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Welfare Impact of Value-Added Tax Reform

The Case of the Democratic Republic of Congo

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Abstract

The adoption of the value-added tax the Democratic Republic of Congo in 2012 led to price increases that are thought to adversely affect the welfare of most Congolese households. To date, research has not yet examined the poverty and distributional impacts of this tax reform. Using data from the 2012 Living Standards Measurement Survey, this paper investigates whether the current value-added tax regime, with its exemptions, is progressive. Relying on the Quadratic Almost Ideal Demand System and several welfare measures, the analysis finds that the adoption of the value-added tax erodes the purchasing power of all Congolese households by a factor of 10 to 12 percent. Yet, the value-added tax appears to be highly progressive. Households in the top food expenditure quintile bears approximately 40 percent of the welfare loss compared with less than 10 percent among households in the bottom food expenditure quintile. Other inequality measures, such as the Gini coefficient, further support this finding that the value-added tax is progressive. Finally, the study finds that the adoption of the value-added tax leads to a worsening of the food poverty headcount by approximately 1.2 percentage points.

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1 Introduction

On January 1, 2012, the Democratic Republic of Congo (DRC) enacted the value-added tax (VAT) to reduce the budget deficit. Consistent with the IMF guidelines, the VAT rate is uniformly fixed at 16 percent with zero-rating basic commodities, including milk, bread, rice, and meat. The new policy pertains to a tax reform that seeks to replace the turnover tax (Impôt sur le chiffre d'affaires (ICA)). A strong body of evidence has shown that the VAT can help to reach revenue targets with both administrative and economic efficiencies. This stems from the fact that the VAT requires few administrative constraints, while it generates a minimal dead weight loss. Within a year of implementation, the shift from ICA to VAT has increased tax revenue by 29 percent representing 1.1 percent of the GDP (A. Ramarozatovo, 2013). Revenue projections to the following years suggest a sustained reduction in the budget deficit.

However, as attractive as it may appear, the VAT raises many questions with respect to its distributional impacts. Whether the adoption of a given VAT hits harder the poor than the non-poor is an open question. To be sure, the VAT will unequivocally lead to price increases, which may disproportionately affect the poor when taxed commodities represent a large share of expenditures of low income households. Rate differentiation seems to be one way to mitigate the undesirable distributional impacts of the VAT. Yet rate differentiation comes with its own limits as it is subject to the political economy of government decision making. Not surprisingly, in some places, luxury goods may be zero-rated (N. Salti and J. Chabaan, 2008). The VAT can also induce a disproportionate welfare loss for the poor by shifting upward the demand for basic commodities through substitution between commodities across income categories (N. Gemmell and O. Morrissey, 2003). The Government of the Democratic Republic of Congo took a number of steps to grapple with distributional concerns associated with the adoption of the VAT.

A subsequent policy change, following the adoption of the VAT, led both to broaden the tax base so as to include milk and cement, and to exonerate oil companies. This change makes inference about the distributional impact of the entire VAT reform more complex. On the one hand, milk is likely to be a basic commodity for poor households; therefore, its inclusion in the VAT base seems regressive. On the other hand, exonerating oil companies may be a pro-poor policy, as it reduces the price of kerosene, which is an important consumer good for the poor. Furthermore, this exoneration of oil companies is likely to have positive spillovers by reducing the price of most consumption goods through the reduction of transportation costs. Thus, analysis concerned with the distributional impacts of the VAT adoption needs to account for behavioral responses to changes in relative prices.

This paper uses a conceptual framework, which is built on economic theory, to measure the welfare loss associated with the introduction of the VAT in the DRC among the poor and the non-poor in rural and urban areas. To do so, the paper relies on the compensating variation with data from a nationally representative household expenditure survey fielded in 2012. It examines how welfare loss is spread across expenditure categories in both rural and urban areas. Central to the analysis is the question whether the rate differentiation is well-targeted.

The paper is organized as follows; the second section presents the related literature; the third section presents the context and data; the fourth section describes the empirical model; while the fifth section shows estimation results; the sixth section takes on the task of welfare analysis; and the last section concludes.

2 Welfare and Equity Impacts of the VAT

The analysis of the VAT impacts has employed a variety of methodological approaches, whose choice is usually constrained by data availability. Most recent studies use partial equilibrium models relying on estimated demand systems. Such models embody some behavioral responses through possible substitution effects among commodities. New advance in consumer theory helps to disentangle the part of those responses that pertain to built-in assumptions (A. Deaton and J. Muellbauer, 1980, R. Pollak and T. Wales, 1995). The Stone-Geary's linear expenditure system (LES) and the Deaton-Meullbauer's almost ideal demand system (AIDS) are two popular demand systems used in empirical work. Because they rely on the assumption of linearity in Engel curves, the theoretical justification for their choice is increasingly challenged. However, they still provide researchers and practitioners with invaluable insights into welfare analysis when it comes to evaluating a VAT reform. A VAT reform is bound to have welfare, poverty, and distributional implications.

In terms of welfare impacts, studies have consistently shown that the introduction of the VAT results in welfare losses when direct impacts are accounted for (N. Gemmell and O. Morrissey, 2003, S. M. Hossain, 1994, S. Muñoz and S. Cho, 2003, D. Newhouse and D. Zakharova, 2007, N. Salti and J. Chabaan, 2008). For example, using Engel curves, quintile ratios and the AIDS demand system, Salti and Chaaban (2008) find consumption losses as large as 11 and 19 percent among the poorest and the richest respectively resulting from an increase of the VAT rate from 10 to 12 percent. Projected impacts are even higher for a rise in the VAT rate from 10 to 15 percent. These estimated welfare losses are large compared to results from other studies, including a study conducted in the Philippines by Newhouse and Zakharova (2007) that uses a partial equilibrium model to find welfare losses varying between 2.5 and 2.7 percent. It is worth mentioning that the estimates of welfare losses from the study by Newhouse and Zakharova are unusually low (S. M. Hossain, 1994, 1995, S. Muñoz and S. Cho, 2003, D. Newhouse and D. Zakharova, 2007, P. Roy et al., 2006).

With respect to poverty, the introduction of the VAT is shown to have mixed effects when direct effects are examined. In a study on the impact of tax reform on rural and urban households in India, Roy, Raychaudhur, and Sinha (2006) find that switching from sales and import taxes to the VAT is poverty improving, while in a study on VAT impact on welfare in Lebanon, Salti and Chabaan (2008) find two sets of results depending on the poverty measure under consideration. On the one hand, they show that an increase in the VAT would have a modest impact on extreme poverty. On the other hand, the same increase would cause the poverty headcount to dramatically increase (N. Salti and J. Chabaan, 2008).

As far as equity is concerned, empirical evidence shows that the VAT is more or less progressive. Although the effect size is context sensitive, progressivity of the VAT is a quite robust finding across a variety of low and middle income countries (N. Gemmell and O. Morrissey, 2003). In a study on the distributional impact of the VAT in Lebanon, Salti and Chabaan (2008) find a modest increase in the VAT rate to be mildly progressive. At the same time, they show that a change by 5 percentage points would be less so. Similarly, Newhouse and Zakharova (2007) find that the tax reform in the Philippines is progressive (D. Newhouse and D. Zakharova, 2007, N. Salti and J. Chabaan, 2008). But the VAT is not unequivocally progressive.

There are both theoretical and empirical results showing that the VAT can be regressive when effective taxation of commodities mostly consumed by the poor increases. Roy, Raychaudhur, and Sinha (2006) document such results in their analysis of a tax reform in India (P. Roy, A. Raychaudhur and S. K. Sinha, 2006).

Exemption and public transfer programs can help to improve VAT equity. A well-targeted exemption reduces the income loss for the poor. It also alters relative prices, by inducing substitution among consumption goods of the poor in a way that increases their real income. Many studies have shown that the equity impact of the VAT depends largely on the bundle of exempted goods. Newhouse and Zakharova (2007) find that exemption of commodities largely consumed by the poor is key to the progressivity of the VAT in the Philippines. They also show that a transfer program better geared toward the poor would further improve progressivity. The question then becomes how to choose those goods to be exempted. A popular and simple approach consists of computing social weights based on some social welfare function, whose choice can become problematic because it embeds some value judgment. Alternatively, one can analyze consumption patterns among the poor and single out those items they mostly consume (E. Ahmad and N. Stern, 1984, J. Gibson, 1998).

A puzzling finding from impact analysis of tax reform is the fact that a single tax rate affects subpopulations (defined by geography, gender, or educational attainment) differently. By design, the VAT reduces the income available to individuals. In a context where welfare transfers are uncommon, a uniform VAT rate is likely to have undesirable distributional characteristics because subpopulations consume different bundles of both exempted and taxed goods. A possible solution to achieve optimal taxation is the introduction of differential tax rates across regions. Yet this solution comes at the potential cost of reducing administrative efficiency (S. M. Hossain, 1994).

Overall, VAT equity impacts are often progressive up to the choice of exempted goods. A partial equilibrium and short-term impact analysis of a VAT reform is highly unlikely to find any poverty improvement. Effect sizes of a welfare analysis depend on both methods used and transfer programs in place. Mitigating interventions such as transfer programs usually have net positive aggregate impacts on the poor, while in most countries, improvement is still possible through a careful selection of policy packages along with close attention to end beneficiaries, who ought to massively be the poor.

3 Context and Data

3.1 Fiscal Revenue and Public Expenditure in the DRC

Between 2006 and 2013, the DRC mostly experienced low fiscal deficits with some signs of improvement starting from 2012, especially in terms of domestic fiscal balance. Over this time period, the relative share of government expenditure in GDP increased from 13.9 to 19.1 percent (Table 1). Public expenditures rose more slowly than public revenues, shrinking the fiscal deficit, which varied between 1.4 and 2.5 percent, with a record budget surplus occurring in 2010. Similarly, in 2012, there was a budget surplus taking place in the year of the VAT adoption.

