Dairy farmers' access to market in Uganda: Observing the unobservable

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Abstract

Enhancing access to output markets for smallholder farmers is recognized as an effective tool for poverty reduction: the more smallholders produce and sell to the market, the higher their income and overall livelihoods. The underlying assumption, which is rarely spelled-out, is that market access represents a major incentive for smallholders to shift their production objective from subsistence to commercial, i.e. to set up sustainable businesses, be they either small or large, around their agricultural assets.

This paper relies on the Uganda 2011/12 National Panel Survey (NPS) to investigate the linkages between access to market and dairy farmers' self-reported subsistence and commercial production objectives. Market access, including both market participation and intensity of participation, is found to depend on a variety of observable farmers' characteristics. Market participation, however, does also depend on whether the farmer considers himself or herself as commercially-oriented. There are thus some unobservable characteristics, such as smallholder's risk attitude and willingness to invest in dairy, that influence farmer's decision to participate in markets, and that are difficult to capture using traditional household and farm level data. This makes it challenging for decision-makers to design and implement policies that utilize markets as a tool out of poverty.

Keywords: Smallholders, Dairy, Uganda, Market Access, Household Surveys, Heckman model

1. Introduction

Enhancing access to output markets for smallholder farmers is widely recognized as an effective tool for poverty reduction: the more smallholders produce and sell to the market, the higher their income and overall livelihood (AGRA, 2015; Commission for Africa, 2005; Olwande *et al.* 2015; Omiti *et al.*, 2009). The underlying assumption, which is rarely spelled-out, is that market access represents a major incentive for smallholders to shift their production objective from subsistence to commercial, i.e. to set up sustainable businesses, be they either small or large, around their agricultural assets.

The economic literature on access to market in developing countries, and elsewhere for that matter, provides hints on priority areas for investments for commercialising agriculture, i.e. for facilitating farmers' transition from subsistence to commercial. A partial list of variables that have been found to influence market access of smallholder farmers, and in particular dairy producers, include level of education, age and gender of the household head; household size; farm size; herd size; value of agricultural equipment; access to credit; access to extension services; years in dairy production; distance to market; membership in farmer groups; production level; and milk yield (Balgatas et al., 2007; Baltenweck and Staal 2007, Bardhan et al., 2012; Bellemare and Barrett, 2006; Holloway and Ehui, 2002; Omiti et al., 2009).

The literature, however, is not explicit on the commercial-orientation of smallholder farmers and it implicitly assumes that there is one-to-one or close relationship between access to market and farmers' commercial orientation. This, however, does not always hold true. First, there is evidence of smallholders' opportunistic utilization of markets, e.g. farmers selling surplus livestock products or live animals only for facing specific expenditures, such as paying medical or school fees (MAAIF, 2016). On the other hand, there is evidence that only a small sample of the population does have the characteristics to be an opportunity-entrepreneur, i.e. to tap into market opportunity and set up profitable and growing businesses. The majority of farmers are often referred to as "forced entrepreneurs": it is because the lack of alternative livelihood opportunities that they end up running small farms rather than because of their choice (Banerjee and Duflo, 2011).

This paper investigates the linkages between access to markets and smallholder production objectives by exploring whether Uganda dairy farmers who sell surplus milk to the market consider themselves as commercially oriented. This is an important development question: only farmers who utilize their agricultural assets more for business than for livelihood purposes, and who are thus fully responsive to price signals, are expected to exit poverty or considerably improve their livelihoods through market access (Banerjee and Duflo, 2011; World Bank, 2008).

The paper relies on the Uganda 2011/12 National Panel Survey (NPS), a nationally representative survey with a large focus on agriculture. The NPS includes a question on whether farmers sell their animal or livestock products for subsistence or commercial purposes. This provides an unprecedented opportunity to appreciate the correlation between farmer's market access and commercial orientation.

