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Food security and value supply chain: the case of Ugandan maize

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Abstract

In many African countries, the crop commercialization is produced along a supply chain where farmers interact with intermediaries and traders. Using detailed panel data from Uganda 2009-12 (LSMS-ISA), this article examines whether farmer's participation (inside or outside) and position (downstream and upstream) to maize value supply chain (VC) affect their food security. The paper finds some evidence that farmers' food consumption, both in terms of level and variability, is affected by selling maize inside the VC. The results are suggestive that the gain from participation is driven by selling maize upstream in the VC.

Key words: maize, value supply chain, panel, Uganda.

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1 Introduction

In many African countries, small-holder farmers produce crops both for home consumption and commercialization. The commercialization of crops is produced along a supply chain where intermediaries and traders interact with farmers. Recent studies focus on the effect of farmers' participation to value supply chain (VC). However this approach require specific data on VC, usually own collected (Fafchamps and Hill, 2005). As a result our knowledge of the effects of VC participation on farmers outcomes is still quite limited.

In this study, we use data from the Uganda Living Standards Measurement Study - Integrated Survey on Agriculture (LSMS-ISA) to extend this line of research on the the causal effects on farmers' food security of their participation in the maize value supply chain (VC) in Uganda. Furthermore, our specific aim is to investigate the effects on farmer household food security of their heterogeneous participation to the maize VC, distinguishing between farmers selling maize at different level of the chain, namely upstream or downstream.

Heterogeneity in supply chain participation implies not only different trade exposure but also market access and risk exposure. Indeed the heterogeneous participation implies a different length of the supply chain, where the greater transactions increase the level of distortions to the international prices. Consequently the different participation to the supply chain of export crops has a differentiated effect on household welfare.

Our empirical analysis establishes a positive and statistically significant relations between the household food security, measured by household food consumption, and the participation in the VC. With respect to the previous analysis testing the overall effect of the trade exposure on poverty (Niimi et al, 2007 for Vietnam; Balat et al. 2009 for Uganda), we can distinguish the effect on food security according to position to the supply chain. Specifically our results show that higher food security gains associated with VC participation are explained by upstream position.

The contribution of this study is threefold. We extend the analysis of the trade impact on poorest households (Niimi et al.,2007; Balat et al.,2009; Magrini and Montalbano, 2012) using household surveys to trade and food security. Second, we focus on supply chain participation: we differentiate the farmer households according to their participation to the maize supply chain as proxy of different trade exposure, market access, risk exposure etc. In doing so, we use households data not collected ad hoc. In deed our approach can be applied to other country and other crop. Finally, we propose an identification strategy controlling for observable characteristics, heterogeneity time invariant and linearly varying and self-selection to assess the effect of VC participation and position on food security.

2 The Ugandan maize and the VC

Maize is assuming an increasing importance in the Ugandan economy. It is the third main crop grown in the country, after banana and cassava. The maize production more than doubled during between 1990 and 2013, from 0.8 million tons to 2.3 million tons (Ahmed and Ojangole, 2014). Furthermore, even if maize is not part of the traditional diet in Uganda, its consumption has recently increased, especially in urban areas, due to the growing costs of traditional staple food (USAID, 2010).

The export market for Uganda's maize is mainly regional among the East Africa Community. The most relevant importer is Kenya, and recently Sudan, which suffer chronic maize deficits (Ahmed and Ojangole, 2014).

Maize is grown predominantly by farmers on a subsistence level. They account for up to 75% of maize production and over 70% of marketable surplus (USAID 2010). Notwithstanding the transactions involved in the maize supply chain are complex (ICG, 2003; IFPRI, 2008), following Ahmed and Ojangole (2014) we can sketch four big levels of the maize VC in Uganda as follows (see Figure 1):

1. from farm gate to traders in village markets;
2. from rural markets to secondary markets in regional towns;
3. from urban markets to buying centers outside the district;
4. the export market.

[Figure 1 here]

As it is apparent from Figure 1, Ugandan maize farmer households' selling strategy is mixed. They sell maize directly to neighbours, relatives and/or consumers at the local rural market (i.e., they do not participate to the supply chain and so are considered out of the chain); and/or to rural local traders (i.e., they participate to the supply chain, even if far from final destinations), and/or to district/urban traders (i.e., they participate to the supply chain in a more downstream position, i.e. more closely to the final markets/exports).

2.1 Data

We use the Uganda Living Standards Measurement Study - Integrated Survey on Agriculture (ULSMS-ISA), implemented by the Uganda Bureau of Statistics in collaboration with the World Bank. The survey sample includes 3,123 Ugandan households selected from the Uganda National Household Survey 2005/06[1] and is representative at national, urban/rural and regional levels. The sample is visited three times, respectively in 2009/10, 2010/11 and 2011/12.

We use two sets of data from the Uganda LSMS-ISA: household data and agricultural data. The household-level data include modules related to household characteristics (household composition, demographics), education and household amenities. There are also modules on consumption expenditures and household welfare. From the latter we construct different measures of food security at household level. First we construct the household food consumption per capita. We also use number of meals taken per day in the household and a dummy for weather the household faced a situation of not having enough food to feed the household in the past 12 months. Finally we construct the Household Dietary Diversity Score (HDDS) indicator, defined as the number of unique foods consumed by household members over the last week before the interview.

