	0.33	-7.42
ERURQ1	-1.50	-1.83	0.87	0.14	0.11	1.14
ERURQ2	-2.52	-2.89	1.14	0.01	-0.02	0.92
ERURQ3	-1.74	-2.04	1.12	-0.16	-0.18	1.20
ERURQ4	-1.12	-1.27	0.66	0.04	0.03	-2.38
EURBQ1	0.15	0.14	0.05	-0.01	-0.01	0.20
EURQ2	0.21	0.18	0.08	-0.02	-0.02	0.31
EURQ3	0.35	0.33	0.19	-0.03	-0.03	0.01
EURQ4	0.50	0.95	-0.15	-0.10	-0.07	-1.25
NRURQ1	-1.45	-1.78	0.70	0.05	0.03	1.18
NRURQ2	-1.03	-1.26	0.53	-0.04	-0.05	1.39
NRURQ3	0.24	0.09	0.47	-0.01	-0.02	1.03
NRURQ4	0.17	0.02	-0.22	0.02	0.01	-0.92
NURBQ1	0.22	0.15	-0.16	-0.03	-0.03	1.93
NURQ2	0.18	0.15	0.07	-0.02	-0.02	0.26
NURQ3	0.28	0.26	0.14	-0.02	-0.02	0.01
NURQ4	0.28	0.51	0.09	-0.05	-0.04	-0.53
WRURQ1	-1.12	-1.34	0.40	0.29	0.28	1.62
WRURQ2	-1.98	-2.41	0.68	0.15	0.11	3.49
WRURQ3	-0.85	-1.19	1.07	0.26	0.23	2.71
WRURQ4	1.29	0.83	-0.59	0.11	0.08	-3.14
WURBQ1	0.30	0.28	0.07	-0.01	-0.01	0.24
WURQ2	0.35	0.33	0.13	-0.02	-0.02	0.17
WURQ3	0.45	0.42	0.22	-0.02	-0.02	-0.05
WURQ4	2.07	2.45	0.55	0.13	0.16	-1.11
TOTAL	3.61	3.68	0.47	0.21	0.22	-0.31

Table 8.2 Cont'd:

	INCTAX2	PTRTAX1	VATTAX6	VATTAX7	EXCISE3	EXCISE4
CRURQ1	1.65	0.04	-0.96	-1.12	0.44	0.41
CRURQ2	3.33	0.06	-2.11	-2.42	0.71	0.66
CRURQ3	2.29	0.07	-1.93	-2.20	0.77	0.66
CRURQ4	-3.67	-0.15	-1.73	-1.65	-0.12	-0.18
CURBQ1	0.31	-0.01	0.22	0.20	-0.05	-0.04
CURQ2	0.34	-0.02	0.65	0.61	-0.09	-0.08
CURQ3	0.02	-0.03	0.77	0.74	-0.10	-0.29
CURQ4	-24.46	-0.53	14.97	18.45	-1.45	-1.70
ERURQ1	2.48	0.05	-1.50	-1.83	0.05	0.10
ERURQ2	2.66	0.06	-2.52	-2.89	0.18	0.22
ERURQ3	2.86	0.06	-1.74	-2.04	0.03	0.06
ERURQ4	-1.94	-0.04	-1.12	-1.27	-0.42	-0.36
EURBQ1	0.27	-0.01	0.15	0.14	-0.03	-0.02
EURQ2	0.43	-0.01	0.21	0.18	-0.03	-0.03
EURQ3	0.18	-0.02	0.35	0.33	-0.08	-0.07
EURQ4	-1.70	-0.03	0.50	0.95	-0.20	-0.27
NRURQ1	2.34	0.06	-1.45	-1.78	0.20	0.24
NRURQ2	2.34	0.04	-1.03	-1.26	0.06	0.09
NRURQ3	1.69	0.01	0.24	0.09	-0.15	-0.12
NRURQ4	-1.36	0.00	0.17	0.02	-0.39	-0.35
NURBQ1	2.05	-0.01	0.22	0.15	-0.05	-0.04
NURQ2	0.36	-0.01	0.18	0.15	-0.02	-0.02
NURQ3	0.13	-0.01	0.28	0.26	-0.06	-0.05
NURQ4	-0.57	-0.01	0.28	0.51	-0.07	-0.10
WRURQ1	2.49	0.03	-1.12	-1.34	0.05	0.10
WRURQ2	5.09	0.06	-1.98	-2.41	0.28	0.37
WRURQ3	4.47	0.04	-0.85	-1.19	-0.05	0.04
WRURQ4	-4.54	-0.07	1.29	0.83	-0.66	-0.52
WURBQ1	0.32	-0.01	0.30	0.28	-0.04	-0.03
WURQ2	0.30	-0.01	0.35	0.33	-0.04	-0.03
WURQ3	0.12	-0.01	0.45	0.42	-0.07	-0.06
WURQ4	-0.94	-0.07	2.07	2.45	-0.35	-0.37
TOTAL	-0.64	-0.45	3.61	3.68	-1.78	-1.78