The Government of the Democratic Republic of Congo has relied on a variety of instruments to raise fiscal revenues. Such instruments include customs duties, excise taxes, direct and indirect taxes, taxes on oil. Customs and excise taxes and direct and indirect taxes are major sources of fiscal revenues. While the contribution of direct and indirect taxes to public revenues increased modestly between 2009 and 2011, it experienced a sharp increase in 2012, which was sustained in 2013. The relative contribution of these taxes rose from 4.4 to 4.9 percent of the gross domestic product from 2011 to 2012. At the same time the DRC experienced a net budget surplus. However, this was short-lived as there was a sharp fiscal deficit in 2013 associated with a drop in customs and excise taxes and administrative revenues. Changes in fiscal revenues in 2012 and 2013 were likely to be related to the adoption in 2012 of the VAT, which was a new tax instrument introduced to improve fiscal efficiency. Although the VAT was instituted with the objective of revenue neutrality, its adoption was associated with increase in fiscal revenues.

There is tentative evidence that the adoption of the VAT crowded out revenues from customs and excise taxes as the relative share of these items decreased in the year after the VAT adoption.[1] From 2006 to 2012, customs duties and excise taxes are the single most important tax revenue; but in 2013, the year following the VAT adoption, direct and other indirect taxes became the most significant contributor to tax revenue. This is consistent with results from other developing countries. Empirical evidence indicates that these taxes are often substitutes. The adoption of the VAT has often been a package policy embedded in efforts to reform trade, leading to the suppression of other taxes such as tariffs, customs duties, and excise taxes, to improve productive efficiencies.

The Congolese VAT is set at 16 percent in a context where prices are tax inclusive. This VAT is characterized by a rate differentiation, with a few basic consumption goods benefiting from low rates. This would be seen as a pro-poor measure to relieve the tax burden of the poor. But this VAT also provided exemptions to companies in the oil sector. The efficiency and distributional rationale of these latter exemptions are not yet clearly understood.

[1] Recent works have revised this performance. It provided an overestimation of revenues related to the VAT as the adoption of the VAT is associated with tax debits collected from firms, which must be paid back at the closure of the fiscal year (Etude sur les Ecarts Fiscaux and Republique Democratique du Congo).

Table 1: Central Government Financial Operations, 2006—13 (In percent of Gross Domestic Product; unless otherwise indicated)

	2006	2007	2008	2009	2010	2011	2012	2013
Total revenue and grants	**12.0**	**10.4**	**13.1**	**14.9**	**21.1**	**18.0**	**20.1**	**17.4**
Total revenue	7.9	9.0	11.5	10.3	12.1	12.4	14.9	13.0
Customs and excise	2.9	3.3	4.0	3.8	4.1	4.6	5.2	4.8
Direct and indirect taxes	2.4	3.1	4.0	3.8	4.2	4.4	4.9	5.1
Petroleum (royalties and taxes)	2.0	1.9	2.3	0.9	1.4	1.7	1.3	1.2
Administrative revenues	0.6	0.8	1.1	1.8	2.3	1.7	3.5	1.6
Total grants	4.1	1.4	1.6	4.6	9.0	5.6	5.2	4.4
Total expenditure	**13.9**	**12.5**	**14.3**	**16.0**	**16.9**	**19.1**	**19.5**	**19.1**
Current expenditure	9.4	10.5	11.6	11.2	9.3	10.9	10.4	10.5
Capital expenditure	2.0	1.4	2.1	3.2	6.8	5.7	7.0	7.7
Exceptional expenditure[1]	2.6	0.5	0.6	1.6	0.8	2.6	2.1	1.0
Change in arrears (increase = +)	-0.1	-0.1	-0.2	-0.1	-0.2	-0.3	-0.2	-0.3
Float (increase = +)	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Central bank operational result	-0.3	-0.2	-0.3	-0.5	-0.6	0.0	-0.1	0.0
Overall fiscal balance (cash basis, before interest rescheduling)	**-2.0**	**-2.5**	**-1.7**	**-1.7**	**3.4**	**-1.4**	**0.3**	**-2.0**
Domestic fiscal balance	-0.7	-0.1	0.4	-1.5	1.1	-1.1	1.2	0.2

Sources: Congolese authorities and IMF staff estimates

[1]Exceptional expenditure includes spending for the Demobilization, Disarmament, and Reintegration (DDR) program,
cost of the elections, payments for retirement allowances, repayments of domestic arrears, and payments for bank restructuring.

3.2 Data

Data come from the 2012 wave of the 1-2-3 survey, representative of the DRC civilian non-institutionalized population. The data, containing anonymous information on household expenditure and composition, are obtained from the DRC National Institute of Statistics. They are organized to reflect annual expenditures. The 1-2-3 survey provides rich socioeconomic data along with large sample size, which allows detailed analysis by area of residence, poverty status, and quintile. The 1-2-3 survey further provides data on quantities and prices of food commodities; but there is some concern about pricing the food commodities, as some households engage in self-consumption. Good practice in the analysis of welfare data recommends the use of farm-gate prices among households that consume their own production (A. Deaton and S. Zaidi, 2002). Unfortunately, our data do not include enough information to compute reliably such prices. Thus, we rely on median cluster prices for the prices of the aggregate commodities. We believe that this would not distort our results. To the extent that markets exist and that substitution effects are accounted for in the demand systems we use in this paper, households would consume their own production provided they gain from so doing at the prevailing prices that include taxes. Furthermore, it is not clear whether households do not incur any tax burden through the taxes they pay for agricultural inputs to their outputs. The farm-gate prices of such outputs are then likely to reflect these increased input prices.

Figures 3.1a and 3.2b present nonparametric Engel curves for two aggregate commodities, namely food and non-food items, defined from the 1-2-3 survey by poverty status and area of residence. Nonparametric techniques are particularly suitable for Engel curve analysis because they allow for arbitrary relationship between budget share and expenditure (Deaton, 1989). The graphs indicate that households devote a relatively large budget share to foodstuffs. Food represents up to 90 percent of household expenditure. The mean budget share devoted to food is lower among non-poor (67.5 percent), than poor (71.2 percent). The budget share devoted to food is on average lower in urban areas compared to rural areas, despite the fact that its levels remain relatively high. Among the poor, the budget share devoted to food experiences high variability at lower levels of expenditures before leveling off at medium and large values of total expenditure. Budget share devoted to food remains high at high expenditure levels. Because food represents a relatively large share of total expenditures and because price and quantity data are well detailed for food items, in the rest of this analysis, we focus on food commodities.

Figure 3.1a: Engel Curve for Food (Poor)

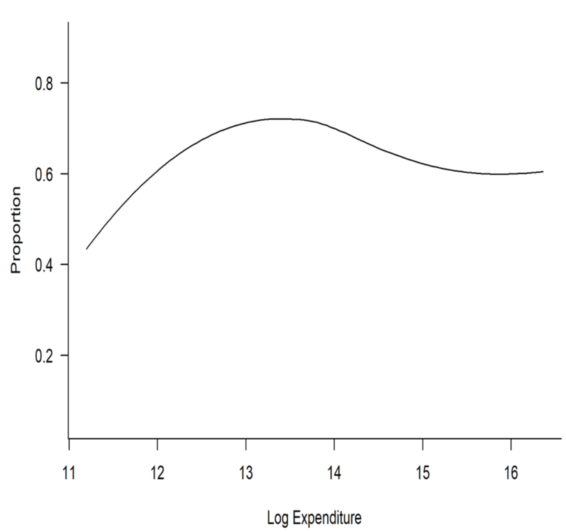
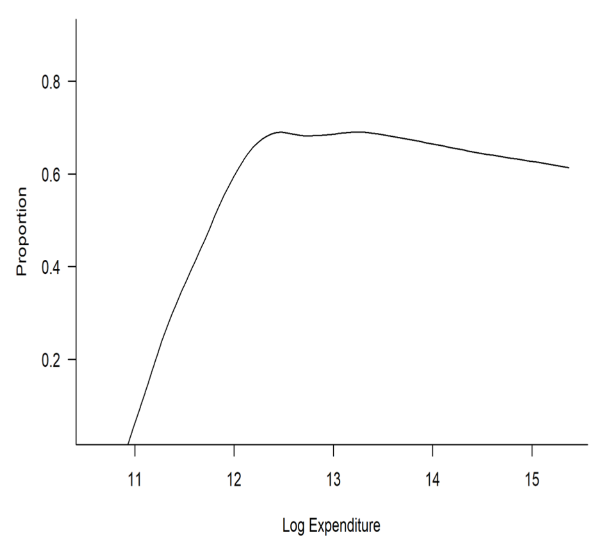


Figure 3.1b: Engel Curve for Food (Non-Poor)



Five categories are generated from about 200 individual food items, consumed by sample households, for which harmonized price and quantity data are provided. Specifically, the analysis categories consist of cereal (grains), meat, oil, tubers, and the rest of food items. There is no natural choice for generating such food categories. Here, they are defined by accounting for patterns in the data, their intuitive grouping based on local diets, and the requirement that demand for aggregate commodities be positive for all households. We then proceed to calculate aggregate "unit prices" by category. To compute this aggregate unit price, for each category, we divide the total expenditure on all items in a given category by the total quantity of the items in the said category (C. Nelson, B. Wood and L. Nogueiraz, 2011). While unit prices have some intuitive meaning for most categories, their interpretation is not quite clear for the residual category labeled "other food items". But our approach is fairly consistent with most works in the literature (C. Nelson, B. Wood and L. Nogueiraz, 2011, N. Salti and J. Chabaan, 2008). The analysis relies on prices (expressed in Congo francs) indexed to year 2012 prices.