The main advantage of the survey is the presence of an extended agricultural questionnaire. This allows us to investigate in detail the characteristics of small-

[1]The response rate at household level with respect to baseline in 2005/06 is quite high, respectively of 83.5% in 2009/10; 82.1% in 2010/11 and 75.4% in 2011/12. In order to minimize the attrition between rounds, all the baseline (2005/06 UNHS) households and individuals have been traced irrespective to whether they moved from the original location. Furthermore, a 20 percent of households were selected from each Enumeration Area to trace and interview their split-offs, which became part of the panel household in the subsequent rounds.

holder farmers, the key player of the maize supply chain. Indeed the questionnaire includes detailed informations on household crop production, productivity of main crops, farming inputs and practices and so on and so forth. Our empirical analysis focuses on farmers' participation to maize VC. Therefore the sample of the analysis is roughly halved to agricultural households producing maize (table 1). While the survey is carries out annually, the agricultural questionnaire is administrated in two visits to capture the agricultural variability due to two cropping seasons of the country.

[Table 1 here]

To define the farmers' participation and position to VC, we focus on farmers net producer of maize, namely producing maize not only for own consumption. Our measure of maize VC participation and position comes from a specific question on "who bought the largest part of maize sold by the household" (Agricultural questionnaire - Section 5A and 5B, respectively for the first and second crop season). Following the maize VC structure described in the previous section, we use the possible answers to categorize the farmers participation and position to the maize VC as following:

- selling maize to consumers at market; neighbor / relative; other; as **selling maize outside the VC**, namely not participating to the VC;
- selling maize to private trader in local market / village; as selling maize inside the VC with an **upstream** position;
- selling maize to private trader in district market; government[2]; as selling maize inside the VC with a more **downstream** position.

As showed in table 1, the majority of farmer households participate to maize VC, while only 325 sell maize only outside. Among the participants, the majority of farmer households sell maize upstream. Looking at the difference between pure versus mixed selling strategies, it is more common to sell maize only to one partner than to multi-partners.

[2]Note that the percentage of households answering to sell maize to other or government is negligible.

[Table 2 here]

As it is apparent from table 2, farmer households that are closer to the final market show, on average, a higher level of maize unit price, a higher level of food consumption per capita, a higher household diverse dietary score (HDDS), and are less subject to shocks (in a nutshell, they are more food secure).

On the other hand, it is apparent as well that the households with differentiated selling strategy show clear heterogeneity in their structural characteristics too. This is evident if we look at their maize production and selling conditions (farmers selling closer to the final markets show, on average, bigger numbers in maize acreage, harvest and selling quantities) as well as at the characteristics of their production inputs (farmers selling closer to the final markets use, on average, more pesticides, fertilizers, and improved seeds. They also hire more labour and, of course, face higher transport costs). There is also a strong polarization in their geographical location while there is not much heterogeneity in the households' standard characteristics.

3 Estimation and results

3.1 An econometric model of VC participation and position

Our main focus is investigating the relation between household food security and their maize VC participation and position. Several empirical issues arises when assessing this relationship. First, household that participate to VC (and that participate to VC with a specific position) may have unobservable characteristics that also influence their food security. For this reason, we avoid using matching procedures which only control for observable heterogeneity. Second, both VC participation and position are not fixed in time. On the contrary, the households may change the commercial partner over different years. This rules out the possibility of combining, for example, matching procedures with Difference-in-Difference approach. In addition, there may be two issues of selectivity. On one hand, participation includes position. In fact, only households that participate to VC, can reach the downstream position. The Heckman approach may address this problem in a cross-section setting. Again, in our case participation and position may change over time and this implies the use of the panel probit model with individual specific effects, which has its shortcomings[3]. On another hand, farmer households may select into VC participation and position on the base of their characteristics of maize inputs, as the use of fertilizers, the use of improved quality of seeds, or the quantity of harvested maize. Including such maize variables in the analysis may introduce potential endogeneity if there are omitted variables that affect both household food security and VC participation and position simultaneously.

Being aware of this issues, we employ different specifications. First, we use the following benchmark model for the households net-producer of maize:

$$FS_{h,t} = \alpha_h + \gamma_t + \alpha_h * t + \phi_1 InsideVC_{h,t} + +\boldsymbol{\delta} X_{h,t} + \epsilon_{h,t} \tag{1}$$

where:
$FS_{h,t}$ is the (log) household food consumption per capita[4]; α_h controls for household fixed effects; γ_t is a year fixed effect while $\alpha_h * t$ allows for household-specific time-trends; $X_{h,t}$ is a vector of household controls (presented in table 6); $InsideVC$ is a dummy for selling maize inside the VC (both upstream and downstream).

If we reject H(0): $\phi_1 = 0$ in equation (1), supply chain participation impacts on household food security.