Financing of VAT revenue losses by increasing direct taxes paid by Q4

We also consider a scenario where the losses in VAT tax revenues are mainly financed by households in the fourth quartile. The general welfare of urban households in Q4 declines. This is because they bear the burden of the tax. However, over taxation of households in this income category could have more negative effects at the macroeconomic level due to the reduction in savings and investments. As expected, the welfare of the households in the other quartiles

improved because the taxation system became more progressive which impacts positively on the poorer households.

Removal of VAT on all food items across the board

In order to make the tax system more progressive, we analyzed a case where food items are exempted from VAT. The implications of this scenario would be an overall improvement in the welfare of households in the lower quartiles. However, in this case the urban households benefit the most because they are the main consumers of food products that are VAT eligible. The rural households are affected negatively by this because the urban households who are the main consumers of these food items produced by the rural households switch to manufactured products which impacts negatively on the market of food products from rural areas.

Removal of all income taxes on low income households i.e. Q1, Q2 & Q3

We also experiment with the case of removing all income taxes on low income households and mainly targeting the rich households. The argument for this policy stance is that it's administratively cheaper to target rich individuals, than spreading the tax collection resources thin across so many individuals who are more difficult to target. The welfare of Q4 households is negatively affected because they bear the burden of the tax. For the other quartiles, their welfare improves because they will fall outside the tax bracket. This implies that the income tax in this scenario is progressive because it improves the welfare of the poorer members of the society. Under the fixed fiscal balance the Q4 become worse off compared to the flexible regime.

Increasing excise taxes all manufactured products

Due to lack of other sources of revenues, the government has been taxing goods considered to be luxurious very heavily. In particular goods like beers, cigarettes and soft drinks have attracted very high excise duties. While these commodities are not generally consumed by the poor, over taxing them could actually harm the real objective of raising revenues due to reduced consumption. For the simulations, the rural households are better off as they consume less of the manufactured products compared to the urban households.

Increasing excise tax on only petrol

We also specifically run a simulation of increasing excise taxes on petroleum products. The objective behind this simulation is that petrol could have other indirect effects on the poor especially given its interdependency with other sectors like transport. This had a general negative impact on almost all households in the country. This is because increase in excise tax on petrol directly or/and indirectly impacts negatively all economic activities that depend on petrol such as transport and manufacturing.

9. Conclusion and Policy Implications

From a historical perspective, we note that Uganda has gone a long way to improve its tax system. Income taxes which were largely paid by a few individuals are now being paid more households. This is partly due to the growth in comes of households that has been witnessed over the past ten years. However, a few specific areas would still need improvement.

Key policy conclusions from this paper are as follows. Uganda should continue to strengthen VAT and further streamline it so that VAT can be captured both at the production and consumption stage. At the moment, it’s only formally registered

companies which are paying VAT at the retail stage. This narrows the scope of collection and provides some room to widen the tax base. Second, to stimulate production in the agricultural sector, all agricultural activities should be fully exempted from VAT. This would make the tax system more progressive as most of the low income households depend on the agricultural sector. Third, while excessive excise taxes may not directly impact poor households, the revenue authorities should be aware that this could reduce the consumption levels of these commodities. Therefore there should be a balance between excessive taxation of a few commodities considered to be luxury goods and the quest for revenue.