Figure 3.2a: Engel Curve for Cereal

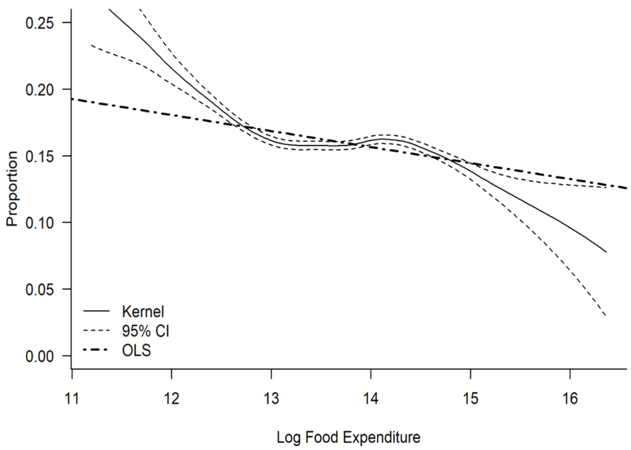


Figure 3.2b: Engel Curve for Meat

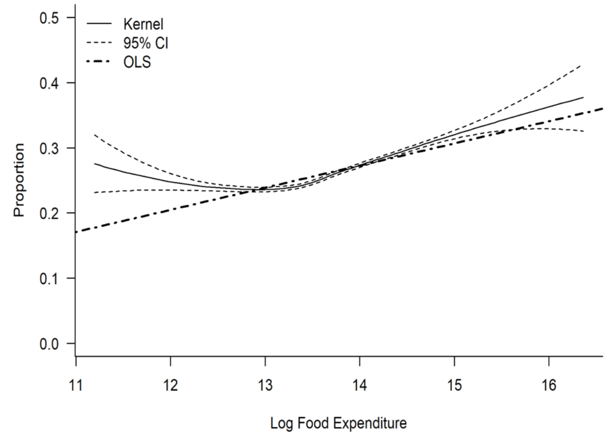


Figure 3.2c: Engel Curve for Oil

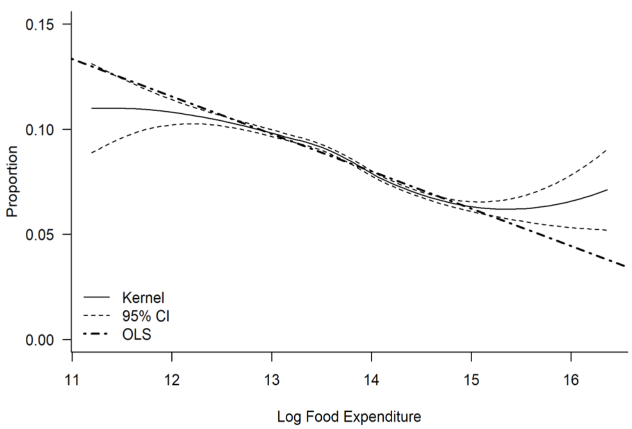


Figure 3.2d: Engel Curve for Tubers

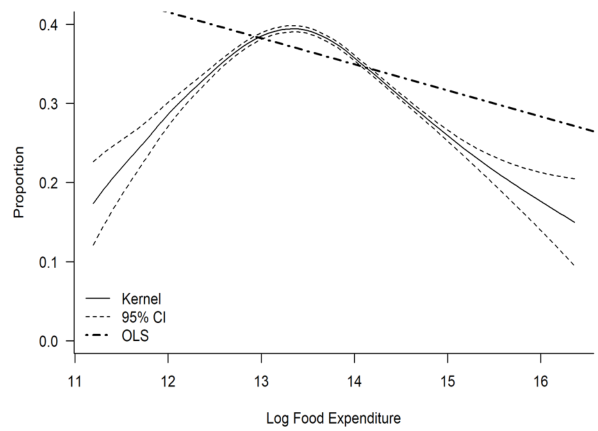
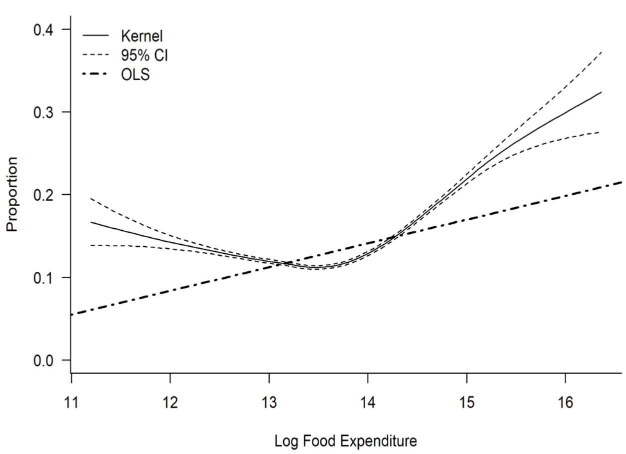


Figure 3.2e: Engel Curve for Other Foods



Figures 3.2a through 3.2e present nonparametric Engel curves of the five aggregate food commodities, a 95 percent nonparametric confidence interval, and an OLS regression line. Cereals turn out to be necessities. Main cereals consumed in the DRC are corn and rice. While corn production is mostly domestic, rice is mainly imported. Meat and fish are luxuries for most households. Oil is a necessity commodity at low and medium expenditure levels. The upturn of the oil Engel curve may reflect some change in product quality or the fact that high income households buy in different markets. The Engel curve for tubers and plantain shows that those goods are luxury goods at low income, while they are necessities for lower-middle and high income households.

The OLS regression lines help to check linearity in the Engel curves. The examination of these curves reveals that budget share in cereals, meat and fish, and oil are the closest to linearity. For all practical purposes, none of these Engel curves appears to be globally linear. In addition, the Engel curves are less precisely estimated at high levels of expenditure, reflecting the fact that there are few observations at those consumption levels. Such data points may be highly influential on regression lines.

Visual inspection of OLS regression lines combined with the nonparametric Engel curves also serves to identify influential observations. To avoid influence of outliers on regression coefficients, we identify high leverage observations by using unity as the upper bound of the dfbeta coefficients. The analytical sample is then restricted to observations whose budget shares lie within the range defined by values between negative one and unity.

Missing data received careful attention throughout the process of data analysis. When data are missing on price or quantity on any food category for a household, we use information from retrospective files to assign a value. The few cases of missing values for some items are resolved by assigning a median value of the cluster to these cases. This procedure for handling missing information combined with the fact that the food commodities are broad defined guarantees that expenditure shares are always positive. For other covariates, such household size, there is no missing value in the data set. The analytical sample consists of about 21,239 households.

Table 2: Summary Statistics – Entries are proportion or means unless otherwise noted

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
Food budget shares					
Cereal	0.160	0.159	0.143	0.184	0.150
	[0.001]	[0.002]	[0.002]	[0.002]	[0.002]
Meat/fish	0.262	0.242	0.257	0.261	0.303
	[0.001]	[0.002]	[0.002]	[0.002]	[0.002]
Oil	0.086	0.092	0.089	0.084	0.074
	[0.000]	[0.001]	[0.001]	[0.001]	[0.001]
Tubers/plantain	0.360	0.393	0.396	0.353	0.272
	[0.001]	[0.002]	[0.002]	[0.002]	[0.002]
Other	0.132	0.114	0.116	0.118	0.200
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]
Aggregate prices (/1000)					
Cereal	1.003	0.995	1.016	0.989	1.023
	[0.002]	[0.003]	[0.004]	[0.003]	[0.004]
Meat/fish	3.313	3.039	3.039	3.669	3.594
	[0.009]	[0.019]	[0.018]	[0.014]	[0.010]
Oil	1.470	1.393	1.351	1.500	1.700
	[0.006]	[0.009]	[0.009]	[0.012]	[0.014]
Tubers/plantain	0.667	0.548	0.563	0.717	0.923
	[0.002]	[0.002]	[0.002]	[0.003]	[0.004]
Other	1.785	1.580	1.628	1.941	2.099
	[0.005]	[0.008]	[0.013]	[0.011]	[0.010]
Annual per Cap. food expenditure (/1000)*	257.194	116.877	346.691	176.281	507.085
	[1.437]	[0.657]	[3.199]	[1.001]	[6.060]
Observations	21,239	6,766	4,785	5,743	3,945

*prices - Franc Congolais; food expenditure in 1000 FC per year
standard errors in brackets, 100 bootstrap replications
Source: 2012 1-2-3 Survey, DRC

Table 2 shows summary statistics of budget shares, aggregate prices for food commodities, and per capita food expenditure by area of residence and poverty status. Tubers and plantain are the main staple crop in the Congolese diet, representing the most important food commodities in terms of food budget. Households devote between 27.2 (urban non-poor) and 39.6 (rural non-poor) percent of their food budget to these food commodities. Meat and fish represent the second most important food commodities of both poor and non-poor households in urban as well as in rural areas. They account for relative budget share ranging from 24.2 (rural poor) to 30.3 (urban non-poor) percent. Cereals represent an important budget share of the household food budget. Together, cereals, tubers and plantain, and meat and fish represent 78.2 percent of food expenditure of the households in the sample. Among the poor, this share is even higher, representing 79. 4 and 79.8 percent of the budget share of the rural and urban poor, respectively. It is important to point out that these food commodities constitute the bulk of the exempted food products. Other exempted foodstuffs are grouped in the "other foods" category; but the structure of the data set does provide us a means to further investigate the relative share of such goods. Annual per capita food expenditure varies between 116,877 and 507,085 FC. Aggregate food prices varies by commodity, with animal proteins being the most expensive, while cereals are the cheapest.

There are variations in food shares, aggregate prices, and expenditure levels by area of residence and poverty status. Less expensive food commodities tend to represent a relatively large share of the food budget of the poor, while the converse is true for more expensive food commodities. Although the non-poor tend to face higher aggregate prices than the poor, differences in prices of commodities by poverty status are rather small. Not surprisingly, the level of the per capita food expenditure is the lowest among the poor compared to the non-poor. In urban areas, the per capita food expenditure is 176,281 and 507,085 FC [2] for the poor and non-poor respectively, while, in rural areas, this expenditure level is 116,877 and 346,691 FC for the poor and non-poor respectively. Comparison between rural and urban consumption levels shows that non-poor households in the cities spend on food as high as four times what the poor rural households spend on food. This spending difference is more related to income levels than to area of residence as the consumption ratio (to rural poor) of rural non-poor households is higher than that of urban poor households.

