IMPLICATIONS OF SEASONAL PRICE AND PRODUCTIVITY CHANGES AT THE HOUSEHOLD LEVEL IN UGANDA - A HETEROGENEOUS AGENT APPROACH

Mark Musumba
Agriculture and Food Security Center
Earth Institute at Columbia University
mmusumba@ei.columbia.edu

Yuquan W. Zhang
Institute of New Rural Development / School of Agriculture and Biology
Shanghai Jiao Tong University, China
yqwzhang@sjtu.edu.cn

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Abstract:

Developing economies are affected by price and productivity changes and this was evident during the 2007-2008 world food crisis and the 2010-2011 food price surge. For this study, we use a heterogeneous-agent modelling approach to simulate production and consumption responses of a household producing bananas (matooke), beans and maize; three of the top five staple food crops by per capita calorie intake in Uganda. Preliminary results focusing on maize producing households indicate substitution of maize for other items when market prices increase. Please note that complete results are pending and this work will be updated.

Key words: farm heterogeneity, computable general equilibrium model, maize productivity, price

JEL codes: C61, Q12

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Introduction

Agriculture is a major sector in Uganda and is a main source of livelihood, providing direct employment to over 80% of the population (Haggblade and Dewina 2010). In addition, Uganda is a net food exporter with agriculture accounting for 90% of the exports (Kraybill and Kidoido 2009; Benson et al. 2008). The majority of agriculture is undertaken by smallholder farmers and price volatility affects their livelihoods and access to market goods and services. Seasonal changes in management practices also affect the productivity of the farming households and can have adverse effect on their welfare. Changes in both market prices and productivity have a potential effect on both food security and nutrition in a country where about 51% of the calories are obtained from the products bought from the market (Benson et al. 2008). During the price hikes of 2008 for example, market of staples such as millet and cassava flour rose by 35%, bananas by 20%, and maize by 75% from March to May of 2008 (Van Campenhout et al. 2013). These price changes not only had an adverse effect on farmers who are net buyers of staples but also influence a substitution effect for poorer households that consumed these products from own production (Benson et al. 2008; Simler 2010). Understanding these dynamics in Uganda is critical for agricultural policy changes that target enhancing food security and farmer income levels. Earlier studies have examined the effect of price and productivity changes at the household level with focus on a single crop like bananas (Komarek and Ahmadi-Esfahani 2011) or a staple cereal (Matovu and Twimukye 2009).

In this analysis, we compare household behavior across seasons, price and production scenarios, and across food crops. A wide range of staples are consumed in Uganda and to understand the effect on the household with heterogeneous consumption and production choice

may provide some important insights. It has been observed that prices of food crops in Uganda change across seasons and regions given the agro-ecological zones, consumption patterns, and religious and social events. Using data from the Living Study Measurement Study (LSMS) survey for 2009-2010, we examine the implications of price changes across staple and cash crops at the household level applying a heterogeneous agent approach by simulating consumption and production household responses of each household. This work is an extension of earlier work by Taylor and Adelman (2003), while Komarek and Ahmad-Esfhani (2011) and Johnson et al. (2006) provide guidance on implementing a heterogeneous agent modelling approach with a single crop. The regions in Uganda that cover Central, Southern, Eastern, Northern, and Kampala have households with distinct agricultural enterprises that differ by region and across households. Banana (matooke), maize, and beans are included in this analysis because they are important food crops that account for over 30% of daily per capita calorie intake. Maize accounts for 11% of per capita calorie intake and grown by 57 % of farmers in Uganda (Haggblade and Dewina 2010; Simler 2010).

Data

Data used from this study were obtained from the Uganda LSMS survey of 2009-2010 (UBoS 2011). This data is part of data collection initiative by the Uganda government in collaboration with the World Bank to collect nationally representative panel data[1]. The survey design is a multi-stage cluster design with regions as principle strata. These regions include Central, Western, Eastern, and Northern. Enumerations areas are selected randomly from with a probability proportional to the population from each stratum (UBoS 2011). For the preliminary data analysis, this paper focused on maize producing households to adapted/modified the model used in Taylor and Adelman (2003), and calibrated the model for our Uganda case in this study.

[1] The data collection initiative is currently funded by the Bill and Melinda Gates Foundation

Statistics presented in this paper will focus on maize. The main variables used in the model are presented in Table 1.

Labor used for production is obtained from household survey as the number of labor days allocated to production of maize in the major cropping season. Given that there is no wage rate for family labor, the wage rate was obtained from households who indicated that they hired labor. To obtain the wage rate for households that did not hire labor, the median regional hired wage rate was imputed for these households as the daily wage rate. In this analysis, obtaining total income for the household from survey data was challenging so we replaced it with the households' total expenditure on food and non-food items that is calculated from the household survey (similar to consumption expenditure approach for poverty estimations). This was calculated on a monthly basis. For our preliminary analysis, we use data from a single season. To match with one maize producing season, which is half a year, we multiply this expenditure by six. To examine the households' full income constraint, we calculate the full income constraint taking into consideration the labor endowment. Using the household size and assuming that each adult may work 180 days, the time endowment is household size multiplies by 180 to reflect half a year's worktime.

In addition, farming household tend to produce maize both as a food and cash crops. In the survey we obtain the value of the crop that is kept for household consumption versus what is sold to the market. As a percentage, households in the Northern and Eastern regions sell over 40 percent of the maize produced in value versus Central and Western regions at below 20 percent. Price of maize was obtained from the survey which was computed from the report on the value of the maize sold divided by the quantity of maize sold. For households that did not sell maize,

the median regional price of maize we imputed as the maize price that they faced. Table 1 provides a complete summary of these results.