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Table A1. CGE model sets, parameters, and variables

Symbol	Explanation	Symbol	Explanation
Sets			
$a \in A$	Activities	$c \in CMN(\subset C)$	Commodities not in *CM*
$a \in ALEO(\subset A)$	Activities with a Leontief function at the top of the technology nest	$c \in CT(\subset C)$	Transaction service commodities
$c \in C$	Commodities	$c \in CX(\subset C)$	Commodities with domestic production
$c \in CD(\subset C)$	Commodities with domestic sales of domestic output	$f \in F$	Factors
$c \in CDN(\subset C)$	Commodities not in *CD*	$i \in INS$	Institutions (domestic and rest of world)
$c \in CE(\subset C)$	Exported commodities	$i \in INSD(\subset INS)$	Domestic institutions
$c \in CEN(\subset C)$	Commodities not in *CE*	$i \in INSDNG(\subset INSD)$	Domestic non-government institutions
$c \in CM(\subset C)$	Aggregate imported commodities	$h \in H(\subset INSDNG)$	Households
Parameters			
$cwts_c$	Weight of commodity c in the CPI	$qdst_c$	Quantity of stock change
$dwts_c$	Weight of commodity c in the producer price index	$\overline{qg}_c$	Base-year quantity of government demand
ica_{ca}	Quantity of c as intermediate input per unit of activity a	$\overline{qinv}_c$	Base-year quantity of private investment demand
$icd_{cc'}$	Quantity of commodity c as trade input per unit of c' produced and sold domestically	$shif_{if}$	Share for domestic institution i in income of factor f
$ice_{cc'}$	Quantity of commodity c as trade input per exported unit of c'	$shii_{ii'}$	Share of net income of i' to i (i' ∈ INSDNG'; i ∈ INSDNG)
$icm_{cc'}$	Quantity of commodity c as trade input per imported unit of c'	ta_a	Tax rate for activity a
$inta_a$	Quantity of aggregate	$\overline{tins}_i$	Exogenous direct

	intermediate input per activity unit		tax rate for domestic institution i
iva_a	Quantity of aggregate intermediate input per activity unit	$tins01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates
$\overline{mps}_i$	Base savings rate for domestic institution i	tm_c	Import tariff rate
$mps01_i$	0-1 parameter with 1 for institutions with potentially flexed direct tax rates	tq_c	Rate of sales tax
pwe_c	Export price (foreign currency)	$trnsfr_{i\,f}$	Transfer from factor f to institution i
pwm_c	Import price (foreign currency)		

Table A1 continued. CGE model sets, parameters, and variables

Symbol	Explanation	Symbol	Explanation
Greek Symbols			
α_a^a	Efficiency parameter in the CES activity function	δ_{cr}^t	CET function share parameter
α_a^{va}	Efficiency parameter in the CES value-added function	δ_{fa}^{va}	CES value-added function share parameter for factor *f* in activity *a*
α_c^{ac}	Shift parameter for domestic commodity aggregation function	γ_{ch}^m	Subsistence consumption of marketed commodity c for household h
α_c^q	Armington function shift parameter	θ_{ac}	Yield of output c per unit of activity a
α_c^t	CET function shift parameter	ρ_a^a	CES production function exponent
β^a	Capital sectoral mobility factor	ρ_a^{va}	CES value-added function exponent
β_{ch}^m	Marginal share of consumption spending on marketed commodity c for household h	ρ_c^{ac}	Domestic commodity aggregation function exponent
δ_a^a	CES activity function share parameter	ρ_c^q	Armington function exponent
δ_{ac}^{ac}	Share parameter for domestic commodity aggregation function	ρ_c^t	CET function exponent
δ_{cr}^q	Armington function share parameter	η_{fat}^a	Sector share of new capital
υ_f	Capital depreciation rate		
Exogenous Variables			
$\overline{CPI}$	Consumer price index	$\overline{MPSADJ}$	Savings rate scaling factor (= 0 for base)
$\overline{DTINS}$	Change in domestic institution tax share (= 0 for base; exogenous variable)	$\overline{QFS}_f$	Quantity supplied of factor
$\overline{FSAV}$	Foreign savings (FCU)	$\overline{TINSADJ}$	Direct tax scaling factor (= 0 for base; exogenous variable)
$\overline{GADJ}$	Government consumption adjustment factor	$\overline{WFDIST}_{fa}$	Wage distortion factor for factor f in activity a
$\overline{IADJ}$	Investment adjustment factor		
Endogenous Variables			
AWF_{ft}^a	Average capital rental rate in time period t	QG_c	Government consumption demand for commodity
$DMPS$	Change in domestic	QH_{ch}	Quantity consumed of