Second, we test for the households net-producer of maize three different dummy variables as follows:

$$FS_{h,t} = \alpha_h + \gamma_t + \alpha_h * t + \phi_1 OusideVC_{h,t} + \phi_2 Upstream_{h,t} + \phi_3 Downstream_{h,t} + \boldsymbol{\delta} X_{h,t} + \epsilon_{h,t} \tag{2}$$

The ϕ are the main coefficients of interest:

1. $OutsideVSC$ is a dummy for selling maize *only* to local consumers (outside

[3]The first lies in the arbitrariness of the normality and homoscedasticity assumption. The second is the inconsistency of the maximum likelihood estimator for the panel probit whit fixed effects when the number of time periods is small and the number of individuals is large (See Chamberlain, 1984).

[4]To consider other dimension of food security, we also use the number of meals per day, the HDDS and a dummy for whether the household did not have enough food for the members' needs in the past 12 months. The results are available upon request.

the VC)

2. *Upstream* is a dummy for selling maize to local traders and (possibly) local consumers (inside the VC with an upstream position)

3. *Downstream* is a dummy for selling maize to district traders and (possibly) local traders and consumers (inside the VC with a downstream position, i.e., closer to the final market/exports).

If we reject H(0): $\phi_1 = \phi_2 = \phi_3 = 0$, heterogeneous supply chain participation impacts on household food security. Specifically, in equation (2), ϕ_2 and ϕ_3 explain how the VC position (downstream or upstream) contribute to the participation effect.

We acknowledge the empirical evidence of households' multi-level strategy (i.e., selling maize to different partners) by let the treatment be a time variant combination of different markets access. Practically speaking, instead of having a single binary treatment, we classify the households by different treatment according to the chosen selling strategy within the available ones.

To test the presence of heterogeneity in food consumption according to household supply chain participation we control for: observable farmer characteristics changing with time; heterogeneity time invariant - exploiting the panel dimension - and linear time-varying heterogeneity - using a time-trend which is specific for each household. For example, we control not only for household ability which can explain both why an household sells maize to different partners and its level of food security, but also for household experience linearly changing in time.

One relevant implication of this demeaned specification is that it only identifies the effect of variable that change in time though the movers (namely those who have different variables' values over time). In terms of our main regressors, this means that the effect of VC participation and position is estimated by exploiting the time-variation of the observations that change their commercial partners over years.

Finally we take into account self-selection into VC participation and position based on farmer characteristics and maize inputs. In doing so, we estimate the predicted probability of selling maize inside the VC, upstream and downstream and we include them as control respectively in equation (1) and equation (2). This is an exploratory approach in order to combine the panel analysis with a method for controlling the selection on observable characteristics used in the impact evaluation literature. Contrary to the latter, we do not impose the "common support" of the predicted probabilities to avoid to restrict the sample size[5].

Furthermore, our empirical analysis investigates the households' exposure to shocks to test whether the heterogeneous participation in the maize VC is associated with a diverse variability in the farmer households' food security too. With this aim we estimate the models (1) and (2) by using as outcome variable the squared mean difference of (log) food consumption per capita.

3.2 Results

Before looking at the results of the main empirical models, some interesting patterns emerge from table 3. It reports the results of the probit model used to estimate the probabilities of participation to VC, downstream and upstream (the dependent variable changes as indicated in the column headings) on maize inputs and farmer characteristics. First, hired labour is the input which has the strongest effect on the probability of selling maize inside the VC compared to selling maize only outside the VC. Also the quantity of harvested maize[6] has a positive effect on the probability of selling inside the VC. On the other hand, hired labour and maize acreage are correlate with a higher probability of selling maize inside the VC with a more downstream position. Second, farmer characteristics and year dummies do not play a relevant role in explaining VC participation and position. Finally, the location dummies are strongly correlated with the VC probabilities. Living in Central and East regions increases the probability of selling maize inside the VC. As showed in figure 2, these regions are those more likely to export to Kenya, the main importer of Ugandan maize. Second, living in East increase the probability of selling upstream while living in North decreases it. Finally, living in Central and North increases the probability of selling downstream.

[5]This can be been done as robusteness

[6]Fafchamps and Vargas Hill (2005) find that Ugandan farmers producing coffee are more likely to sell it to the market when the quantity sold is large.

[Table 3 here]

Table 4 reports the outcome of the above identification strategy on the effects of VC participation and position on household food consumption. Results on the effects of VC participation are shown in columns 1-3 by increasing the order of complexity. The first column only includes the VC regressor; the second column adds some control variables and the third one controls for the predicted probability of selling inside the VC (estimated as described above). Results on the effects of VC position are shown in columns 2-6 with the same differences in terms of specification (without controls; with control variables; with predicted probabilities). Table 5 follows the same structure in assessing the effect of VC participation and position on the variability of food consumption.

[Table 4 here]

In table 4 column 3, which includes all the above controls (households and time varying fixed effects) shows a very good fit of the per capital food consumption at the household level. Notwithstanding this strong predictive ability of the full specified model and its clear ability to explain both observable and unobservable determinants of heterogeneity in households food consumption, it is evident that the households' participation keeps its significance in explaining heterogeneity in households consumption. More specifically, Ugandan households that participate to the maize VC register, on average and ceteris paribus, a per capita consumption which is 23 percentage points higher than farmer households out of the chain. The main difference between column 2 and 3 is that the former does not control for selection based on maize inputs and characteristics. Column third offers an exploratory approach to control for it by adding the predicted probability of selling inside the VC estimated as described above. This predicted probability is not statistically significant. The participation to VC may be driven by unobservable heterogeneity not captured by the probit model[7]. This aspect needs further investigation.