Aggregate prices are on average higher in urban areas than in rural areas, reflecting the difference in living standards between these two areas of residence. Ratios of cereal prices facing any group to cereal prices facing rural poor households vary from 0.99 to 1.02, where the lowest ratio is for poor in urban areas, while the largest is for non-poor in urban areas. Data on price ratios for the rest of aggregate commodities follow a similar gradient, whereby prices are lowest for rural poor households, and the largest for urban non-poor households. The range of variation in the price ratios is the widest for 'other foods'. These results illustrate the fact that living is relatively cheaper in rural areas compared to urban areas and, especially, that food costs are relatively lower for the poor than the non-poor. This finding hints at some possible quality difference in the baskets of goods purchased. The observed difference may also imply that the poor and non-poor purchase in different markets. This result further suggests that the food budget of urban non-poor households consists of high quality and rich nutrient commodities.

4 Empirical Model

The analysis of the Engel curves shows violation of the crucial assumption of linearity. To be consistent with the data, the demand system must be rank 3 consistent with the finding in consumer theory by Banks, Blundell, and Lewbel (1997). In actual fact, there is no lower rank demand system compatible with these data (J. Banks et al., 1997). Because Banks and colleagues show that any rank 3 demand system with an optimal number of parameters must be quadratic in logged income, we proceed with the quadratic almost ideal demand system. The QUAIDS retains the price flexibility of the AIDS, while allowing for nonlinear Engel curves. It derives from a 'theoretically plausible' utility function and allows for aggregation over both households and commodity categories (A. Deaton and J. Muellbauer, 1980, R. Pollak and T. Wales, 1995). This demand system shows good empirical properties, including parsimony in estimated parameters, as the QUAIDS nests the AIDS.[3]

A typical QUAIDS equation for budget share is as below:

[2] $\$US1 \approx 900FC$

[3] In the Appendices, we estimated both the linear expenditure demand system and the almost ideal demand system.

$$s_i(p,x) = \frac{\partial lna(p)}{\partial lnp_i} + \frac{b(p)}{\partial lnp_i} lnw + \frac{\partial \lambda(p)}{\partial lnp_i} \frac{(lnw)^2}{b(p)} \tag{1}$$

where $s_i(p,x)$ is the budget share for food commodity i; p is the aggregate price vector; $ln(w) = lnx - ln(a(p))$, with x being total food expenditure; $\lambda(.)$ is a homogeneous function of degree zero in price that is differentiable, and $a(.)$ and $b(.)$ are two differentiable functions specified as follows:

$$a(p)) = \alpha_0 + \sum_i \alpha_i lnp_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} lnp_i \times lnp_j \tag{2}$$

$$b(p) = \prod_i p_i^{\beta_i} \tag{3}$$

The expenditure function of the QUAIDS presented in equation (1) is as follows:

$$e(p,u) = lna(p) + \frac{ub(p)}{1-\lambda(p)} \tag{4}$$

The QUAIDS can be derived from an indirect utility function of the form:

$$V(p,x) = ((\frac{lnx - lna(p)}{b(p)})^{-1} + \lambda(p))^{-1} \tag{5}$$

The specification of budget share consistent with equations (1) and (5) then becomes:

$$s_i(p,x) = \alpha_i + \sum_j \gamma_{ij} lnp_j + \beta_i ln(\frac{x}{a(p)}) + \frac{\lambda_i}{b(p)} (ln(\frac{x}{a(p)}))^2 \tag{6}$$

A system of five equations, representing each of the the five commodities (cereals, meats/fish, oil, tubers/plantain, and other foods), is estimated. Each of these equations has the specification presented in equation (6). The demand system is estimated by a nonlinear seemingly unrelated regression, which allows for imposing cross-equation restrictions for homogeneity and symmetry and does not rule out correlation between residuals. To ensure that the disturbance covariance matrix is invertible, we estimate the system of equations dropping one aggregate commodity (Other Foods), whose parameters are recovered later. In addition, we impose the following restrictions to the equations system to guarantee a theoretically plausible demand system, satisfying adding-up, homogeneity, and symmetry:

$$\sum_i \alpha_i = 1; \quad \sum_j \gamma_{ij} = 0; \quad \sum_i \beta_i = 0 \quad \gamma_{ij} = \gamma_{ji} \quad and \quad \sum_i \lambda_i = 0$$

Because we are working with food commodities from a developing country, we do not specify a test of economies of scale. The literature on economies of scale shows that private goods are unlikely to yield economies of scale when the number of household members increases in these countries (A. Deaton, 1997, A. Deaton and C. Christina Paxson, 1998).

In Living Standards surveys, a cluster approach is often used to select households. We account for this cluster effect by using 'White' robust standard errors. Inference is based on both large sample approximation and bootstrapping. The estimated parameters of the demand system help to complete the welfare analysis by providing expenditure and price elasticities, which are calculated with the following equations.

Elasticities

Expenditure elasticity:

$\varepsilon_i = \frac{\partial s_i(p,x)}{\partial x}|_p$ after some algebraic transforms and after rearranging terms:

$$\varepsilon_i = \beta_i + \frac{2\lambda_i}{b(p)}(ln(\frac{x}{a(p)})) \tag{7}$$

The compensated elasticities are provided below:

$$\varepsilon_{ij} = \gamma_{ij} - \varepsilon_i(\alpha_j + \sum_k \gamma_{jk} lnp_k) - \frac{\lambda_i \beta_j}{b(p)}(ln(\frac{x}{a(p)}))^2 \tag{8}$$

5 Estimation Results

Table 3: QUAIDS Parameter Estimates (Part 1)

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
\alpha_{cereal}	-0.112***	0.118**	-0.008	0.146**	-0.095**
	[0.024]	[0.047]	[0.056]	[0.066]	[0.047]
\alpha_{meat}	0.483***	0.640***	0.482***	0.377***	0.407***
	[0.028]	[0.042]	[0.074]	[0.065]	[0.061]
\alpha_{oil}	0.005	0.026	-0.002	0.023	0.140***
	[0.016]	[0.029]	[0.029]	[0.032]	[0.053]
\alpha_{tuber}	-0.064***	0.109***	0.076	-0.191***	-0.289***
	[0.024]	[0.035]	[0.065]	[0.049]	[0.041]
\alpha_{oth.}	0.689***	0.107***	0.452***	0.645***	0.837***
	[0.020]	[0.037]	[0.062]	[0.038]	[0.055]
\beta_{cereal}	-0.088***	0.045*	-0.025	0.012	-0.073***
	[0.012]	[0.024]	[0.029]	[0.031]	[0.025]
\beta_{meat}	0.014	0.161***	0.031	-0.028	-0.03
	[0.014]	[0.027]	[0.039]	[0.028]	[0.029]
\beta_{oil}	-0.018**	-0.018	-0.018	0	0.063**
	[0.008]	[0.016]	[0.016]	[0.016]	[0.028]
\beta_{tuber}	-0.157***	-0.225***	-0.182***	-0.210***	-0.242***
	[0.013]	[0.021]	[0.042]	[0.025]	[0.024]
\beta_{oth.}	0.249***	0.038*	0.194***	0.226***	0.281***
	[0.008]	[0.020]	[0.029]	[0.016]	[0.028]
\lambda_{cereal}	-0.008***	0.009***	-0.003	0.002	-0.007**
	[0.001]	[0.003]	[0.004]	[0.003]	[0.003]
\lambda_{meat}	-0.002	0.020***	0.001	-0.006*	-0.007**
	[0.002]	[0.004]	[0.005]	[0.003]	[0.004]
\lambda_{oil}	0	0	0.001	0.002	0.010***
	[0.001]	[0.002]	[0.002]	[0.002]	[0.004]
\lambda_{tuber}	-0.018***	-0.037***	-0.024***	-0.022***	-0.028***
	[0.002]	[0.003]	[0.006]	[0.003]	[0.003]
\lambda_{oth.}	0.028***	0.008***	0.026***	0.024***	0.032***
	[0.001]	[0.003]	[0.004]	[0.002]	[0.004]
Observations	21,239	6,766	4,785	5,743	3,945

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Table 4: QUAIDS Parameter Estimates (Part 2)

	All	**Rural**		**Urban**	
		Poor	Non-Poor	Poor	Non-Poor
\gamma_{cereal_cereal}	-0.085***	-0.101***	- 0.170***	-0.112***	-0.067***
	[0.006]	[0.007]	[0.007]	[0.005]	[0.011]
\gamma_{meat_cereal}	0.059***	0.083***	0.117***	0.064***	0.056***
	[0.004]	[0.011]	[0.006]	[0.006]	[0.008]
\gamma_{oil_cereal}	0.005**	0.010***	0.002	-0.017***	-0.027***
	[0.002]	[0.003]	[0.003]	[0.002]	[0.007]
\gamma_{tuber_cereal}	0.097***	-0.002	0.054***	0.064***	0.083***
	[0.005]	[0.017]	[0.014]	[0.017]	[0.015]
\gamma_{oth._cereal}	-0.075***	0.010***	-0.004	0.001	-0.045**
	[0.008]	[0.004]	[0.015]	[0.018]	[0.020]
\gamma_{meat_meat}	-0.081***	-0.004	- 0.096***	-0.080***	-0.059***
	[0.003]	[0.027]	[0.009]	[0.008]	[0.011]
\gamma_{oil_meat}	-0.001	-0.008	-0.003	0.016***	0.002
	[0.002]	[0.008]	[0.004]	[0.003]	[0.006]
\gamma_{tuber_meat}	0.031***	-0.078***	-0.017	0.029*	0.049***
	[0.007]	[0.025]	[0.020]	[0.015]	[0.018]
\gamma_{oth._meat}	-0.007	0.006	-0.001	-0.028	-0.048**
	[0.009]	[0.009]	[0.019]	[0.017]	[0.022]
\gamma_{oil_oil}	-0.004***	-0.028***	-0.002	-0.008***	0.036***
	[0.001]	[0.003]	[0.003]	[0.002]	[0.010]
\gamma_{tuber_oil}	0.011***	0.023**	0.009	0.005	-0.052***
	[0.004]	[0.010]	[0.008]	[0.009]	[0.019]
\gamma_{oth._oil}	-0.010*	0.002	-0.006	0.004	0.041**
	[0.005]	[0.003]	[0.008]	[0.009]	[0.017]
\gamma_{tuber_tuber}	-0.049***	0.092***	0.064	0.021	0.078**
	[0.012]	[0.030]	[0.040]	[0.029]	[0.031]
\gamma_{oth._tuber}	-0.089***	-0.035***	- 0.110***	-0.119***	-0.158***
	[0.011]	[0.013]	[0.027]	[0.020]	[0.028]
\gamma_{oth._oth.}	0.181***	0.016***	0.122***	0.143***	0.210***
	[0.011]	[0.005]	[0.028]	[0.021]	[0.041]
Observations	21,239	6,766	4,785	5,743	3,945