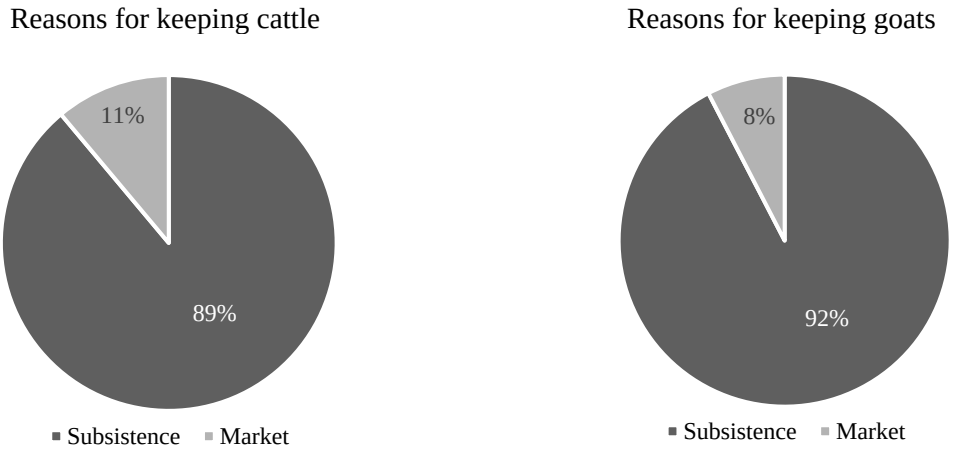
The article proceeds as follows. The next section discusses the challenge of commercializing agriculture in the Ugandan context, while section 3 describes the dataset and the methodology. Section 4 presents and discusses the main results: it first presents the differences between subsistence and commercial dairy farmers in rural Uganda and then investigates the factors affecting households' decision to participate in market and intensity of market participation. Concluding remarks are reported in section 5.

2. The challenge: commercializing livestock in Uganda

In Uganda, the agricultural sector accounts for 21% of GDP and employs about 72% of the population which denotes low productivity (GoU, 2015, UBOS, 2014a). The Government of Uganda considers thus agricultural development as one of the three so-called "growth priorities", along with tourism, and mineral, oil and gas (GoU, 2015).

The Uganda 2015/16 – 2019/20 Agricultural Sector Strategic Plan (ASSP) provides a framework for investments in agriculture. It prioritises the development of coffee, cotton, tea, maize, rice, beans, cassava, Irish potatoes, bananas, fruits and vegetables, meat, dairy and fisheries value chains (MAAIF, 2015). Promoting such value chains requires making input and output markets work so as to transform agriculture from subsistence to commercial, i.e. to ensure that farmers primarily produce for the market rather than for self-consumption.

This is a daunting task in a country where the largest share of livestock keepers consider themselves as subsistence-oriented. According to a 2016 report released by the Uganda Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) on the Smallholder Livestock Sector: "In general, livestock farmers are subsistence-oriented; only a minority regularly sell live animals and surplus livestock products to the market" (MAAIF, 2016). The MAAIF reports utilize the 2011/12 National Panel Survey data to differentiate livestock keepers between market- or commercially-oriented and subsistence-oriented – depending on whether the household reported to keep livestock for subsistence purposes or for selling live animals or livestock products to the market – and presents the below highlighting figure.



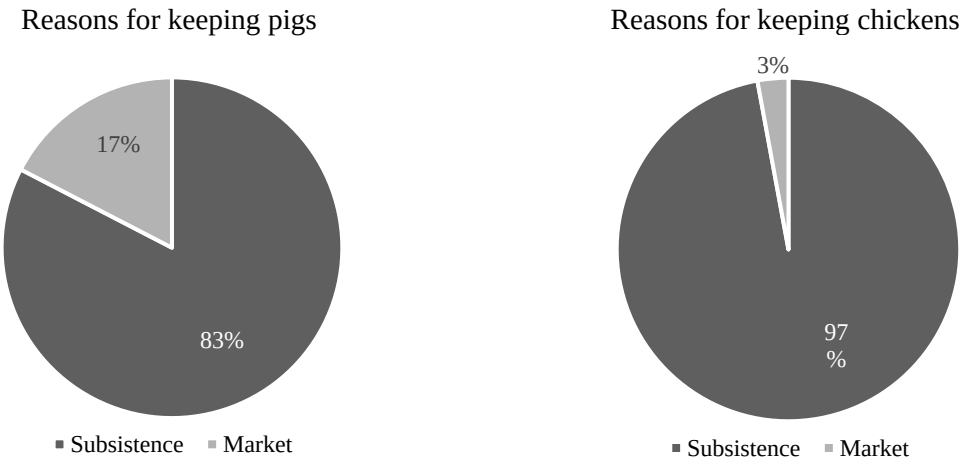


Figure1. Rural livestock farmers' stated reasons for keeping cattle, goats, pigs and chickens

Source: MAAIF (2016)

3. Data and methodology

3.1. Data

This paper relies on the 2011/12 Uganda National Panel Survey (UNPS) data. The UNPS is an integrated multi-topic survey that was first implemented by the Uganda Bureau of Statistics (UBOS) in 2009/10, and then in 2010/11, 2011/12 and 2012/13. Data are currently available for the first three NPS waves. The UNPS aims at producing annual estimates in key policy areas, and at providing a platform for assessing and experimenting with national policies and programs. It is carried out on a nationally representative sample of households over a twelve-month period for accommodating the seasonality associated with household consumption and agricultural production.