In terms of position, in column 6 downstream dummy has not a statistically significant effect while selling upstream results in a 24 percentage points increase in

[7]On the other hand, sine the panel model controls for fixed effects, also the predicted probabilities are demeaned. This may help in partially controlling for fixed heterogeneity in selection

household consumption. Accordingly, the gains in VC participation are explained by upstream position. A possible explanation can be the fact that the survey only includes three years. During the consider period, the gains from selling to district trader may be negatively affected by external factors, as the drop of maize export in 2010, mainly driven by the drop in import demand from Kenya (Ahmed and Ojangole, 2014). Furthermore, since this specification identifies the coefficient of interest though the movers, some issue may arise if farmer households change their commercial partners over years accordingly to year-specific effects. This may be the case if, for example, farmer households that were selling maize downstream in 2009, decide to not sell downstream in 2010 due to year-specific effects[8].

Table 5 reports the outcome of the same identification strategy, testing this time the impact of maize farm households selling strategy on exposure to food consumption shocks (proxied by the squared mean difference of household per capita consumption). As it is apparent from the table column 3, which includes the usual controls and shows that the households' participation in the Ugandan maize VC has also an impact on the exposure to shocks. Specifically, the more households participate, the lower is, all other things being equal, the volatility of their per capita consumption. In terms of position (column 6), selling upstream, that is further away from the final market/export, lowers the volatility of consumption[9].

[Table 5 here]

4 Conclusions

Using household data from Uganda, we have examined whether participation and position within maize VC affect farmers' food consumption.

To test the presence of heterogeneity in food security according to household supply chain participation we control for: observable farmer characteristics changing with time; heterogeneity time invariant and linear time-varying heterogeneity.

[8] In table 8, we test whether selling maize downstream at t-1 and not at t (column 1); selling maize downstream at t and not at t-1 (column 2); both (1) and (2) (column 3); are correlated with the year dummy 2010. Summary statistics on the movers are presented in tables 7 and 9.

[9] As in table 4, the differences between columns 2 and 3 and 5 and 6 should be interpreted with caution.

Finally we take into account self-selection into VC participation and position based on farmer characteristics and maize inputs.

The paper finds some evidence that farmers' food consumption is affected by selling maize inside the VC with respect to selling only outside it. The results are suggestive that the gain from participation is driven by selling maize upstream in the VC.

References

[1] Ahmed M. and Ojangole S., 2014. Analysis of price incentives for maize in Uganda, Technical notes series, MAFAP, FAO, Rome.

[2] Balat J., Brambilla I. and Porto G., 2009. "Realizing the gains from trade: export crops, marketing costs and poverty", in *Journal of International Economics* 78, 21-31.

[3] Chamberlain, G., 1984. "Panel data", in Z. Griliches und M.D. Intriligator, Ed. *Handbook of Econometrics*, Vol.II, Ch.22, North-Holland, Amsterdam.

[4] Fafchamps M. and Vargas Hill R., 2005. "Selling at the farmgate or traveling to the market", in *American Journal of Agricultural Economics* 87(3), 717-734.

[5] ICG, 2003. "Analysis of the maize supply chain in Uganda. Final Report", Kampala, Uganda.

[6] IFPRI, 2008. "Value chains for staple food crops in Uganda: impediments and options for improvement", Uganda Strategy Support Program Brief No.2, Kampala, Uganda.

[7] Magrini E. and Montalbano P., 2012. "Trade openness and vulnerability to poverty: Vietnam in the long-run (1992-2008)", University of Sussex WP N.35-2012.

[8] Niimi, Y., Vasudeva Dutta, P., and Winters, L.A., 2007. "Trade liberalization and poverty dynamics in Vietnam", in *Journal of Economic Integration* 22(4), 819-51.

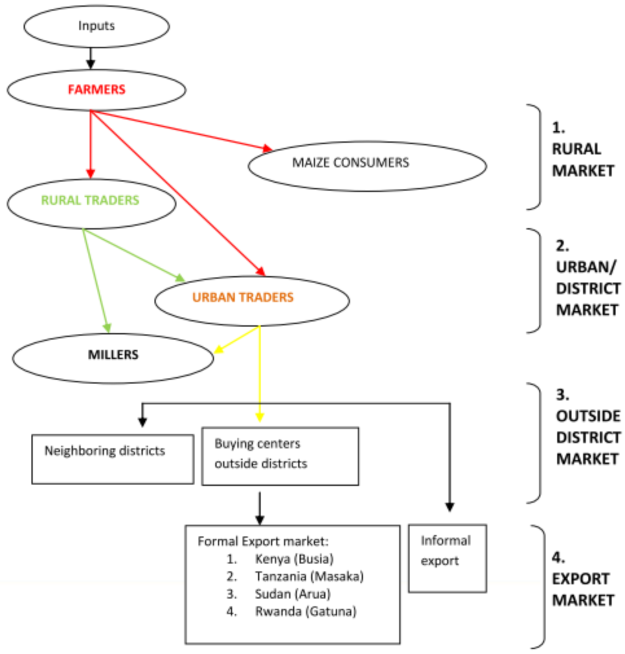
[9] Porto, G., 2006. "Using survey data to assess the distributional effects of trade policy", in *Journal of International Economics* 70, 140-160.