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Tables 3 and 4 present estimates of the parameters of the QUAIDS for rural and urban households by poverty status. Most estimates are statistically different from zero, showing an overall good fit of the model. Estimated parameters differ in magnitude and sometimes in sign between rural and urban areas, highlighting the need to conduct a stratified analysis by area of residence and poverty status. These estimated parameters do not have a straightforward economic interpretation. The fact that most λ coefficients are statistically different from zero further supports the choice of the QUAIDS that captures well the nonlinear relationship between the budget share devoted to aggregate commodities and logged expenditure, which is noticed in figures 3.2a-3.2e.

Table 5: Expenditure Elasticities

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
Cereal	-1.563***	2.907***	-0.076**	1.405***	-0.928***
	[0.039]	[0.082]	[0.032]	[0.010]	[0.060]
meat/Fish	0.996***	3.292***	1.249***	0.466***	0.573***
	[0.000]	[0.070]	[0.005]	[0.016]	[0.008]
Oil	0.675***	0.636***	0.825***	1.327***	4.566***
	[0.003]	[0.007]	[0.003]	[0.005]	[0.066]
Tubers/Plantain	-0.269***	-1.103***	-0.398***	-0.462***	-1.386***
	[0.013]	[0.052]	[0.030]	[0.010]	[0.039]
Other Foods	9.753***	2.870***	8.923***	10.154***	7.429***
	[0.111]	[0.043]	[0.168]	[0.223]	[0.231]
Observations	21,239	6,766	4,785	5,743	3,945

Standard errors in brackets, 100 bootstrap replications

*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Table 5 shows expenditure elasticities for the aggregate commodities. Expenditure elasticities are computed in a two-step approach. First, they are computed for each household; then sample mean and standard error are calculated using bootstrap. Elasticities are statistically different from zero for all commodities in each area, showing that a linear demand system would provide inadequate estimates of welfare losses.

From these results, aggregate commodities display different expenditure elasticities depending on the analysis group. Among the non-poor (in rural and urban areas), cereals are inferior goods. Animal proteins (meats and fish) are normal goods. They are luxury goods in rural areas, whereas they are necessity goods in urban areas for both the poor and the non-poor. For all the analysis groups, tubers and plantains are inferior goods. An important fact from this table is that a price change is bound to have an income effect for most commodities; the size of the demand response to the price change will then depend on both income and substitution effects; the latter is captured by compensated elasticities.

Table 6: Hicksian Own Price Elasticities

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
Cereal	-2.968***	-3.221***	-4.113***	-2.518***	-2.293***
	[0.036]	[0.089]	[0.083]	[0.033]	[0.038]
Meat/Fish	-1.613***	-2.857***	-1.683***	-1.259***	-1.221***
	[0.011]	[0.059]	[0.015]	[0.011]	[0.007]
Oil	-0.844***	-1.056***	-0.768***	-0.856***	-0.568***
	[0.001]	[0.012]	[0.002]	[0.003]	[0.012]
Tubers/Plantain	[0.006]	[0.023]	[0.018]	[0.005]	[0.008]
	-1.596***	-1.563***	-1.314***	-1.779***	-2.593***
Other Foods	[0.008]	[0.018]	[0.008]	[0.008]	[0.023]
	-7.662***	-0.896***	-5.526***	-7.521***	-6.992***
	[0.084]	[0.003]	[0.117]	[0.193]	[0.253]
Observations	21,239	6,766	4,785	5,743	3,945

Standard errors in brackets, 100 bootstrap replications
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Table 6 shows compensated own price elasticities, which has been computed with the two-step approach presented above for expenditure elasticities. All the entries in the table are strictly negative, suggesting that the Slutsky matrix is likely to be negative definite. Own price elasticities vary by area of residence and poverty status. These compensated elasticities provide a means to assess the welfare implications of the change in relative prices induced by the VAT.

Price elasticity of Marshallian demand η_{ij} is related to the compensated elasticities ε_{ij} with the Slutsky equation:

$$\eta_{ij} = \varepsilon_{ij} - \eta_i \times s_i(p, x)$$

where η_i is the expenditure elasticity for commodity i, and s_i its budget share. Because income and substitution effects do not counteract, a first order or second order approximation of the welfare loss would respectively overestimate and underestimate the true change in welfare resulting from the introduction of VAT. We proceed to assess the welfare loss with alternative welfare measures.

6 Welfare Analysis

6.1 Welfare Loss: Measurement and Estimates

Equipped with the parameter estimates from the QUAIDS, we compute the compensating variation, by simulating the impact of price changes. The CV is a measure of welfare change, consistent with consumer theory. It is defined as the amount of income to be given to a household after a price change so that its members experience the utility level they had before the price change. Economic theory and recent econometric research suggest that the exact CV is a better metric for welfare analysis than its more popular competitors - the first and second order approximations (J. Banks et al., 1997, 1996, C. Nelson et al., 2011). The CV is computed with the following equation:

$$CV^h(p^0, p^1, x^h) = e(p^1, u^1) - e(p^1, u^0) \quad (9)$$

Where, p^0 and p^1 denote the price vectors before and after VAT, x^h expenditure of household h; u^0 is the pre-tax utility level; and $e(p,u)$ is the expenditure function represented in equation (4).

The CV has an intuitive meaning in the sense that whether a welfare change results in a loss can be inferred from the fact that the CV is negative. Furthermore, its size provides an assessment of the welfare change in money value.

To compute the aggregate CV, we generate a CV for each household with the estimated parameters; then, we calculate summary measures by area of residence and by poverty status. For the inference, we compute bootstrap standard errors with 100 replications. The principal ingredient in calculating the CV is the magnitude of price changes induced by the VAT, which are obtained from scenarios. Because the aggregate commodities cereal, meat and fish and other foods consist of a mix of exempted and taxed individual commodities, we envision two scenarios emerging from the introduction of the VAT. First, we make the assumption that the introduction of the VAT leads to a price increase that amounts to a half of the tax rate. This approach projects an 8 percent increase of aggregate prices. Second, we assume that aggregate prices raise by three-quarters the VAT rate. An increase of the aggregate prices in a range between 8 and 12 percent is below simulation values used in applied work on welfare assessment (J. Banks, R. Blundell and A. Lewbel, 1997, C. Nelson, B. Wood and L. Nogueiraz, 2011, D. Newhouse and D. Zakharova, 2007, N. Salti and J. Chabaan, 2008) and seems reasonable because aggregate commodities include many taxed commodities. For example, cereal consists of rice and corn, which are important staple foods. Notice that aggregate commodities tubers and plantain and oil are not exempted. It is also worth mentioning that the aggregate prices already incorporate the VAT. We proceed by deflating the aggregate prices in a way consistent with the steps outlined above.

The derivation of the magnitude of price changes rests of the assumption that the VAT is totally shifted onto consumers for taxed items with no extra disturbances. This assumption implies that there is no inflation generated by the VAT nor monopolist behaviors that lead to price increase greater than the tax rate. Empirical evidence shows that violation of this assumption does not alter significantly the results of a welfare analysis (E. Ahmad and N. Stern, 1984, N. Gemmell and O. Morrissey, 2003). There is an additional concern with the price change induced by the VAT in the Congolese context, which is related to the fact that the VAT was introduced to replace customs and some excise taxes. This should indeed reduce the magnitude of price change attributable to the adoption of the VAT. Modeling this has proven to be challenging. The price changes pojected in the remainder of this paper should be seen as upper bound estimates.

Table 7: Welfare Loss from the VAT by Area of Residence and Poverty Status

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
	8% Increase in cereal, meat, and other foods				
Compensating variation (x1000)	-106.979	-68.207	-116.034	-101.383	-170.638
	[0.479]	[0.414]	[0.977]	[0.560]	[1.507]
	12% Increase in cereal, meat, and other foods				
Compensating variation (x1000)	-126.648	-78.499	-134.753	-119.87	-209.263
	[0.586]	[0.474]	[1.159]	[0.678]	[1.899]
	Expenditure ratio to rural poor				
Mean food expenditure	1.647	1.000	1.728	1.558	2.786
Observations	21,239	6,766	4,785	5,743	3,945

Standard errors in brackets, 100 bootstrap replications

Note: Gini coefficient of welfare loss = 0.32 and 0.33

Source: 2012 1-2-3 Survey, DRC

Table 7 presents the welfare and equity impacts of price increases by poverty status and area of residence. The welfare impacts of the price changes are sizable for all analytical groups. Households in both rural and urban areas suffer aggregate welfare losses ranging from 68,207 to 170,638 FC in total household expenditure on food as a direct consequence of the introduction of the VAT in the case of an 8.0 percent price increase. They are even higher for a 12 percent price increase. These welfare losses are statistically different from zero and amount to 10 to 12 percent decrease in food expenditure. The ratio of welfare losses to total food expenditure varies across analytical groups but more so between urban and rural areas irrespective or poverty status.

