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Market participation by smallholder rice farmers in Tanzania: a double hurdle analysis

Smallholder farmers account for over 90 per cent of domestic rice production in Tanzania. Their participation in markets provides opportunities for growth through income and employment. However, their ability to participate is hampered by personal, household and institutional constraints. We adopt the double hurdle model to explore determinants of market participation by rice farmers using data collected from selected rice growing regions in Tanzania. The decision to participate in the market is affected by the cropped area, yield, distance to the market and type of variety grown. Besides these factors, the quantity marketed is affected by the existence of a market within the village. There is need for labour-saving technologies for area expansion and yield improvement.

Keywords: average partial effects, rice marketing, developing country

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Introduction

Product marketing plays a key role in the process of agricultural development and in stimulating and extending development opportunities (Abbott, 1993). The increase in production of food crops requires effective demand from outside the farming area in the form of population growth or demographic change (von Braun *et al*., 1994). Such demand increases commodity prices. The importance of markets to smallholder farmers entails several facets: (a) households derive benefits such as income and open opportunities for rural employment (Dorward *et al*., 2003), and (b) marketing activities such as processing, transportation and selling provide avenues of employment for smallholder farmers willing to exit the farming sector (Jari and Fraser, 2009).

In spite of the market importance, a farmer's ability to take advantage of the existing market opportunities is highly dependent on personal and institutional factors. For instance, age can have a positive or negative effect on market participation: older farmers may be more concerned about food security while the young farmers may want to enhance the quality of their lives through participating in the market (Musah *et al*., 2014). Furthermore, households that have more dependants may be associated with higher levels of consumption, thus lowering their marketable surplus (Ehui *et al*., 2009). The gender of the household head can also affect market participation, with male headed households expected to participate more in the market (Reyes *et al*., 2012) while female headed households are less likely to participate in the market due to higher transaction costs of searching for buyers, contracting and enforcing of sales as compared to their male counterparts (Jagwe *et al*., 2010). Jaleta *et al*. (2009) find that household crop market participation is determined by the literacy level of the head of household and household's market orientation. Namazzi *et al*. (2015) further explain that literacy level of a farmer has a positive effect on the level of participation in the market as it determines how the farmer makes marketing decisions and interprets market signals. Makhura *et al*. (2001) and Gebremedhin and Jaleta (2010) find that distance to the market negatively influences both the decision to participate in the market and the proportion of output that is sold. Furthermore, Fafchamps and Hill (2005) show that wealthy farmers can sell their produce at distant markets given that they can afford high transport costs as compared to poorer farmers.

Despite the highlighted importance of marketing, key factors that can boost commercialisation of rice in the developing world are less well known, even in a situation where rice is recognised as a major cash crop.

The objective of this paper is to determine the key factors that affect smallholder farmers' decisions to market as well as those that affect quantities sold when they participate in the market. The study takes the case of the rice sector in Tanzania where there has been much emphasis on production but where pertinent marketing information is lacking. Rice is the second most important crop after maize and 90 per cent of all rice production is undertaken by smallholder farmers. Annual milled rice consumption is estimated at 25-30 kg per capita and the growth rate of rice consumption is estimated at an average of 4 to 7 per cent for the period 2007-2012 as a result of income growth, urbanisation and the perception of its ease of cooking and storage (MAFC, 2009; Stryker, 2013). Locally-produced rice has wider market potential as it is preferred to imported rice, especially due to its aromatic attributes.

Methodology

Marketing studies are plagued with the possibility of recording zero sales or purchases for certain commodities. These observed zeros are in some cases genuine corner solutions, for instance when some farmers decide not to participate in the market in an optimising behaviour. The outcome is continuous for other farmers in terms of the intensity of participation. Two distinct decisions are observed: a participation decision and a supply volume decision, also described as the extent of participation (which is measured in quantities). While some authors take these decisions as being simultaneous, implying that the same vector of parameters determines both decisions, other studies in the literature assume sequential decisions. In this case, the two decisions are determined by a different set of explanatory variables (Bellemare and Barrett, 2006).