[10] Porto, G., Depretis Chauvin, N. and Olarreaga, M., 2011. Supply chains in export agriculture, competition and poverty in sub-Saharan Africa. The World Bank and The Centre for Economic and Policy Research Publication.

[11] USAID, 2010. "Market assessment and baseline study of staple foods. Country report Uganda", USAID.

[12] Winters, L. A., 2002. "Trade Liberalization and Poverty: What Are the Links?", in *The World Economy* 25, 1339-1367.

Figure 1: The maize VC in Uganda



Source: Elaboration of the authors from ICG (2008), IFPRI (2008), Ahmed and Ojangole (2014)

Table 1: Household by VC participation and position in Uganda LSMS-ISA pooled sample of maize net-producers 2009/12

	Number of households	
Tot. households	8,541	
Farmer households producing maize	4,695	
Net-producer of maize, selling:	1,832	
1. *only* to district trader	128	
2. to local consumers *and* to district trader	38	
3. to local trader *and* to district trader	73	**Downstream: 245**
4. to local consumers *and* trader *and* to district trader	6	
5. *only* to local trader	1,131	**Upstream: 1,262**
6. to local consumers *and* to local trader	131	
7. *only* to local consumers	325	**Outside the VC: 325**

Table 2: Summary statistics of households selling maize only outside of VC (325), upstream (1,262) and downstream the VC (245) in the pooled sample

	Mean values		
	Only outside the VC	Upstream	Downstream
Household Food security			
(log) Food Cons pc	12.376	12.380	12.454
	(0.779)	(0.733)	(0.609)
Squared difference of (log) food cons	0.173	0.163	0.136
	(0.616)	(0.412)	(0.297)
N.meals per day	2.514	2.537	2.519
	(0.603)	(0.585)	(0.586)
Food shock	0.238	0.270	0.326
	(0.426)	(0.444)	(0.470)
HDDS	6.648	6.814	7.217
	(2.263)	(2.063)	(1.853)
Characteristics of maize production and sale			
Maize acreage	1.174	1.095	1.356
	(1.144)	(1.016)	(1.001)
Use of pesticides (dummy)	0.037	0.116	0.174
	(0.189)	(0.321)	(0.380)
Use of fertilizers (dummy)	0.012	0.040	0.054
	(0.110)	(0.197)	(0.226)
Use of improved seeds (dummy)	0.138	0.188	0.260
	(0.346)	(0.391)	(0.440)
Hire labor (dummy)	0.369	0.461	0.545
	(0.483)	(0.499)	(0.499)
Transport cost (UShs)	886.259	2,691.153	6,840.120
	(7,543.133)	(31,089.450)	(26,104.640)
Harvested maize (Kg)	1,898.435	3,269.049	3,902.799
	(3,189.155)	(6,420.443)	(6,730.110)
Consumed maize (Kg)	705.624	920.989	881.732
	(998.781)	(2,253.267)	(1,386.008)
Sold maize (Kg)	1,043.129	1,751.885	2,316.673
	(2,787.349)	(3,129.768)	(3,795.620)
Unit price (UShs per Kg)	764.595	803.293	1,125.877
	(2,847.338)	(2,894.757)	(3,134.366)
Characteristics of farmer households			
HH size	6.326	6.635	6.950
	(2.853)	(3.176)	(3.273)
Female HH head	0.163	0.156	0.095
	(0.370)	(0.363)	(0.294)
Married HH head	0.785	0.797	0.888
	(0.412)	(0.402)	(0.316)
Age HH head	46.400	45.893	44.021
	(14.700)	(14.479)	(13.293)
Average years of education	4.242	4.504	4.489
	(2.250)	(2.426)	(2.439)
Electricity	0.016	0.029	0.038
	(0.124)	(0.168)	(0.191)
Improved water	0.745	0.714	0.729
	(0.437)	(0.452)	(0.445)
Location dummies			
Center	0.123	0.256	0.331
	(0.329)	(0.437)	(0.471)
East	0.194	0.336	0.178
	(0.396)	(0.473)	(0.383)
North	0.378	0.187	0.380
	(0.486)	(0.390)	(0.486)
West	0.305	0.221	0.112
	(0.461)	(0.415)	(0.315)

Standard deviation in parenthesis.