Starting from the 2011/12 NPS, the Uganda Bureau of Statistics (UBOS) has expanded the livestock section of the questionnaire. The latter currently includes about 90 livestock questions in three major domains: livestock ownership; livestock inputs and husbandry practices; and livestock outputs. The UNPS livestock dataset represents thus one of the largest datasets on livestock at household level available throughout Africa (MAAIF, 2016; UBOS, 2014b).

The 2011/12 UNPS data allow, for the first time ever to our knowledge, to better appreciate some of the characteristics that are associated with the commercial-orientation of livestock farmers. The survey, in fact, includes a question on whether farmers sell live animals or livestock products for subsistence or commercial purposes. We explore this issue for rural and urban dairy farmers, as milk is one of the agricultural products for which a regular, almost daily, access to market is critical for establishing profitable businesses.

After the process of data cleaning, the sample included 328 dairy farmers, who all produced some cow milk in the past 12 months. The sample included both rural dairy farmers (296 observations) and urban dairy farmers (32 observations).

3.2. Methodology

In the first step of data analysis we used descriptive statistics and cross tabulations to compare rural and urban dairy farmers, and between subsistence-oriented farmers and commercial ones. Mean (t-test), proportion (z-test), and Chi-square tests were applied to identify statistical differences between the groups.

In the second step of analysis, a Heckman (1979) two stage model was used to assess the determinants of dairy farmers' market participation. For the purpose of this analysis, market participation was represented as the average daily quantities (litre/day) of fresh milk sold. Market participation has a censored distribution and involves two decisions: (i) whether or not to participate in the market; and (ii) how much to sell conditional on having decided to be a market participant. Under these conditions, use of a Heckman two stage selection model rather than ordinary Tobit regression to evaluate determinants of market participation was favored, as the latter often yields parameter estimates that are biased (Bellemare and Barrett, 2005).

To model producers' decisions on whether or not to participate in markets, a Probit model was used. Denoting market participation as a dummy variable, Z_i which takes a value of 1 if the i^{th} producer decides to participate and 0 otherwise, the Probit model was formulated as follows:

$$Z_i = 1 \quad if \quad Z_i^* = W_i\gamma + u_i > 0 \tag{1}$$

$$Z_i = 0 \quad if \quad Z_i^* = W_i\gamma + u_i < 0$$

$$Prob(Z_i = 1|W_i) = \Phi(W_i\gamma)$$

Where:

Z_i^*: is an unobservable random variable representing utility derived from market participation

W_i: is a set of explanatory variables influencing market participation

γ: is a vector of parameters to be estimated

u_i: is a vector of stochastic error terms that follows a normal distribution $N(0,1)$

$\Phi(\cdot)$: is the standard normal cumulative distribution function

In the second stage of modelling (modelling the intensity of market participation), the quantity of milk sold was expressed as a function of a set of explanatory variables with the inverse of mills ratio (IMR) also included as a regressor in equation (2):

$$Y_i = X_i\beta + \tau\frac{\varphi(-W_i\gamma)}{1-\Phi(-W_i\gamma)} + \varepsilon_i \quad if \quad Z_i = 1 \tag{2}$$

Where:

IMR: is represented as $\frac{\varphi(-W_i\gamma)}{1-\Phi(-W_i\gamma)}$ and serves to correct for the bias attributable to non-use of observations where no sales had taken place.

φ: the normal probability density function

X_i: is a vector of explanatory variables influencing intensity of market participation

β_i: is a vector of parameters to be estimated

ε_i: is a vector of stochastic error terms and follows $N(0, \sigma_\varepsilon^2)$

τ: is an unknown parameter computed as $\rho_{\varepsilon u}\sigma_\varepsilon$ where $\rho_{\varepsilon u}$ is the correlation coefficient between the error terms ε_i and u_i

The two sets of explanatory variables (W_i *and* X_i) comprise mainly different variables. Explanatory variables (W_i) influencing market participation (equation 1) included: number of cows milked; distance to market; whether the farmer is subsistent or market oriented; share of non-farm income; whether the household owns a vehicle or not; and literacy of the household head. Explanatory variables (X_i) influencing market intensity (equation 2) included: distance to market; quantity of milk consumed; and number of household members of working age.