In addition to the measure of the proportionate welfare loss, we compute the Gini coefficient for the welfare loss (actually the absolute value of the welfare loss). Notice that a strictly positive Gini coefficient shows progressivity in this setup because it implies that the welfare loss is concentrated at high levels of expenditure. We find a Gini coefficient of 0.32 and 0.33 for effective tax rates of 8.0 and 12.0 percent respectively. These results further support the idea that the VAT is progressive. They also highlight the increasingly progressive nature of the VAT as the statutory tax rate rises.

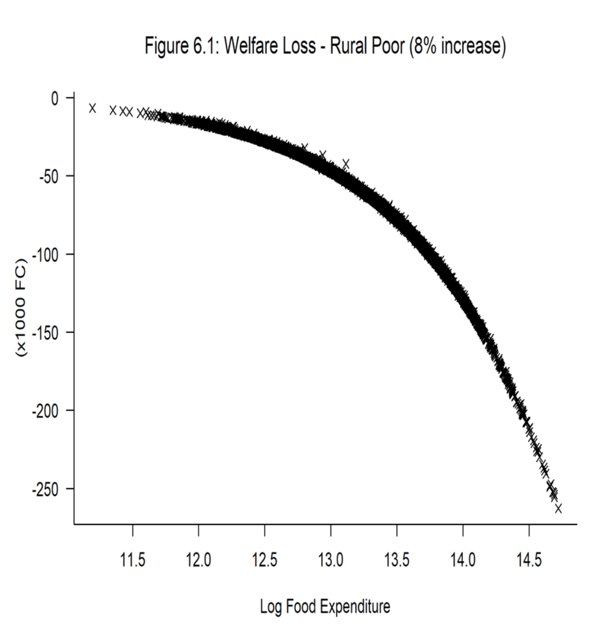


Figure 6.1: Welfare Loss - Rural Poor (8% increase)

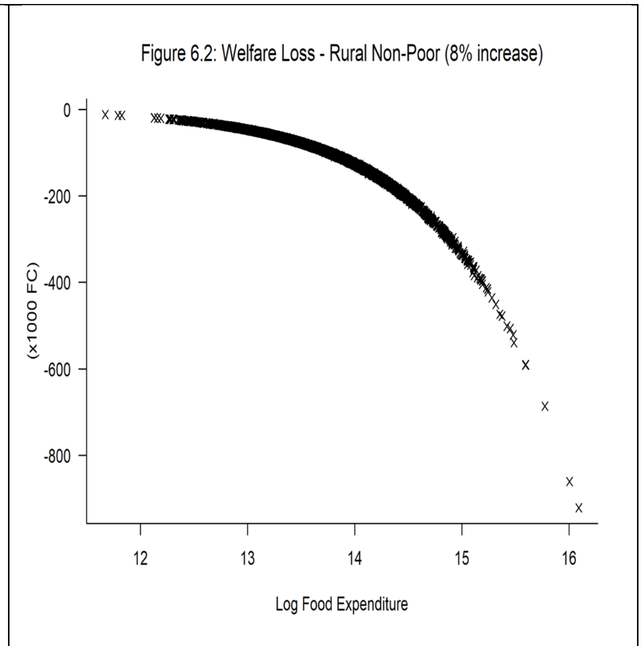


Figure 6.2: Welfare Loss - Rural Non-Poor (8% increase)

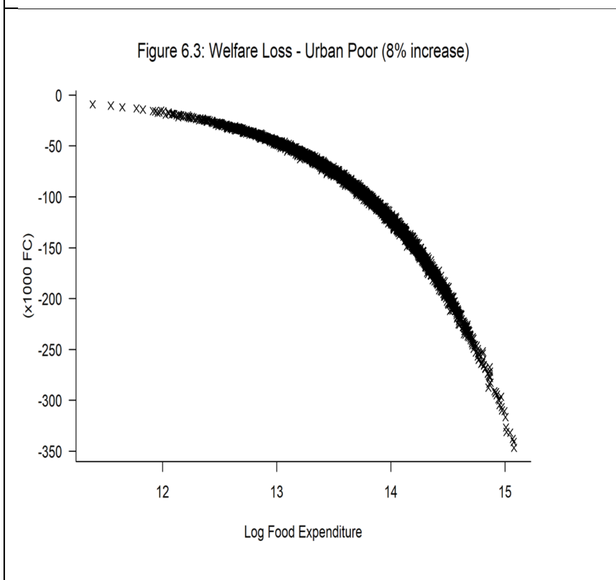


Figure 6.3: Welfare Loss - Urban Poor (8% increase)

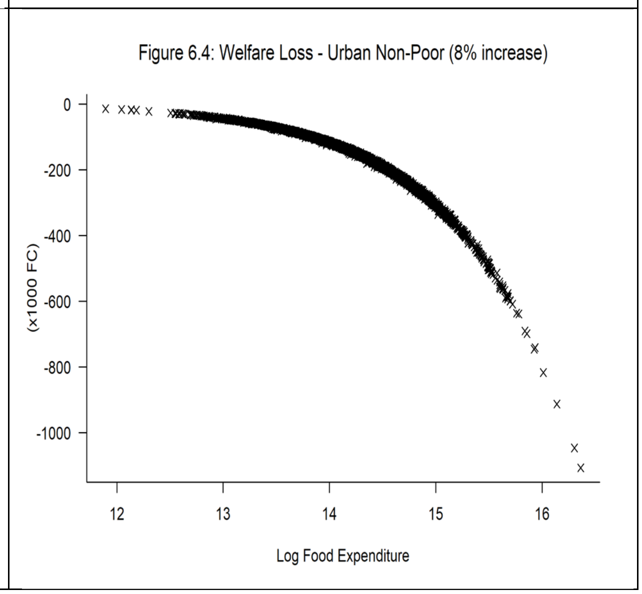


Figure 6.4: Welfare Loss - Urban Non-Poor (8% increase)

Finally, we plot the distribution of the welfare loss by area of residence and poverty status in figures 6.1 through 6.4. The examination of these figures reveals two things. First, the magnitude of the welfare loss increases as total food expenditure rises, which is consistent with the Gini coefficient. Second, the range of the welfare loss is different across groups; it is largest for urban non-poor households.

6.2 Distribution of the VAT Burden by Quintile

To provide numeric values for the distribution of the tax burden by expenditure level, we proceed with an analysis by quintile of food expenditure, which is generated from the data. This variable accounts for difference in living costs between rural and urban areas. The quintile variable is based on the aggregate food expenditure deflated by the Paasche index, computed with the median aggregate price at the level of each data collection stratum (A. Deaton and S. Zaidi, 2002). Following Deaton and Zaidi (2002), we compute the Paasche index for each sample household with the following equation:

$$ln(P_P) \approx \sum_i s_i (ln(p_i) - ln(p_i^0)) \tag{10}$$

where P_P is the Paasche index; s_i is the budget share for commodity i; p_i is the aggregate price for commodity i; and p_i^0 is the reference aggregate price for commodity i, which is set to the median aggregate price in each stratum.

Table 8: Welfare Loss from the VAT by Food Expenditure Quintile

	Bottom	2nd quintile	3rd quintile	4th quintile	Top
	8 % Increase in cereal, meat, and other foods				
Compensating variation (x1000)	-39.138	-67.136	-91.616	-123.922	-213.267
	[0.145]	[0.109]	[0.148]	[0.208]	[1.241]
Share of aggregate loss	0.073	0.125	0.171	0.232	0.399
	12 % Increase in cereal, meat, and other foods				
Compensating variation (x1000)	-45.434	-77.802	-106.694	-145.849	-257.681
	[0.167]	[0.125]	[0.170]	[0.246]	[1.574]
Share of aggregate loss	0.072	0.123	0.168	0.230	0.407
Observations	4,266	4,230	4,248	4,250	4,245

Standard errors in brackets, 100 bootstrap replications

Source: 2012 1-2-3 Survey, DRC

Table 8 presents welfare losses from the introduction of the VAT by quintile of food expenditure. The magnitude of the welfare loss increases from the bottom to the top quintile. The bottom quintile only accounts for 7.3 percent of the aggregate welfare losses, while the top quintile accounts for 39.9 percent of the aggregate welfare loss. The results from the table cleary highlight that the current regime of the VAT is progressive.

Although our results suggest that the VAT is progressive, we do not know whether exemptions are well-targeted. To address this issue, we assess budget share devoted to exempted goods. Engel curves plotted in figures 3.2a-3.2e show the relationship between log-household food expenditure and budget share devoted to specific food commodities. Indeed, these graphs can help to access whether exemptions are well targeted. Because cereals, including bread and rice, are necessities one can infer that these exemptions are well-targeted. However, based on Figure 3.2b, exemption of meat does not seem to be pro-poor because meat is a luxury good in this context.

6.3 Poverty Impact of the VAT

Table 9: Impact of the Value-Added Tax on Poverty Measures (Proportion)

Foster-Greer-Thorbecke Poverty Measures	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2012			8% Increase in Prices			12% Increase in Prices		
	All	Rural	Urban	All	Rural	Urban	All	Rural	Urban
Poverty Headcount (p0)	0.465	0.336	0.67	0.453	0.334	0.644	0.451	0.334	0.637
	[0.005]	[0.006]	[0.008]	[0.005]	[0.006]	[0.008]	[0.005]	[0.006]	[0.008]
Poverty-Gap (p1)	0.182	0.121	0.279	0.172	0.12	0.257	0.171	0.119	0.252
	[0.003]	[0.003]	[0.005]	[0.003]	[0.003]	[0.005]	[0.003]	[0.003]	[0.005]
Squared Poverty-Gap (p2)	0.095	0.061	0.148	0.088	0.06	0.133	0.087	0.06	0.13
	[0.002]	[0.002]	[0.004]	[0.002]	[0.002]	[0.004]	[0.002]	[0.002]	[0.004]
Observations	21,239	11,551	9,688	21,239	11,551	9,688	21,239	11,551	9,688

Standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

The adoption of the VAT eroded the purchasing power of all households. Household aggregate food consumption decreased, with the highest losses, measured by the compensating variation, occurring among rural poor households. The relative drop in aggregate food consumption varies between 10 (for 8 percent price increase) and 12 (for 12 percent price increase) percent (results not shown).