The Tobit model (Tobin, 1958) is sufficient to accommodate the zero observed figures alongside other positive val-

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ues if simultaneity of decisions is assumed. The participation decision hence becomes irrelevant and the observed zeros imply that the producer does not participate in market. This limitation undermines the sufficiency of the Tobit model for empirical analysis. Cragg (1971) proposed a two-tiered process, namely the double hurdle model, which incorporates relevance of the participation decision to the Tobit model with the probability of participation and the intensity of participation being determined by separate processes. The idea behind the double hurdle model is looking at an event that may or may not occur. Occurrence of the event is associated with a continuous positive random variable while if the event does not occur, the random variable takes a value of zero. Such is the decision about market participation. It is guided by a latent variable model linking unobserved utility derived from market participation to the behaviour observed.

The individual's decision to participate in rice marketing can be represented by:

$$d_i^* = Z_i'\alpha + u_i \quad (1)$$

where d_i^* is a latent variable indicating whether or not the individual participates in marketing, α is a vector of unobserved parameters to be estimated, Z_i is a vector of observed independent covariates that explain an individual's decision and u_i is an unobserved error term capturing all other factors.

The extent of participation is indicated by:

$$y_i^* = X_i'\beta + v_i \quad (2)$$

where y_i^* is the amount marketed, X_i is a vector of covariates that explain this amount, β is a vector of unobserved parameters to be estimated and v_i is a random variable indicating all other factors apart from X. An individual will participate in marketing if $u_i > -(Z_i'\alpha)$ with the probability of observing the individual participate in marketing given as $P(u_i > -(Z_i'\alpha))$. The model gives room for possible differences between factors that affect participation $(u_i, Z_i'\alpha)$ and factors that affect extent of participation $(v_i, X_i'\beta)$.

The interaction between the two decisions leads to the following estimation for the model:

$$\left.\begin{array}{l} y_i = X_i'\beta + v_i \ \ if \ \ y_i^* > 0 \ \ and \ \ d_i^* > 0 \\ y_i = 0 \ \ otherwise \end{array}\right\} \quad (3)$$

While the double hurdle model provides us with an understanding of which factors affect each stage in the decision making process, Yen and Jones (1996) highlight its key limitation, namely that it decomposes the effects of the first hurdle onto the second hurdle while interpreting the results. Consequently, to understand the overall effect of explanatory variables in the first and second hurdles, we follow Burke's (2009) approach by incorporating the likelihood function and the partial effects of both hurdles in the calculation of the average partial effects (APE) of these variables and using bootstrapped standard errors.

For the variables that explain participation in the market and extent of participation, data were collected from seven major rice growing agroecological zones of Tanzania. Twenty one districts were proportionately sampled based on the 2002/03 and 2004/05 rice production data. About five villages were randomly selected from each district, and ten rice growing households were selected from each village giving a target sample size of 1040 smallholder farmers. After dropouts and missing data considerations and aggregation at the household level, the effective sample was 676 households.

Results

The results do not reveal any influence of personal characteristics on the decision to participate in the market or quantity of rice that is sold. Cropped area and yield positively affect the decision of the household to market rice, while growing an improved variety and distance to the market negatively affect decision to participate in the mar-

Table 1: Descriptive statistics of the non-marketing and marketing rice growing households surveyed in the study and maximum likelihood estimates of double hurdle model for market participation (total n=676).