	institution savings rates (= 0 for base; exogenous variable)		commodity c by household h
DPI	Producer price index for domestically marketed output	QHA_{ach}	Quantity of household home consumption of commodity c from activity a for household h
EG	Government expenditures	$QINTA_a$	Quantity of aggregate intermediate input
EH_h	Consumption spending for household	$QINT_{ca}$	Quantity of commodity c as intermediate input to activity a
EXR	Exchange rate (LCU per unit of FCU)	$QINV_c$	Quantity of investment demand for commodity
$GSAV$	Government savings	QM_{cr}	Quantity of imports of commodity c
QF_{fa}	Quantity demanded of factor f from activity a		

Table A1 continued. CGE model sets, parameters, and variables

Symbol	Explanation	Symbol	Explanation
Endogenous Variables Continued			
MPS_i	Marginal propensity to save for domestic non-government institution (exogenous variable)	QQ_c	Quantity of goods supplied to domestic market (composite supply)
PA_a	Activity price (unit gross revenue)	QT_c	Quantity of commodity demanded as trade input
PDD_c	Demand price for commodity produced and sold domestically	QVA_a	Quantity of (aggregate) value-added
PDS_c	Supply price for commodity produced and sold domestically	QX_c	Aggregated quantity of domestic output of commodity
PE_{cr}	Export price (domestic currency)	$QXAC_{ac}$	Quantity of output of commodity c from activity a
$PINTA_a$	Aggregate intermediate input price for activity a	RWF_f	Real average factor price
PK_{ft}	Unit price of capital in time period t	$TABS$	Total nominal absorption
PM_{cr}	Import price (domestic currency)	$TINS_i$	Direct tax rate for institution i (i $\in$ INSDNG)

PQ_c	Composite commodity price	$TRII_{ii'}$	Transfers from institution i' to i (both in the set INSDNG)
PVA_a	Value-added price (factor income per unit of activity)	WF_f	Average price of factor
PX_c	Aggregate producer price for commodity	YF_f	Income of factor f
$PXAC_{ac}$	Producer price of commodity c for activity a	YG	Government revenue
QA_a	Quantity (level) of activity	YI_i	Income of domestic non-government institution
QD_c	Quantity sold domestically of domestic output	YIF_{if}	Income to domestic institution i from factor f
QE_{cr}	Quantity of exports	ΔK^a_{fat}	Quantity of new capital by activity a for time period t