In this sub-section, we investigated the poverty impact of the VAT reform. We first calculated counterfactual welfare aggregates by adding the welfare loss to the 2012 adjusted food consumption aggregate. Then, we generated new food poverty lines that accounted for the changes in relative prices. To do so, we calculated the welfare loss among those whose food consumptions were in a 15 percent bandwidth above and below the food poverty line, and we added the welfare loss corresponding to each scenario to the food poverty line prevailing in 2012. Finally, we derived the three poverty measures of interest (poverty headcount, poverty gap, and squared poverty gap) in each scenario using the appropriate food consumption aggregate and food poverty line.

Not surprisingly, the adoption of the VAT increased the food poverty headcount by 1.2 and 1.4 percentage points in the scenarios of 8 and 12 percent increase in prices, respectively. In both urban and rural areas of residence, the VAT reform led to worsening of the living conditions of the households based on the poverty headcount. The poverty gap and the squared poverty gap further supported this deterioration in the food poverty status due to the adoption of the VAT. The short-term effect of the adoption of the VAT, hence, contributed to the high level of poverty headcount recorded in 2012.

7 Conclusion

In 2012, the DRC enacted the value added tax, whose rate is uniformly fixed at 16 percent with zero-rating basic commodities, including bread, rice, and meat. Although, this VAT reform was crucial to stemming the fiscal deficit, it could adversely erode household real income. In this paper, we examined the welfare and distributional impacts of the tax reform. We further investigated whether the exemptions are well-targeted.

The current study finds a 10 and 12 percent loss in real expenditure induced by a statutory tax rate of 8 and 12 percent, respectively. Our results are consistent with findings from the literature on the welfare implications of the introduction of the VAT, though with some differences in magnitude (N. Gemmell and O. Morrissey, 2003, S. M. Hossain, 1994, S. Muñoz and S. Cho, 2003, D. Newhouse and D. Zakharova, 2007). These results are low compared to a welfare loss between 11 and 19 percent subsequent to an increase of two-percentage points in the VAT rate in Lebanon reported by Salti and Chabaan (2008). The differences between the two sets of findings can possibly be attributed to the fact that the effective tax rate in the DRC is lower than in Lebanon. This also potentially reflects the fact that the exempted items are important consumption goods for the poor. Compared to findings from an impact analysis of tax reform in the Philippines, the welfare losses computed in this study are large (D. Newhouse and D. Zakharova, 2007). In this case, the discrepancies between the results from the two studies may be due to the focus of this study on direct effects without accounting for the effects of mitigating programs such as public transfer programs targeting the poor.

We also find that the VAT scheme is strongly progressive, with urban households bearing a higher tax burden than rural households. This finding echoes results from most studies on VAT impact (N. Gemmell and O. Morrissey, 2003, S. M. Hossain, 1995, D. Newhouse and D. Zakharova, 2007, N. Salti and J. Chabaan, 2008). What is important in the context of this study is the robustness of the VAT progressiveness even when we do not take into consideration the indirect effects of the VAT.

Overall, exempted goods constitute a large budget share among the poor (at least 79.4 and 79.8 percent of the food budget shares of the rural and urban poor, respectively). Although we have not implemented a very detailed analysis of exempted goods, it is hoped that exemptions can be refined to better help the poor by further subsidizing luxury goods that are important on nutritional grounds (for example, meat and fish, which tend to be luxury goods). In addition, the adoption of the VAT led to a worsening of the food poverty headcount by 1.2 to 1.4 percentage points.

The current analysis provides nationally representative estimates, which does not fully reflect regional specificities. Nor does it account for general equilibrium effects resulting from the VAT reform. These two points highlight the need for an analysis of the data disaggregated at the regional level. They also underscore the need for an analysis that accounts for macro level interactions with respect to the impacts of the VAT reform.

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Appendices: Other Functional Forms

A.1 Motivation

Although the analysis of Engel curves shows the need for the QUAIDS, we provide estimation results with other functional forms, consisting of the linear expenditure (LES) and the almost ideal demand system (AIDS). Since the groundbreaking article by Stone on demand systems, the LES has been the main ingredient in most demand analysis. It thus seems a reasonable approach to include it in our analysis. This step also allows easy comparison with previous works. In addition, it provides a reference framework for the analysis presented earlier. From a purely theoretical viewpoint, the LES is consistent with a realistic utility maximization behavior, provided that its specification does not entail restrictions leading to either pure Cobb-Douglas or Leontief utility functions. The model allows for aggregation over either commodities or households. The LES is a very parsimonious demand system, requiring estimation of fewer parameters than its competitors in the class of flexible functional form (Deaton and Muellbauer, 1980; Pollak and Wales, 1992).

However, the LES's good theoretical and empirical properties come from its overrestrictiveness. The LES only allows for substitution among commodities under analysis. In practical work, the demand system produces often substitution elasticities that are too high compared to those from the AIDS for example. Moreover, it requires price and expenditure elasticities to be nearly proportional. In some special cases, utility functions leading to the LES may be such that the demand system displays expenditure proportionality, violating Engel's law (Deaton and Muellbauer, 1980; Pollak and Wales, 1992). To account for these shortcomings, we supplement the analysis with estimates from the AIDS demand system.

The AIDS provides a flexible specification of demand systems; it can be seen as a first-order approximation to an arbitrary demand system. It derives from a 'theoretically plausible' utility function and allows for aggregation over both households and commodities. Furthermore, the AIDS demand system has good empirical properties, supporting its wide utilization. Its properties are well established; its estimation well understood. Although it requires more parameters than the LES, the AIDS specification is quite parsimonious in the class of flexible functional forms. Its nonlinearity in prices can be addressed with improved computing capabilities. Furthermore, that demand system allows for testing important features of demand theory such as symmetry and homogeneity.

A.2 Linear Expenditure System

The Stone-Geary linear expenditure system, derives from maximization of the following utility function:

$$U(q) = \prod_{j=1}^{j=n} (q_j - \gamma_j)^{\beta_j},\ \beta_j > 0,\ \sum \beta_j = 1 \tag{11}$$

The resulting Marshallian demand is:

$$p_i q_i = p_i \gamma_i + \beta_i (x - \sum_j p_j \gamma_j) \tag{12}$$

Where p_i is price of commodity i; q_i is quantity of commodity i; x is total household expenditure; $p_i \gamma_i$ can be viewed as a household's 'committed expenditure' on commodity i; $(x - \sum_j p_j \gamma_j)$ is the 'supernumerary income', and β_j is the share of the supernumerary income devoted to commodity j.

A.3 Almost Ideal Demand System

The AIDS can be derived from a flexible indirect utility function in the price independent generalized log linearity family represented by:

$$V(p,x) = (\frac{lnx - lna(p)}{b(p)}) \tag{13}$$

Where p is the price vector, and

$$a(p)) = \alpha_0 + \sum_i \alpha_i lnp_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} lnp_i \times lnp_j \tag{14}$$

$$b(p) = \prod_i p_i^{\beta_i} \tag{15}$$

A typical AIDS equation for commodity i is presented below:

$$s_i(p,x) = \alpha_i + \sum_j \gamma_{ij} lnp_j + \beta_i ln(\frac{x}{a(p)}) \tag{16}$$

where s_i is the budget share for food commodity i; p is the aggregate price vector; $ln(w) = lnx - ln(a(p))$, with x being total food expenditure.

A.4 Estimation

To estimate each model presented above, we added a disturbance term to equation (12) and (16) and then run a weighted regression.

To estimate the LES parameters, we use a non-linear seemingly unrelated regression (SUR), because equation (12) is non-linear when both $gamma_i$ and β_j are unknown. The system of equations is estimated dropping one commodity category (Other Food), whose parameters can be recovered later on from the restrictions to the system. In addition, we impose the following theoretically sound restrictions to the equations system to guarantee a theoretically plausible demand system.

$$\sum \beta_j = 1 \quad and \quad \sum p_i q_i = x$$

The AIDS is estimated by a nonlinear SUR - maximum likelihood estimator. The SUR approach allows for imposing cross-equation restrictions for homogeneity and symmetry, and it does not rule out correlation between residuals. To obtain a demand system fully consistent with consumer theory, we impose the following restrictions to the equations system:

$$\sum_i \alpha_i = 1; \sum_i \gamma_{i,j} = 0; and \sum_i \beta_i = 0, \ for\ adding-up \tag{17}$$

$$\sum_j \gamma_{i,j} = 0, \ for\ homogeneity\ for\ all\ i \tag{18}$$

$$\gamma_{i,j} = \gamma_{j,i}, \ for\ symmetry. \tag{19}$$

$$ln(f(p)^*) = \sum_i w_i \times ln(p_i)$$

Again, the estimation of the equations system is implemented, leaving out one commodity category (Other Food) whose parameters can be recovered.

A.5 Elasticity Formula

Linear Expenditure System

Expenditure elasticity

$$e_i^x = \frac{\beta_i}{p_i \gamma_i} x \tag{20}$$

The uncompensated price elasticities are:

$$e_{ii} = \frac{\gamma_i(1-\beta_i)}{q_i} - 1 + s_i \eta_i^x \tag{21}$$

where s_i is budget share devoted to commodity i.

AIDS System

Expenditure elasticity $\frac{\partial s_i}{\partial x}|_p$ which yields:

$$e_i^x = 1 + \frac{\beta_i}{s_i} \tag{22}$$

The uncompensated elasticities are provided below:

$$e_{ij} = \frac{1}{s_i}(\gamma_{i,j} - \beta_i \times s_j) - \delta_{i,j} \tag{23}$$

Where $\delta_{i,j}$ is the Kronecker delta with $\delta_{i,j} = 1$ if $i = j$ and $\delta_{i,j} = 0$ if $i \neq j$.

