High Food Prices and their Implications for Poverty in Uganda – From Demand System Estimation to Simulation

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DRAFT – PRELIMINARY RESULTS: NOT SUITABLE FOR CITATION

Abstract

This paper represents an initial attempt at assessing the importance of estimated demand systems for the simulation of large price shocks with respect to poverty analysis. Using a Ugandan household survey data set and an estimated flexible demand system, three different approaches to simulating the compensated expenditure budget due to large food price shocks are compared: a non-behavioral microaccounting, and two behavioral demand systems (LES and QUAIDS). The aim of this study is twofold. First, to provide an indication whether it is worthwhile to invest in the estimation of a demand system for similar consumption side poverty impact analyses. Second, to provide a sense of the magnitude in the loss of fidelity in using a less flexible instead of a more flexible demand system within computable general equilibrium analyses of poverty impacts. The results show that using no demand system overestimates poverty impacts to quite some extent. The differences between using either of the two demand systems are rather small but might be noteworthy in the extremes.

Keywords: Demand system, simulation, Uganda, food price inflation, poverty.

1 Introduction

The repeated occurrence of high food price spells has started intensive research on the impacts of these events on income distribution and poverty, in particular. Initial empirical work attempting to assess the poverty impacts used first-order analysis using household data that differentiates between net buyers and net sellers of food (e.g., Ivanic and Martin, 2008; Wodon et al., 2008; Zezza et al., 2008; Aksoy and Isik-Dikmelik, 2008; Benson et al., 2008; Simler, 2010).

One common feature as well as a major critique of such analyses is that they disregard the second-order impacts of the price changes on both the supply and consumption sides

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(see, e.g., Aksoy and Hoekman, 2010). The objective of the present study is the quantification of the effect of this neglect on the consumption side. More specifically, the aim of this study is twofold. First, to provide an indication whether it is worthwhile to invest in the estimation of a demand system for similar consumption side poverty impact analyses. Second, to provide a sense of the magnitude in the loss of fidelity in using a less flexible instead of a more flexible demand system within computable general equilibrium (CGE) analyses of poverty impacts.

As the basis of this study, a 13-item censored Quadratic Almost Ideal Demand System (QUAIDS) is estimated over data of the Uganda 2005/2006 National Household Survey (UNHS) which covers a representative set of 7426 households. The estimated parameters are used to simulate the impact of the 2007/2008 and 2011 food price spikes on poverty. The shocks are calculated from price time series data for several food commodities and Ugandan market locations which are matched to the households of UNHS. As the Linear Expenditure System (LES) is one of the most popular demand systems used in CGE models, a LES is calibrated, for each household separately, to approximate the QUAIDS elasticities in the point of the base data as done in Yu et al. (2003). Then, the non-behavioral first-order poverty impacts as well as the behavioral poverty impacts employing the two demand systems are simulated. The demand system simulations are conducted fixing the base-period utility and calculating the compensating variation based on an algorithm due to Vartia (1983).

Uganda has a high poverty rate of 31% according to official figures (in 2006, Table 6.9, Uganda Bureau of Statistics, 2006) and even 52% based on the 1.25$/day poverty line (in 2005, World Bank, 2010). It is highly agriculture-centered with 73.3% of the working population working in the agriculture, forestry, and fishing sectors in 2005/06 (Uganda Bureau of Statistics, 2006, Table 4.5) which account for 25% of total value added in 2009.[1] 49.2% of Ugandan households name subsistence farming as their major source of earnings while only 20.8% name wage employment (Uganda Bureau of Statistics, 2006, Table 7.3). This indicates a low dependence of household incomes on markets. Then, apart from rice and wheat, Uganda is largely self-sufficient in terms of the staple foods it consumes. In fact, Uganda is an important source of food for neighboring countries. Additionally, Ugandans base their diets on a variety of staple foods of which many are not actively traded on international markets, see Benson et al. (2008). Finally, Uganda is a landlocked country with poor transport connections to seaports and thus has high transport and transactions. In summary, Uganda appears to be quite well insulated from price shocks on the world market.

Nevertheless, Uganda experienced dramatic consumer price inflation in the period from 2005/06 to 2013 with food prices increasing significantly more than prices for non-

[1] World Bank (2010), series "Agriculture, value added (% of GDP)".

food as presented in Figure 1 using undeflated official Ugandan CPI.