4. Results and discussion

4.1 Subsistence vs commercial dairy farmers: are they different?

Table 1 shows that 86% of dairy farmers consider themselves as subsistence-oriented and 14% commercially-oriented, while Table 2 indicates that 39% of all dairy farmers accessed markets for selling milk in the past 12 months, with clear differences both between rural and urban producers and commercial and subsistence-oriented producers.

Table 1. Subsistence vs commercial orientation of Ugandan dairy farmers

	Rural	Urban	All
Subsistence (%)	85.8	84.4	86.0
Commercial (%)	14.2	15.6	14.0

Table 2. Share of Ugandan dairy farmers selling milk

	Rural	Urban	All
Subsistence (%)	34.6	44.4	36.8
Commercial (%)	47.5	60.0	54.0
All (%)	36.5	46.9	38.5

The ensuing question is whether there are significant differences in key characteristics between commercial and subsistence oriented dairy farmers. Table 3 presents averages for selected household-, livestock- and market-related variables for rural dairy farmers. The literature has found these variables as possible determinants of market access, including market participation and intensity of market participation (Chamberlin and Jayne, 2013).

Table 3. Characteristics of subsistence and commercial rural dairy farmers

Household characteristics		
	Subsistence	*Commercial*
Age of HH Head (years)	50.7	48.2
HH size (number of members)	6.9	7.3
Female headed (%)	23.1	23.7
Household head able to read and write (%)	64.0	72.5
Herd size and composition		
	Subsistence	*Commercial*
Tropical Livestock Unit (TLU)***	3.8	5.8
Number of cattle owned***	6.4	10.2
Number of indigenous cows owned***	2.2	4.5
Number of improved / exotic cows owned	0.6	0.6
Number of cows milked	2.2	2.7
Milk production and sale		
	Subsistence	*Commercial*
Milk yield/day per indigenous cow (lit.)	2.1	2.5
Milk yield/day per improved/exotic cows (lit.)	3.6	3.4
Total annual milk production (lit.)	1133.0	1512.8
Quantity of milk sold per year (lit.)**	269.9	639.1
% of milk sold per year*	14.7	26.8
Market outlets, distance to market, and means of transport		
% selling to neighbour	46.0	47.4
% selling to consumers at market	31.0	26.3
% selling to trader	22.9	26.3
Distance to market (km)	33.3	32.9
Distance to main road (km)	7.7	10.4
% owning bike**	64.8	82.5
% owning motorbike	10.3	12.5
% owning motor vehicle**	3.1	10.0
Income and assets		
	Subsistence	Commercial
Total annual income ('000 UGX)*	3,318.1	4,060.3
Livestock income (% of annual income)**	31.8	19.1
Off-farm income (% of annual income)***	19.8	31.3
Value of assets owned ('000 UGX)***	17,100	47,500
Value of agricultural assets owned ('000 UGX)*	96.5	145.0

***, **, *: *statistically significant at 1%, 5% and 10% respectively*
In 2011/12, the UGX/US$ exchange rate was about 2,500

The table provides two interesting insights. First, many of the variables that the literature identifies as influencing market access are not significantly different between subsistence and commercially oriented dairy farmers. These include household-level variables, such as age and education of household head; production-related variables, with differences emerging not so much in production and productivity levels but only in the quantity and in the share of

milk sold; and market distance variables, including the distance to the main market and to the main road.

The second evidence is that commercially-oriented dairy keepers, while not being more productive than subsistence-oriented ones, have significantly larger cattle herds and are also better-off. Most notably, they have 4.5 indigenous cows vs 2.2 of subsistence-oriented dairy producers; they derive a significantly lower share of their income (19% vs 32%) form their livestock assets than subsistence-oriented producers; and their livelihoods depend significantly more on non-farm or non-agricultural income (31% vs 20%).

Taken together, these results suggest that market access, including market participation and utilization, is not necessarily sufficient to explain the commercial-orientation of dairy farmers, which is yet what matters to make agriculture commercial. They also confirm that commercially-oriented farmers are better off than subsistence-oriented ones, though the channels through which agricultural assets contribute to improve livelihoods are all but clear, as the former derive a significantly lower share of their income from non-agricultural activities than the latter.

4.2. Determinants of market access: looking beyond the observable

Table 4 shows the Heckman two stage model results. The model size was 313 observations (out of which 198 were censored) and the goodness-of-fit was statistically significant at the 1% level. The parameter "rho", which represents the correlation between the error terms in "market participation" and the "intensity of market participation" model equations was also statistically significant ($P<0.01$), justifying the use of Heckman's selection model over ordinary Tobit regression.