A.6 AIDS and LES Estimation Results

A.6.1 Linear Expenditure System

Table A1: LES Parameter Estimates

	All	Rural		Urban	
		Poor	**Non-Poor**	**Poor**	**Non-Poor**
b1	0.147***	0.161***	0.149***	0.182***	0.130***
	[0.001]	[0.002]	[0.003]	[0.003]	[0.003]
b2	0.314***	0.253***	0.269***	0.287***	0.354***
	[0.001]	[0.002]	[0.003]	[0.003]	[0.004]
b3	0.059***	0.080***	0.053***	0.066***	0.054***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
b4	0.258***	0.409***	0.341***	0.291***	0.208***
	[0.002]	[0.003]	[0.004]	[0.003]	[0.003]
g1	-41.780***	-8.610***	-60.756***	-29.135***	-28.776***
	[1.993]	[1.742]	[4.995]	[3.896]	[7.031]
g2	-39.648***	-2.522***	-31.583***	-18.251***	-55.980***
	[0.901]	[0.472]	[1.788]	[1.147]	[4.252]
g3	1.116**	1.435***	7.636***	0.783	7.431***
	[0.510]	[0.517]	[1.172]	[0.615]	[1.855]
g4	-6.832*	-1.981	-109.792***	-4.254	10.983
	[3.974]	[3.379]	[13.507]	[5.916]	[9.662]
g5	8.149***	6.419***	19.618***	3.970***	10.074***
	[0.817]	[0.515]	[1.782]	[0.971]	[3.563]
Observations	21,239	6,766	4,785	5,743	3,945

standard errors in brackets, 100 bootstrap replications
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Table A2: LES Expenditure Elasticities

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
Cereal	2.270***	2.667***	2.744***	2.323***	1.795***
	[0.040]	[0.102]	[0.067]	[0.056]	[0.055]
meat/Fish	1.908***	1.821***	1.649***	1.710***	1.526***
	[0.027]	[0.046]	[0.032]	[0.055]	[0.033]
Oil	1.129***	1.513***	1.012***	1.156***	1.201***
	[0.010]	[0.025]	[0.019]	[0.017]	[0.024]
Tubers/Plantain	0.978***	1.649***	1.122***	0.980***	0.954***
	[0.010]	[0.038]	[0.028]	[0.007]	[0.014]
Other Foods	3.725***	1.726***	3.230***	3.361***	2.714***
	[0.041]	[0.040]	[0.070]	[0.077]	[0.080]
Observations	21,239	6,766	4,785	5,743	3,945

standard errors in brackets, 100 bootstrap replications
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Table A3: LES Hicksian Own Price Elasticities

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
Cereal	-0.854***	-0.839***	-0.852***	-0.818***	-0.870***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
meat/Fish	-0.687***	-0.747***	-0.731***	-0.713***	-0.646***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Oil	-0.941***	-0.920***	-0.947***	-0.934***	-0.945***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Tubers/Plantain	-0.742***	-0.591***	-0.660***	-0.709***	-0.792***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Other Foods	-0.777***	-0.903***	-0.811***	-0.825***	-0.747***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	21,239	6,766	4,785	5,743	3,945

standard errors in brackets, 100 bootstrap replications
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

A.6.2 AIDS System

Table A4: AIDS Parameter Estimates (Part 1)

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
\alpha_{1}	0.017**	-0.007	0.039***	0.113***	0.006
	[0.007]	[0.015]	[0.014]	[0.016]	[0.017]
\alpha_{2}	0.516***	0.360***	0.471***	0.495***	0.516***
	[0.008]	[0.017]	[0.018]	[0.017]	[0.020]
\alpha_{3}	0.002	0.026***	-0.016**	-0.015**	-0.005
	[0.003]	[0.007]	[0.007]	[0.007]	[0.009]
\alpha_{4}	0.242***	0.635***	0.417***	0.211***	0.124***
	[0.009]	[0.021]	[0.021]	[0.017]	[0.016]
\alpha_{5}	0.223***	-0.014	0.089***	0.195***	0.359***
	[0.006]	[0.010]	[0.013]	[0.012]	[0.018]
\beta_{1}	-0.022***	-0.024***	0.000	-0.005	-0.020***
	[0.001]	[0.003]	[0.003]	[0.003]	[0.003]
\beta_{2}	0.029***	0.002	0.024***	0.026***	0.027***
	[0.002]	[0.003]	[0.004]	[0.004]	[0.004]
\beta_{3}	-0.019***	-0.017***	-0.025***	-0.017***	-0.014***
	[0.001]	[0.001]	[0.002]	[0.001]	[0.002]
\beta_{4}	-0.003	0.067***	0.004	-0.018***	-0.022***
	[0.002]	[0.004]	[0.004]	[0.004]	[0.003]
\beta_{5}	0.015***	-0.028***	-0.004	0.013***	0.029***
	[0.001]	[0.002]	[0.003]	[0.003]	[0.004]
Observations	21,239	6,766	4,785	5,743	3,945

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Table A5: AIDS Parameter Estimates (Part 2)

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
\gamma_{11}	-0.104***	-0.106***	-0.171***	-0.113***	-0.080***
	[0.002]	[0.005]	[0.006]	[0.005]	[0.006]
\gamma_{21}	0.062***	0.062***	0.119***	0.064***	0.049***
	[0.002]	[0.004]	[0.005]	[0.005]	[0.007]
\gamma_{31}	0.001	0.013***	0.001	-0.017***	-0.014***
	[0.001]	[0.002]	[0.003]	[0.002]	[0.003]
\gamma_{41}	0.059***	0.025***	0.044***	0.071***	0.039***
	[0.002]	[0.005]	[0.006]	[0.004]	[0.005]
\gamma_{51}	-0.018***	0.006***	0.007**	-0.006**	0.006
	[0.001]	[0.002]	[0.003]	[0.003]	[0.005]
\gamma_{22}	-0.079***	-0.079***	-0.096***	-0.078***	-0.059***
	[0.003]	[0.005]	[0.006]	[0.007]	[0.010]
\gamma_{32}	-0.002	0.000	-0.003	0.014***	0.006**
	[0.001]	[0.002]	[0.003]	[0.002]	[0.003]
\gamma_{42}	0.037***	0.029***	-0.004	0.012***	0.029***
	[0.003]	[0.005]	[0.006]	[0.005]	[0.005]
\gamma_{52}	-0.018***	-0.012***	-0.016***	-0.012***	-0.025***
	[0.002]	[0.003]	[0.003]	[0.003]	[0.006]
\gamma_{33}	-0.005***	-0.028***	-0.002	-0.007***	0.025***
	[0.001]	[0.002]	[0.003]	[0.002]	[0.003]
\gamma_{43}	0.003***	0.011***	0.001	0.006***	-0.012***
	[0.001]	[0.003]	[0.003]	[0.002]	[0.003]
\gamma_{53}	0.001	0.005***	0.002	0.003*	-0.006**
	[0.001]	[0.002]	[0.002]	[0.002]	[0.003]
\gamma_{44}	-0.116***	-0.051***	-0.017*	-0.097***	-0.069***
	[0.003]	[0.008]	[0.010]	[0.005]	[0.006]
\gamma_{54}	0.017***	-0.013***	-0.025***	0.008***	0.014***
	[0.002]	[0.003]	[0.004]	[0.003]	[0.005]
\gamma_{55}	0.017***	0.013***	0.032***	0.007**	0.012
	[0.002]	[0.003]	[0.003]	[0.003]	[0.007]
Observations	21,239	6,766	4,785	5,743	3,945

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Source: 2012 1-2-3 Survey, DRC

Table A6: AIDS Expenditure Elasticities

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
Cereal	0.654***	0.609***	1.005***	0.943***	0.729***
	[0.006]	[0.016]	[0.000]	[0.001]	[0.010]
meat/Fish	1.174***	1.015***	1.150***	1.157***	1.115***
	[0.003]	[0.000]	[0.003]	[0.005]	[0.002]
Oil	0.641***	0.676***	0.525***	0.694***	0.693***
	[0.003]	[0.006]	[0.009]	[0.004]	[0.006]
Tubers/Plantain	0.989***	1.268***	1.013***	0.940***	0.897***
	[0.000]	[0.007]	[0.000]	[0.000]	[0.001]
Other Foods	1.257***	0.504***	0.935***	1.259***	1.312***
	[0.003]	[0.010]	[0.001]	[0.006]	[0.010]
Observations	21,239	6,766	4,785	5,743	3,945

standard errors in brackets, 100 bootstrap replications
*** p<0.01, ** p<0.05, * p<0.1
Source: 2012 1-2-3 Survey, DRC

Table A7: AIDS Hicksian Own Price Elasticities

	All	Rural		Urban	
		Poor	Non-Poor	Poor	Non-Poor
Cereal	-2.598***	-2.732***	-4.162***	-2.426***	-2.082***
	[0.029]	[0.068]	[0.081]	[0.033]	[0.034]
Meat/Fish	-1.493***	-1.516***	-1.556***	-1.449***	-1.248***
	[0.009]	[0.018]	[0.012]	[0.015]	[0.006]
Oil	-0.827***	-1.302***	-0.828***	-0.859***	-0.109***
	[0.001]	[0.010]	[0.002]	[0.003]	[0.011]
Tubers/Plantain	-1.353***	-1.273***	-0.970***	-1.232***	-1.236***
	[0.004]	[0.008]	[0.002]	[0.003]	[0.004]
Other Foods	-0.617***	-0.687***	-0.341***	-0.783***	-0.748***
	[0.002]	[0.005]	[0.012]	[0.002]	[0.002]
Observations	21,239	6,766	4,785	5,743	3,945

standard errors in brackets, 100 bootstrap replications

*** p<0.01, ** p<0.05, * p<0.1

Source: 2012 1-2-3 Survey, DRC