Figure 1: Ugandan food and non-food price indices

Source: Own computation from Bank of Uganda CPI data (base=2005/06), `http://www.bou.or.ug/bou/rates_statistics/statistics.html`, retrieved April 24, 2013.

2 Data and approach

The aim of this study is first, to provide an indication whether it is worthwhile to invest in the estimation of a demand system for similar consumption side poverty impact analyses. Second, to provide a sense of the magnitude in loss of fidelity in using a LES instead of a more flexible demand system like the QUAIDS within CGE model analyses of equivalent price shocks.

2.1 Data

The simulations are based on the UNHS 2005/06 which includes a sample of 7,426 households, corresponding to 40,449 individuals, and is nationally representative, see Uganda Bureau of Statistics (2006). Inflated by sample weights, the sample represents a population of 28,428,169 individuals.[2]

[2] Five households had to be deleted due to missing data, leaving 7421 households.

To derive actual price shocks of food price peaks, we utilize a price time series collected by Farmgain Uganda which contains weekly data for many Ugandan locations and food items. As not all items disaggregated in estimated demand system are present in that data, in particular, non-food, the series is complemented with regional monthly CPI data taken from the Uganda Bureau of Statistics (UBoS)(UBoS, 2013a,b).

2.2 Approach

The foundation is built on the estimation of a censored Quadratic Almost Ideal Demand System (QUAIDS, Banks et al. (1997)) as described in Boysen (2012). It is a 13 item two-stage demand system model, estimated for rural and urban households separately where the first stage budgeting between food and non-food is represented by a Working-Leser-type function and the main, second-stage is represented by a QUAIDS accounting for socio-demographic household characteristics and censoring and focuses on food items.

A second, less flexible demand system examined is the Linear Expenditure System (LES, Stone (1954)) which is also the standard demand system used in CGE models. A consistent set of LES parameters is derived for each individual household using the UNHS and estimates of Ugandan rural and urban demand systems, respectively. To generate consistent parameter sets, a LES is calibrated to fit those given income and own price elasticities as good as possible in terms of a maximum entropy objective function (see Golan et al. (1996)) and the theoretical constraints of the LES, similar to the approach applied in Yu et al. (2003). The LES is fitted individually for each household. The maximum entropy procedure is implemented in GAMS.

The third approach included is a simple microaccounting where quantities remain fixed and only the prices are changed by the shocks. This is the standard approach for first-order studies which has the advantage of being relatively quick to implement and transparent. However, neglecting behavioral adaptation of household consumption to price shocks represents a worst case for the simulation of price shocks.

As with a demand system, quantities change together with prices, a pure price index-based approach for evaluating the after price shock real income is not applicable. Hence, another money-metric measure is employed, the compensating variation (CV). The compensated expenditure is calculated by finding the expenditure budget which allows the household to keep its utility at pre-shock level while adjusting its consumption to the new price levels. The CV of the LES and QUAIDS models is simulated using the algorithmic approach introduced by Vartia (1983). It basically exploits Shephard's Lemma to calculate a movement along a compensated demand curve to approximate the CV. The approach has been shown to approximate the real CV with very high accuracy. The Vartia procedure as well as the demand system simulations are implemented in the statistical programming language R (R Core Team, 2013).

2.3 Poverty lines and measures

For measuring poverty, we employ an absolute poverty line and the measures P_α introduced by Foster et al. (1984).[3] The poverty headcount index P_0 measures the percentage of people falling below the poverty line. The poverty gap P_1 measures the extent by which poor people fall under the poverty line as a percentage of the poverty line on average. The poverty severity index P_2 squares that shortfall percentage of each person before averaging and thus gives more weight to more severely affected people.

Rural and urban poverty lines are derived such that they reproduce the poverty headcounts of 34.2% in rural and 13.7% in urban areas, as reported in the UNHS Report on the Socio-Economic Survey (Uganda Bureau of Statistics, 2006, Table 6.3.2 (a)), when applied to the adjusted household survey data. The UBoS poverty lines are based on the *cost of basic needs approach*, which accounts for the cost of meeting physical calorie needs and allows for vital non-food expenditure, such as clothing and cooking fuels, valued using the average consumption basket of the poorest 50% of the population (Uganda Bureau of Statistics, 2006, Section 6.3). The rural and urban poverty lines account for the differences in prices and consumption baskets of the respective subpopulations. Per capita consumption expenditure is used the income measure. Household income is measured as the sum of the values of market and non-market consumption, both valued at market prices. It should be noted that our poverty classification is not directly comparable with the classification in the official report of the Uganda Bureau of Statistics (2006) due to differences in data adjustments.