Table 3: Probit of VC participation and position on maize inputs and farmer characteristics

	(1) Selling inside the VC	(2) Upstream	(3) Downstream
Maize inputs			
Use of fertilizers	0.129	-0.0262	0.0611
	(0.269)	(0.187)	(0.205)
Use of pesticides	0.336*	0.0101	0.154
	(0.174)	(0.122)	(0.134)
Hire labour	0.177**	0.0304	0.182**
	(0.0803)	(0.0701)	(0.0857)
Use of improved seeds	0.0313	-0.0395	0.0696
	(0.107)	(0.0888)	(0.101)
(log) harvested maize (Kg)	0.139***	0.0629*	0.0475
	(0.0385)	(0.0331)	(0.0399)
(log) Maize acreage	-0.0355	-0.105***	0.131***
	(0.0429)	(0.0380)	(0.0491)
Farmer characteristics			
(log) HH size	0.0217	-0.0285	0.0997
	(0.0752)	(0.0665)	(0.0849)
(log)Age of HH head	-0.192	0.0152	-0.247*
	(0.122)	(0.108)	(0.134)
(log) Average education	-0.108	-0.00705	-0.107
	(0.0703)	(0.0600)	(0.0718)
Electricity	0.0897	0.0450	0.0407
	(0.264)	(0.207)	(0.235)
Improved source of water	-0.0318	-0.0613	0.0512
	(0.0906)	(0.0788)	(0.0968)
Location and year dummies			
Central	0.525***	0.140	0.459***
	(0.127)	(0.108)	(0.140)
East	0.465***	0.435***	-0.0482
	(0.112)	(0.101)	(0.139)
North	-0.0830	-0.423***	0.675***
	(0.102)	(0.0951)	(0.127)
Year 2009	0.171	0.0264	0.129
	(0.121)	(0.103)	(0.120)
Year 2010	0.0151	0.0810	-0.167
	(0.116)	(0.101)	(0.125)
Constant	0.405	-0.0262	-1.007*
	(0.541)	(0.476)	(0.588)
Observations	1,668	1,668	1,668
Log-likelihood	-708.996	-973.089	-613.375
Chi-squared	116.84	117.41	104.01
p-value of Chi-squared	0.000	0.000	0.000
pseudo R-squared	0.076	0.056	0.078

The excluded location dummy is West.
The excluded year dummy is 2011.
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Panel regression of (log) Food Consumption pc on VC participation and position

	Partipation			Position		
	(1)	(2)	(3)	(4)	(5)	(6)
Selling maize inside the VC	0.260*	0.234*	0.239*			
	(0.136)	(0.129)	(0.129)			
Upstream				0.275**	0.244*	0.248*
				(0.137)	(0.130)	(0.130)
Downstream				0.153	0.179	0.147
				(0.180)	(0.166)	(0.165)
(log) HH size		-0.838***	-0.758***		-0.844***	-0.808***
		(0.197)	(0.203)		(0.198)	(0.208)
Female HH head		-0.177	-0.166		-0.177	-0.167
		(0.167)	(0.166)		(0.168)	(0.167)
Married HH head		0.0281	0.0627		0.0191	0.102
		(0.700)	(0.695)		(0.702)	(0.701)
(log) Age of HH head		-0.0906	-0.167		-0.0576	-0.0659
		(0.723)	(0.718)		(0.728)	(0.725)
(log) Average education		-0.0699	-0.141		-0.0775	-0.129
		(0.164)	(0.166)		(0.165)	(0.170)
Electricity		1.671	1.646		1.721	1.909
		(1.264)	(1.267)		(1.271)	(1.301)
Improved source of water		0.143	0.206		0.141	0.183
		(0.137)	(0.141)		(0.138)	(0.143)
Year 2010	-0.493***	-0.486***	-0.497***	-0.500***	-0.492***	-0.418***
	(0.0572)	(0.0588)	(0.0592)	(0.0578)	(0.0598)	(0.115)
Probability of selling inside the VC			-0.811			
			(1.054)			
Probability of upstream						-1.512
						(1.419)
Probability of downstream						0.0258
						(1.109)
Constant	-203.6***	-155.3***	-104.0	-201.5***	-151.0***	-70.62
	(35.74)	(55.06)	(66.80)	(35.83)	(55.79)	(77.61)
Observations	1,778	1,654	1,641	1,778	1,654	1,641
R-squared	0.945	0.963	0.964	0.945	0.963	0.964
Adj R-squared	0.379	0.532	0.540	0.379	0.529	0.537

All the specifications control for household fixed effect, household fixed effect * year trend and location dummies.
The excluded category of specifications (1)-(6) is selling maize ONLY outside the VSC.
The excluded year dummies are 2009 and 2011.
The exclusion of n-2 dummies is due to the presence of HH specific year trends.
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Panel regression of squared mean difference of (log) Food Consumption pc on VC participation and position