Table A2. CGE model equations

Production and Price Equations	
$QINT_{c\,a} = ica_{c\,a} \cdot QINTA_a$	(1)
$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca}$	(2)
$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{f\,a}^{va} \cdot \left(\alpha_{f\,a}^{vaf} \cdot QF_{f\,a} \right)^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}}$	(3)
$W_f \cdot \overline{WFDIST}_{fa} = PVA_a \cdot QVA_a \cdot \left(\sum_{f \in F'} \delta_{f\,a}^{va} \cdot \left(\alpha_{f\,a}^{vaf} \cdot QF_{f\,a} \right)^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{f\,a}^{va} \cdot \left(\alpha_{f\,a}^{vaf} \cdot QF_{f\,a} \right)^{-\rho_a^{va}-1}$	(4)
$QF_{f\,a} = \alpha_{f\,a}^{van} \cdot \left(\sum_{f' \in F} \delta_{f\,f'a}^{van} \cdot QF_{f'a}{}^{-\rho_{f\,a}^{van}} \right)^{-\frac{1}{\rho_{f\,a}^{van}}}$	(5)
$W_{f'} \cdot WFDIST_{f'a} = W_f \cdot WFDIST_{f\,a} \cdot QF_{f\,a} \cdot \left(\sum_{f'' \in F} \delta_{f\,f''a}^{van} \cdot QF_{f''a}{}^{-\rho_{f\,a}^{van}} \right)^{-1} \cdot \delta_{f\,f'a}^{van} \cdot QF_{f'a}{}^{-\rho_{f\,a}^{van}-1}$	(6)
$QVA_a = iva_a \cdot QA_a$	(7)
$QINTA_a = inta_a \cdot QA_a$	(8)
$PA_a \cdot (1 - ta_a) \cdot QA_a = PVA_a \cdot QVA_a + PINTA_a \cdot QINTA_a$	(9)
$QXAC_{a\,c} = \theta_{a\,c} \cdot QA_a$	(10)
$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac}$	(11)
$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A} \delta_{a\,c}^{ac} \cdot QXAC_{a\,c}{}^{-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}-1}}$	(12)
$PXAC_{a\,c} = PX_c \cdot QX_c \left(\sum_{a \in A'} \delta_{a\,c}^{ac} \cdot QXAC_{a\,c}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{a\,c}^{ac} \cdot QXAC_{a\,c}^{-\rho_c^{ac}-1}$	(13)
$PE_{cr} = pwe_{cr} \cdot EXR - \sum_{c' \in CT} PQ_c \cdot ice_{c'c}$	(14)
$QX_c = \alpha_c^t \cdot \left(\sum_r \delta_{cr}^t \cdot QE_{cr}^{\rho_c^t} + (1 - \sum_r \delta_{cr}^t) \cdot QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}}$	(15)
$\frac{QE_{cr}}{QD_c} = \left(\frac{PE_{cr}}{PDS_c} \cdot \frac{1 - \sum_r \delta_{cr}^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t - 1}}$	(16)

Table A3. CGE model equations (continued)

$QX_c = QD_c + \sum_r QE_{cr}$	(17)
$PX_c \cdot QX_c = PDS_c \cdot QD_c + \sum_r PE_{cr} \cdot QE_{cr}$	(18)
$PDD_c = PDS_c + \sum_{c' \in CT} PQ_{c'} \cdot icd_{c'c}$	(19)
$PM_{cr} = pwm_{cr} \cdot (1 + tm_{cr}) \cdot EXR + \sum_{c' \in CT} PQ_{c'} \cdot icm_{c'c}$	(20)
$QQ_c = \alpha_c^q \cdot \left(\sum_r \delta_{cr}^q \cdot QM_{cr}^{-\rho_c^q} + (1 - \sum_r \delta_{cr}^q) \cdot QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}}$	(21)
$\frac{QM_{cr}}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1 - \sum_r \delta_{cr}^q} \right)^{\frac{1}{1+\rho_c^q}}$	(22)
$QQ_c = QD_c + \sum_r QM_{cr}$	(23)
$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + \sum_r PM_{cr} \cdot QM_{cr}$	(24)
$QT_c = \sum_{c' \in C'} \left(icm_{cc'} \cdot QM_{c'} + ice_{cc'} \cdot QE_{c'} + icd_{cc'} \cdot QD_{c'} \right)$	(25)
$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c$	(26)
$DPI = \sum_{c \in C} PDS_c \cdot dwts_c$	(27)
Institutional Incomes and Domestic Demand Equations	
$YF_f = \sum_{a \in A} WF_f \cdot \overline{WFDIST}_{fa} \cdot QF_{fa}$	(28)
$YIF_{if} = shif_{if} \cdot \left[YF_f - trnsfr_{row\,f} \cdot EXR \right]$	(29)
$YI_i = \sum_{f \in F} YIF_{if} + \sum_{i' \in INSDNG'} TRII_{ii'} + trnsfr_{i\,gov} \cdot \overline{CPI} + trnsfr_{i\,row} \cdot EXR$	(30)
$TRII_{ii'} = shii_{ii'} \cdot (1 - MPS_{i'}) \cdot (1 - \overline{tins}_{i'}) \cdot YI_{i'}$	(31)
$EH_h = \left(1 - \sum_{i \in INSDNG} shii_{ih} \right) \cdot (1 - MPS_h) \cdot (1 - \overline{tins}_h) \cdot YI_h$	(32)
$PQ_c \cdot QH_{ch} = PQ_c \cdot \gamma_{ch}^m + \beta_{ch}^m \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma_{c'h}^m \right)$	(33)
$QINV_c = IADJ \cdot \overline{qinv}_c$	(34)
$QG_c = \overline{GADJ} \cdot \overline{qg}_c$	(35)