3 Simulations

3.1 Scenarios

Two sets of price shocks are simulated, representing months of high food price indices in Uganda. These are the changes from 2005/06 to September 2009 and to October 2011. Each of these shocks is simulated using the microaccounting approach (MACC), the LES, and the QUAIDS. The items shocked are alcohol and tobacco, beans, cassava, fats and oils, fish, fruits and vegetables, livestock products, maize, matooke, other foods, sugar,

[3]The formula is given as $P_\alpha = \frac{1}{N} \cdot \sum_{i=1}^{N} \left(\frac{z-y_i}{z}\right)^\alpha \cdot I_i$ with N: population size, z: poverty line, y_i: income of individual i, and $I_i = \begin{cases} 1 & \text{if } y_i < z \text{ and} \\ 0 & \text{otherwise.} \end{cases}$ Setting the parameter α to 0, 1, or 2 computes the poverty headcount, gap, or severity index, respectively.

sweet potatoes, and non-food. The markets distinguished are Arua, Gulu, Jinja, Kabale, Kampala, Lira, Masaka, Masindi, Mbale, Mbarara, Soroti, and Tororo. Each household is shocked with the price inflation of its geographically closest market (according to GPS coordinates) for which a price shock is available.

The after-shock consumption budget is calculated by first dividing the initial budget by the after-shock compensated expenditure to get budget deflator and then this is multiplied by the initial budget times the overall CPI index to account for an increase in income. Thus, for all households it is assumed that their income rises in line with the overall CPI. This very crude approach is adopted to avoid absurd negative income effects as the overall price level increased strongly not only due to the food prices but also to non-food prices.

The shocks are presented in Table 1. Price indices for several market and item combinations in September 2009 exceed 300% of increase from the 2005/06 level and many register more than 400% of increase. By contrast, the increase in the overall CPIs for the regions is about 150% in September 2009 and 200% in October 2011. Thus, depending on the needs and preferences of the consumers, these large price variations across markets and items might have widely differing effects on the individual households.

Table 1: Regional price shock index values with base=2005/06

Item	Arua	Lira	Tororo	Mbarara	Masindi	Kampala	Kabale	Soroti	Masaka	Gulu	Jinja	Mbale
September 2009												
Cassava	184	301	272	219	189	211	169	194	216	–	–	–
Livestock products	240	197	189	205	167	–	224	132	161	–	–	–
Other foods	197	–	–	186	–	176	–	–	170	200	192	178
Non-food	131	–	–	140	–	131	–	–	137	135	138	136
Fruits and vegetables	197	219	132	333	201	192	160	109	151	–	–	–
Fish	159	144	142	206	210	–	206	319	144	–	–	–
Alcohol and tobacco	141	–	–	126	–	124	–	–	124	138	122	120
Sugar	197	–	–	186	–	176	–	–	170	200	192	178
Sweet potatoes	178	231	165	297	316	134	129	273	204	–	–	–
Maize	255	183	282	224	217	214	256	238	235	–	–	–
Matooke	251	295	199	136	207	139	86	172	139	–	–	–
Fats and oils	197	–	–	186	–	176	–	–	170	200	192	178
Overall CPI index	159	–	–	152	–	143	–	–	146	160	155	148
Beans	573	190	158	198	264	112	–	211	142	–	–	–
October 2011												
Cassava	277	247	255	203	209	240	145	215	219	–	–	–
Livestock products	293	240	214	205	167	–	275	166	215	–	–	–
Other foods	279	–	–	247	–	242	–	–	240	268	249	255
Non-food	173	–	–	174	–	166	–	–	175	176	173	165
Fruits and vegetables	253	351	270	400	279	281	335	254	245	–	–	–
Fish	371	271	312	467	371	–	423	458	293	–	–	–
Alcohol and tobacco	174	–	–	164	–	170	–	–	166	187	182	173
Sugar	279	–	–	247	–	242	–	–	240	268	249	255
Sweet potatoes	172	197	244	283	380	130	152	328	134	–	–	–
Maize	271	210	367	286	289	236	290	353	279	–	–	–
Matooke	254	328	250	208	260	177	131	196	208	–	–	–
Fats and oils	279	–	–	247	–	242	–	–	240	268	249	255
Overall CPI index	217	–	–	194	–	188	–	–	193	212	199	193
Beans	351	332	239	235	404	150	–	285	247	–	–	–

Source: Own computation from UBoS CPI and Farmgain Uganda price data.