	Partipation			Position		
	(1)	(2)	(3)	(4)	(5)	(6)
Selling maize inside the VSC	-0.325***	-0.168*	-0.175*			
	(0.114)	(0.0876)	(0.0887)			
Upstream				-0.331***	-0.164*	-0.174*
				(0.115)	(0.0887)	(0.0891)
Downstream				-0.282*	-0.190*	-0.173
				(0.151)	(0.113)	(0.113)
(log) HH size		0.0501	0.0491		0.0478	0.0854
		(0.134)	(0.140)		(0.135)	(0.143)
Female HH size		0.111	0.107		0.111	0.112
		(0.114)	(0.115)		(0.114)	(0.114)
Married HH head		0.188	0.168		0.184	0.0988
		(0.476)	(0.479)		(0.478)	(0.481)
(log) Age of HH head		0.178	0.178		0.191	0.133
		(0.492)	(0.495)		(0.495)	(0.498)
(log) Average education		0.0920	0.110		0.0890	0.0816
		(0.112)	(0.114)		(0.112)	(0.117)
Electricity		-0.465	-0.521		-0.445	-0.763
		(0.859)	(0.873)		(0.865)	(0.893)
Improved source of water		-0.0557	-0.0614		-0.0565	-0.0415
		(0.0934)	(0.0971)		(0.0938)	(0.0982)
Year 2010	0.101**	0.0952**	0.0951**	0.104**	0.0930**	0.00309
	(0.0478)	(0.0400)	(0.0408)	(0.0485)	(0.0407)	(0.0790)
Probability of selling inside the VSC			0.337			
			(0.726)			
Probability of upstream						1.324
						(0.974)
Probability of downstream						-0.305
						(0.761)
Constant	5.765	-31.75	-49.72	4.912	-30.02	-84.52
	(29.92)	(37.44)	(46.04)	(30.06)	(37.96)	(53.30)
Observations	1,778	1,654	1,641	1,778	1,654	1,641
R-squared	0.895	0.947	0.948	0.895	0.947	0.949
Adj R-squared	0.177	0.334	0.332	0.183	0.329	0.332

All the specifications control for household fixed effect, household fixed effect * year trend and location dummies.
The excluded category of specifications (1)-(6) is selling maize ONLY outside the VSC.
The excluded year dummies are 2009 and 2011.
The exclusion of n-2 dummies is due to the presence of HH specific year trends.
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

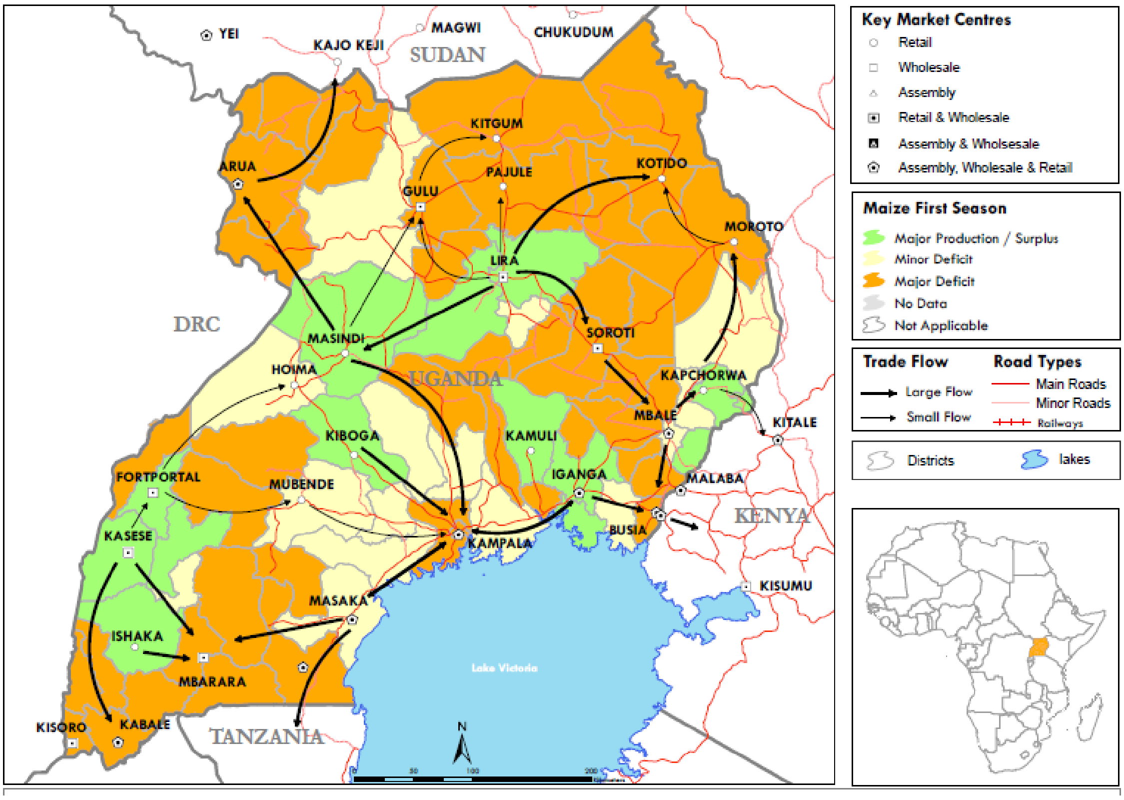
APPENDIX

Table 6: Summary statistics of Net-producer (1,832) versus Net-consumers (3,133) households in the pooled sample