Table A3. CGE Model Equations (continued)

$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{i\,gov} \cdot \overline{CPI}$	(36)
System Constraints and Macroeconomic Closures	
$YG = \sum_{i \in INSDNG} \overline{tins}_i \cdot YI_i + \sum_{c \in CMNR} tm_c \cdot pwm_c \cdot QM_c \cdot EXR + \sum_{c \in C} tq_c \cdot PQ_c \cdot QQ_c + \sum_{f \in F} YF_{gov\,f} + trnsfr_{gov\,row} \cdot EXR$	(37)
$QQ_c = \sum_{a \in A} QINT_{c\,a} + \sum_{h \in H} QH_{c\,h} + QG_c + QINV_c + qdst_c + QT_c$	(38)
$\sum_{a \in A} QF_{f\,a} = QFS_f$	(39)
$YG = EG + GSAV$	(40)
$\sum_{r\,c \in CMNR} pwm_{cr} \cdot QM_{cr} + \sum_{f \in F} trnsfr_{row\,f} = \sum_{r\,c \in CENR} pwe_{cr} \cdot QE_{cr} + \sum_{i \in INSD} trnsfr_{i\,row} + FSAV$	(41)
$\sum_{i \in INSDNG} MPS_i \cdot \left(1 - \overline{tins}_i\right) \cdot YI_i + GSAV + EXR \cdot FSAV = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c$	(42)
$MPS_i = \overline{mps}_i \cdot \left(1 + MPSADJ\right)$	(43)
Capital Accumulation and Allocation Equations	
$AWF^a_{f\,t} = \sum_a \left[\left(\frac{QF_{f\,a\,t}}{\sum_{a'} QF_{f\,a'\,t}} \right) \cdot WF_{f\,t} \cdot WFDIST_{f\,a\,t} \right]$	(44)
$\eta^a_{f\,a\,t} = \left(\frac{QF_{f\,a\,t}}{\sum_{a'} QF_{f\,a'\,t}} \right) \cdot \left(\beta^a \cdot \left(\frac{WF_{f,t} \cdot WFDIST_{f\,a\,t}}{AWF^a_{f\,t}} - 1 \right) + 1 \right)$	(45)
$\Delta K^a_{f\,a\,t} = \eta^a_{f\,a\,t} \cdot \left(\frac{\sum_c PQ_{c\,t} \cdot QINV_{c\,t}}{PK_{f\,t}} \right)$	(46)
$PK_{f\,t} = \sum_c PQ_{c\,t} \cdot \frac{QINV_{c\,t}}{\sum_{c'} QINV_{c'\,t}}$	(47)
$QF_{f\,a\,t+1} = QF_{f\,a\,t} \cdot \left(1 + \frac{\Delta K^a_{f\,a\,t}}{QF_{f\,a\,t}} - \upsilon_f \right)$	(48)
$QFS_{f\,t+1} = QFS_{f\,t} \cdot \left(1 + \frac{\sum_a \Delta K_{f\,a\,t}}{QFS_{f\,t}} - \upsilon_f \right)$	(4

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