Model

To examine these implications of price and productivity change on the household, we use theory from the basic agricultural household model to depict a household essentially as a computable general equilibrium (CGE) of a small economy, integrating both the household production and consumption decisions, with Cobb-Douglas utility function (demand) for demand (including maize, market goods, and leisure). . Specifically, the household maximizes its profit taking into consideration the resources endowments, prices of intermediate inputs and outputs, and the input-output relationships. The profits generated from production plus the value of household endowments (including labor) then constitute the full income (Becker's concept 1965) for consumption. The household utility is maximized subject to the full income constraint, supply and demand balance, and endowments (for total labor allocation). The household CGE model is applied that simulates output for households in each of the 4 regions in Uganda and there is no interaction with other households but the output is calibrated to the given household typology. In order to avoid aggregation bias, our approach focuses of producing a distributional effect of changes in prices due to world market prices and changes using historical events like the world food price hikes data of 2006-2008. We run four policy experiments that examine the impact on household income and consumption demand. For price we look at a 5%[2] and 10% increase in maize prices and a 5% and 10% decrease in household-level productivity of maize.

[2] This price and productivity increase for policy analysis is similar to work done on banana production by in Uganda Komarek and Ahmadi-Esfahani (2011)

Results

In this section, we present some of the preliminary results using a sub section of maize household producing maize in the major season. We caution that this output will be updated with 4 crops (Maize, beans, banana, and coffee) and across seasons. Four hundred and thirty households were incorporated into the model and of these only ten percent generated feasible solutions that we then used to simulate our policy experiments for our initial output. Focusing on the increase in maize price on household consumption and income, we observe that an increase in price leads to a reduction in household consumption of maize and this same increase in price increases household income (Table 2). One explanation for this observation is that intuitively, increase in prices, ceteris paribus, would lead to an increase in income. Though if household decided to couple increase in market demand with reduction in household maize consumption demand, it may indicate a substitution effect toward consumption of a cheaper staple in order to gain additional income for other household needs. Studies have also indicated that increases in price of maize have also lead to reduction in poverty where households are net sellers and higher prices lead to more sales. The inverse is also possible when households are net food buyers. The results on the productivity change scenarios indicate a negative reaction but in depth analysis of the model and calibration is needed.

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References

Ahn, C. Y., I. Singh, and L. Squire. 1981. A Model of an Agricultural Household in A Multi-Crop Economy: The Case of Korea. *The Review of Economics and Statistics*, 63 (4): 520-525.

Becker, G. S. 1965. A Theory of the Allocation of Time. *The Economic Journal*, 75(299), 493-517.

Benson, T., S. Mugarura, and K. Wanda. 2008. Impacts in Uganda of Rising Global Food Prices: the Role of Diversified Staples and Limited Price Transmission. *Agricultural Economics*, 39(1): 513-524.

Haggblade, S. and Dewina, R., 2010, January. Staple food prices in Uganda. In Prepared for the Comesa policy seminar on "Variation in staple food prices: causes, consequence, and policy options," Maputo, Mozambique (pp. 25-26).

Johnson, M. E., W. A. Masters, and P.V. Preckel. 2006. Diffusion and Spillover of New Technology: A Heterogeneous-Agent Model for Cassava in West Africa. *Agricultural Economics*, 35(2): 119-129.

Komarek, A. M., and F.Z. Ahmadi-Esfahani. 2011. Impacts of Price and Productivity Changes on Banana-Growing Households in Uganda. *Agricultural Economics*, 42(1): 141-151.

Kraybill, D., and M. Kidoido. 2009. Analysis of Relative Profitability of Key Ugandan Agricultural Enterprises by Agricultural Production Zone. International Food Policy Research Institute (IFPRI).

Matovu, J. M., and E. P. Twimukye. 2009. Increasing World Food Prices: Blessing or Curse? Research Series No. 61. Kampala, Uganda: Economic Policy Research Centre (EPRC), May. http://www.eprc.or.ug/pdf_files/series61.pdf. (Accessed January 14, 2016)

Simler, K.R., 2010. The short-term impact of higher food prices on poverty in Uganda. World Bank Policy Research Working Paper Series, Vol.

Taylor, J.E. and Adelman, I., 2003. Agricultural household models: genesis, evolution, and extensions. Review of Economics of the Household, 1(1-2), pp.33-58.

Uganda Bureau of Statistics (UBoS), 2011. Uganda National Panel Survey – 2009/2010)Wave 1 http://siteresources.worldbank.org/INTLSMS/Resources/3358986-1233781970982/5800988-1265043582346/UNPS_report_2009_10.pdf

Van Campenhout, B., K. Pauw, and N. Minot. 2013. The Impact of Food Price Shocks in Uganda: First-Order versus Long-Run Effects. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2343152 (Accessed January 14, 2016)

Table 1. Descriptive Statistics of variables (mean/median) used in the model for maize (N=430)

	Regions			
	Central	Eastern	Northern	Western
Area planted (in hectares)	0.6	0.5	0.3	0.6
Price (in shillings per kg)	413	451	372	425
Wage Rate (in shillings per workday)	4404	3807	1295	5056
Labor days (in days)	136	126	72	94
Value of production (in Uganda shillings)	403682	370980	155907	398239
Value of maize for own-consumed (in Uganda shillings)	113790	175247	75120	105130
Monthly expenditure on food and non-food items (in shillings)	271760	258994	205288	214368

Table 2. Price and Productivity policy experiments on consumption demand and income

5% Price increase	10% Price increase	5% Productivity decrease	10% Productivity decrease
Household consumption demand change			
-4.6	-8.7	-0.1	-0.2
Household Income change			
0.1	0.4	-0.1	-0.2