All the variables included in the market participation model are statistically significant (significance varied between 1% and 10% levels). As expected, the variables distance to market, and low educational level (literacy) of the household head have negative effect on the probability of market participation. The results also suggest that the more the household's livelihoods depend on non-farm income, the less is likely to participate in agricultural markets and highlight a negative correlation between ownership of a motor vehicle and market participation. A possible reason is that the richer the farmer, the less s/he derive income from agriculture, the less s/he participate in agricultural markets. The quantities of milk processed by the household into dairy products have a negative effect on market participation. This result was also expected since the dependent variable is the quantities of fresh milk sold. The more the household processes fresh milk into dairy products, the less fresh milk quantities remain to be sold. Unfortunately, the survey does not include a question related to the use of processed dairy products (consumed within the household or sold). As expected, the variable "number of cows milked" have a positive effect on the probability of market participation.

Table 4. Heckman's two-stage model: determinants of dairy farmers' market participation and intensity of participation

Variables	Market participation		Market intensity	
	Coefficient	Std.	Coefficient	Std.
Constant	-.5714***	.1574	4.277***	1.342
Number of cows milked	.2590***	.0239		
Quantities of milk processed into dairy products	-.5242***	.1505		
Distance to market	-.0090**	.0042	.0882***	.0311
Commercial orientation (1=yes; 0=no)	.3519*	.1924		
Share of non-farm income	-.3748*	.2034		
Household own vehicle (1=yes; 0=no)	-.4098**	.2116		
Literacy of household head (1=unable read &write; 0=other)	-.1742*	.1020		
Quantities of milk consumed			.7589***	.2159
Number of household labour			.4763**	.2410
/athrho	-2.2853***	.4865		
/lnsigma	2.0032***	.0995		
rho	-.9795	.0197		
sigma	7.4130	.7379		
lambda	-7.2611	.8365		
Log likelihood	-506.5			
Number of observations	313			
Number of censored observations	198			
Number of uncensored observations	115			
Wald chi2(3)	28.76***			
LR test of independence eqns. (rho = 0):	chi2(1) = 51.96***			

***, **, *: *statistically significant at 1%, 5% and 10% respectively*

Of particular interest is that market participation also depends on some farmer unobservable characteristics, as the dummy variable subsistence-market orientation is significant. Some farmers are therefore more likely to engage in markets and establish a business around their livestock assets because of their intrinsic characteristics, some characteristics that are difficult to capture using traditional household and farm level data. These can refer to as the Kenyan "animal spirits" (Keynes, 1936) that make farmers willing to "exploit market opportunity through technical and/or organizational innovations" (Schumpeter, 1965). Market intensity, on the other hand, is not influenced by the farmer's commercial orientation. This is plausible, as first the farmer's decide to participate in market with a subsistence or commercial orientation, and then allocates his/her resources efficiently to maximise his/her utility.

Factors found significant in influencing market intensity are: distance to market, quantities of milk consumed, and number of household labour. All three variables are statistically significant at 1% with positive coefficients' sign. An increase in the number household labour positively affects market intensity (quantities of milk sold) by, probably, increasing milk production and allocating more household time to look for different types of potential customers.

5. Conclusions

Enhancing access to output markets for smallholder farmers is recognized as an effective tool for poverty reduction: the more smallholders produce and sell to the market the higher their income and overall livelihoods. The underlying assumption, which is rarely spelled-out, is that market access represents a major incentive for smallholders to shift their production objective from subsistence to commercial, i.e. to set up a sustainable business around their agricultural assets. This is a key policy question, as only when this shift occurs households can exit poverty through their utilizing markets.

This paper relies on the Uganda 2012/13 National Panel Survey (NPS) to investigate the linkages between access to markets and smallholder dairy farmers' subsistence and production objectives, as reported by the farmers themselves. In the NPS, in fact, farmers are asked to report on their main use of livestock products, including for subsistence or for the market.

The determinants of market access, including market participation and intensity of participation, are consistent with the available literature. Market participation, however, is also found to depend on whether the farmer define himself/herself as commercially-oriented. There are therefore some unobservable characteristics, such as smallholder's willingness to be entrepreneurs and invest in dairy, that influence farmers' decision to participate in markets. These can be referred to as the Kenyan "animal spirits" (Keynes, 1936) that make smallholders willing to "exploit market opportunity through technical and/or organizational innovations" (Schumpeter, 1965). This evidence makes it challenging for decision-makers to design and implement policies that utilize markets as a tool out of poverty.

This preliminary evidence, which should be substantiated by additional research, suggests that governments and other stakeholders in developing countries should find ways to assess and take into consideration the existence of unobservable farmer characteristics when designing and implementing strategies and policies aiming at commercialising agriculture for poverty reduction.

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