3.2 Results

Table 2 presents first results from the simulations. Overall, the strong food price inflation appears to push the consumption budget of many people under the poverty line. The poverty headcount increases by 5 to 6 percentage points given September 2009 prices, an overall CPI index-increased income, *ceteris paribus*. Rural poor people are more strongly affected with a headcount increase by almost 7 percentage points while the headcount increases by 1 to 2 percentage points in urban areas.

In October 2011, prices remain high but the poverty situation is slightly improved. The poverty headcount decreases by up to 0.5 percentage points compared to September 2009.

Table 2: Simulation results: FGT poverty indices

		September 2009			October 2011		
	2005/06	MACC.	LES	QUAIDS	MACC.	LES	QUAIDS
National							
Headcount	31.06	6.13	4.81	4.82	5.59	4.30	4.38
Gap	9.62	3.23	2.59	2.62	2.98	2.39	2.45
Severity	4.20	1.78	1.41	1.43	1.65	1.31	1.36
Rural							
Headcount	34.21	6.86	5.43	5.53	6.29	4.84	5.05
Gap	10.64	3.63	2.92	2.97	3.34	2.69	2.79
Severity	4.65	2.00	1.58	1.62	1.85	1.48	1.55
Urban							
Headcount	13.70	2.11	1.34	0.90	1.70	1.32	0.71
Gap	3.99	1.02	0.76	0.64	0.99	0.73	0.58
Severity	1.70	0.56	0.42	0.35	0.55	0.42	0.33

The columns show point changes in the indices from the Base column. The poverty figures use rural and urban poverty lines, respectively. Source: Own computation.

Considering the differences in the FGT results between the MACC, LES, and QUAIDS-based simulations, the MACC approach represents the worst case outcome where households are not able to substitute between consumption items in reaction to adverse shifts in relative prices. On the national level, the poverty headcount increase of the MACC approach is 1.3 percentage points or 27% higher than the other two. The two behavioral demand system approaches show quite significant differences in the results compared to the microaccounting approach. In urban areas, the poverty headcount effect is even halved.

The differences between the LES and QUAIDS results are rather small in aggregate with differences in headcount percentage point increase of 0.1 and 0.2 on the national level as well as in rural areas. The differences are largest in the urban results, reaching 0.6 percentage points. This shows that the calibrated LES approximates the original QUAIDS functions to a good extent. But part from the much lower flexibility of the LES, the theoretical restrictions of the LES, which require, for example, own price elasticities between -1 and 0 and positive income elasticities or that all goods are gross complements, suggest that there are strong limitations to the approximation.

Looking at the ratio between the LES- and QUAIDS-simulated consumption budgets, there are differences from about -30% up to +5% but the 5% to 95%-quantile range is 0.987 to 1.008. Thus, there are cases of strong divergence of individual household effects and LES results deviate in positive and negative directions from the QUAIDS results but for the large majority of households, the differences are in the order of less than absolute 1%.

4 Summary and Conclusions

This paper represents an initial attempt at assessing the importance of estimated demand systems for the simulation of large price shocks with respect to poverty analysis. Using a Ugandan household survey data set and an estimated flexible demand system, three different approaches to simulating the compensated expenditure budget due to large food price shocks are compared: microaccounting, LES, and QUAIDS. While the first is a mere mapping of a new price vector to given quantities, the latter two are behavioral demand systems allowing for substitution between consumption items. The LES is frequently used in CGE models but also recognized to be quite limited in its flexibility to depict real world consumption behavior. The QUAIDS, on the other hand, is a rather recent flexible demand system.

Based on the estimated parameters of a two-stage QUAIDS, a LES is calibrated to fit those given income and own price elasticities as good as possible in terms of a maximum entropy objective function and the theoretical constraints of the LES. The LES is fitted individually for each household to the individual household-specific elasticities as derived from the QUAIDS.

The results indicate that both demand systems yield results rather different from those of the microaccounting approach. For example, the poverty headcount effect simulated using the QUAIDS is less than 50% of that simulated using the microaccounting approach.

The results between the LES and QUAIDS demand systems seem quite close for the large majority of cases but can deviate a lot in the extremes. The urban poverty figures point out that noteworthy differences do exist in the details.

With regard to the use of demand systems in CGE models, and in particular to those which integrate large sets of households into the model, it seems that calibrating LES parameters individually for each household might be valuable to mimic the behavior of more flexible demand systems.

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