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Variable	Obs.	Mean	St.dev.	Mean net-producer	Mean net-consumer	Diff. net-prod.-net-cons.
Household food security						
Food consumption pc	4543	12.334	0.748	12.386	12.300	0.086***
N.meals per day	4613	2.465	0.615	2.530	2.423	0.107***
Food shock	4612	0.322	0.467	0.272	0.355	-0.083***
HDDS	4628	6.585	2.143	6.828	6.427	0.401***
Characteristics of maize production						
Maize acreage	4669	1.050	1.046	1.137	0.993	0.143***
Use of pesticides	4669	0.069	0.253	0.109	0.043	0.066***
Use of fertilizers	4669	0.029	0.167	0.037	0.023	0.014***
Use of improved seeds	4669	0.163	0.369	0.189	0.146	0.042***
Hire labor	4669	0.363	0.481	0.455	0.304	0.152***
Transport cost	4669	1187.686	17444.380	2912.814	65.651	2847.163***
Harvested maize (Kg)	4669	1647.650	4218.748	3105.456	699.483	2405.973***
Consumed maize (Kg)	4669	629.461	1505.265	875.689	469.314	406.375***
Characteristics of farmer households						
HH size	4695	6.588	3.097	6.624	6.564	0.06
Female HH head	4695	0.191	0.393	0.149	0.218	-0.069***
Married HH head	4663	0.772	0.419	0.807	0.750	0.057***
Age HH head	4664	47.212	14.721	45.717	48.186	-2.470***
Average years of education	4598	4.056	2.257	4.180	3.976	0.204***
Electricity	4623	0.039	0.193	0.028	0.046	-0.018***
Improved water	4623	0.731	0.443	0.720	0.738	-0.018
Location dummies						
Center	4695	0.243	0.429	0.241	0.245	-0.004
East	4695	0.295	0.456	0.291	0.298	-0.008
North	4695	0.266	0.442	0.247	0.277	-0.030**
West	4695	0.196	0.397	0.221	0.179	0.042***

t-test is used to compares the means of the two subsample of households. In column (7), *** denotes statistical significance at 1%, ** denotes statistically significance at 5%, * denotes statistically significance at 10%.

Figure 2: Production and market flows map: Uganda maize



Source: USAID and FEWSNET (2013)

Table 7: Mover households

Type	N.hhs
(1) Selling downstream at t-1 and not at t	77
(2) Selling downstream at t and not at t-1	64
(3) Tot	141

Table 8: Probit of moving on year dummy 2010

	movers (1)	movers (2)	movers (3)
Use of fertilizers	-0.266	0.110	-0.0827
	(0.414)	(0.378)	(0.320)
Use of pesticides	0.0671	-0.0954	-0.0203
	(0.228)	(0.239)	(0.195)
Hire labour	0.323**	-0.160	0.124
	(0.154)	(0.165)	(0.130)
Use of improved seeds	0.0163	0.391**	0.220
	(0.170)	(0.185)	(0.146)
(log) harvested maize (Kg)	0.00241	0.0432	0.0368
	(0.0722)	(0.0784)	(0.0616)
(log) Maize acreage	0.106	-0.117	-0.00128
	(0.0774)	(0.0818)	(0.0641)
(log) HH size	-0.0354	0.175	0.0926
	(0.142)	(0.156)	(0.122)
(log) Age of HH head	-0.000490	-0.291	-0.173
	(0.237)	(0.262)	(0.203)
(log) Average eduction	-0.0256	0.121	0.0672
	(0.128)	(0.149)	(0.111)
Electricity	0.612	-0.393	0.240
	(0.523)	(0.624)	(0.472)
Improved source of water	-0.101	-0.144	-0.150
	(0.159)	(0.167)	(0.135)
Center	0.257	0.984***	0.719***
	(0.239)	(0.256)	(0.197)
East	-0.0700	0.160	0.0297
	(0.238)	(0.272)	(0.200)
North	0.662***	0.585**	0.743***
	(0.216)	(0.249)	(0.185)
Year 2010	0.268*	-0.665***	-0.176
	(0.146)	(0.167)	(0.123)
Constant	-1.579	-1.283	-1.050
	(1.061)	(1.163)	(0.903)
Observations	626	626	626

All control variables are expressed at t-1.
The first year for each observation is dropped.
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Summary statistics by type of movers

	movers (1)	movers (2)	movers (3)
(log) Food Consumption pc	12.429	12.627	12.516
Squared difference of (log) food consumption	0.251	0.221	0.238
N.meals per day	2.487	2.508	2.496
Food shock	0.184	0.159	0.173
HDDS	7.195	7.349	7.264
Maize acreage	1.221	1.795	1.482
Use of pesticides	0.221	0.203	0.213
Use of fertilizers	0.078	0.078	0.078
Use of improved seeds	0.234	0.141	0.191
Hire labor	0.506	0.484	0.496
Transport cost	1246.753	4812.500	2865.248
Harvested maize (Kg)	3333.879	4889.219	4039.849
Consumed maize (Kg)	905.568	785.053	850.866
Sold maize (Kg)	2089.955	2207.875	2143.479
Unit price (Ushs per Kg)	717.649	1961.400	1282.188
HH size	6.545	6.857	6.686
Female HH head	0.078	0.063	0.071
Married HH head	0.857	0.889	0.871
Age HH head	45.208	44.143	44.729
Average years of education	3.891	3.901	3.895
Electricity	0.026	0.032	0.029
Improved water	0.684	0.667	0.676
Center	0.299	0.484	0.383
East	0.182	0.141	0.163
North	0.390	0.266	0.333
West	0.130	0.109	0.121