Variable	Non-marketing (n=115)	Marketing (n=561)	ANOVA/ Chi-square	First hurdle (participation)	Second hurdle (quantity)
Paddy sold (tonne)	0	2.09 (2.07)	***		
Share of sold rice over production (%)	0	0.67 (0.26)	***		
Age (years)	43.7 (12.0)	44.5 (13.0)	NS	-0.04 (0.03)	0.10 (0.09)
Age squared				0. 00 (0.00)	-0.00 (0.00)
Gender of household head, HH (1=male)	0.83 (0.38)	0.81 (0.40)	NS	-0.24 (0.20)	-0.23 (0.56)
Marital status of HH (1=married)	0.81 (0.40)	0.82 (0.39)	NS	0.18 (0.20)	-0.59 (0.59)
Education (1=above primary)	0.17 (0.37)	0.12 (0.33)	NS	-0.19 (0.17)	0.64 (0.50)
Ecology (1=irrigated)	0.30 (0.46)	0.32 (0.47)	NS	0.15 (0.13)	-0.29 (0.39)
Cropped area (ha)	2.21 (2.23)	2.65 (2.23)	*	0.06 (0.03)**	0.94 (0.08)***
Variety grown (1=improved†)	0.29 (0.45)	0.22 (0.41)	NS	-0.28 (0.14)*	0.98 (0.42)**
Yield (tonne/ha)	1.17 (1.42)	1.41 (1.28)	*	0.11 (0.05)**	1.40 (0.13)***
Existence of market within the village (1=market exists)	0.28 (0.45)	0.29 (0.46)	NS	-0.06 (0.14)	0.97 (0.43)**
Distance to nearest market (km)	6.97 (12.57)	5.21 (6.81)	**	-0.01 (0.01)*	0.06 (0.03)**

ANOVA test is performed for continuous variables and Chi-square test is performed for categorical variables
*/**/*** statistically significant at the 10%, 5% and 1% levels respectively
NS: not significant
† Varieties classified as improved are TXD 306 (commonly known as SARO5), TXD 85, TXD 88, IR54, IR56, IR64, Improved ADRAO Nerica and Improved ADRAO non-Nerica while other 105 varieties were classified as non-improved.
Source: own calculations

ket. The quantity of rice sold is positively influenced by the cropped area, variety type, yield, existence of a market and distance to the market (Table 1).

The unconditional APE for continuous variables that were significant in affecting quantity of milled rice sold are shown in Table 2. For each additional hectare of cropped area, the sale of rice increases by 0.32 tonnes on average. The variable yield bears the expected sign with an increase of 1 tonne per hectare leading to an increase in the quantity of milled rice sold by 0.47 tonnes on average. Following this process however, distance is now found to be not statistically significant in affecting quantity of rice sold.

For the nominal and ordinal variables that affect quantity of rice sold, we compare the average values of milled rice by category in Table 3. Married household heads sell more rice than the non-married household heads. Male-headed households sell on average more rice than the female-headed households. The less-educated household heads sell more rice than the more-educated household heads. Smallholder farmers who grow rice on irrigated land also sell more on average than those who grow rice in rainfed lowland areas. When a market exists within the village, farmers sell more rice than when markets do not exist. The average rice marketed varies significantly only across the category of variety type with those growing improved varieties selling more rice.

Table 2: Unconditional average partial effects (APE) for factors affecting quantity of milled rice sold.

Variable	APE (bootstrapped S.E.)
Cropped area	0.32*** (0 .04)
Distance to market	0.01 (0.01)
Yield	0.47***(0.08)

*/**/*** statistically significant at the 10%, 5% and 1% levels respectively
NS: not significant
Source: own calculations

Table 3: Average rice sold in tonnes for nominal and ordinal variables.

Variable	Category	Average rice sold (S.D.)	ANOVA
Gender of HH	Male	1.75 (2.05)	NS
	Female	1.64 (2.02)	
Marital status	Married	1.77 (2.07)	NS
	Not married	1.58 (1.88)	
Education level	Primary	1.73 (2.05)	NS
	Above primary	1.71 (1.99)	
Ecology type	Irrigated	1.75 (2.14)	NS
	Rainfed lowland	1.72 (1.99)	
Variety grown	Traditional	1.64 (1.88)	**
	Improved	2.05 (2.48)	
Existence of market within the village	No market	1.69 (1.94)	NS
	Market	1.84 (2.26)	

** statistically significant at the 5% level
NS: not significant
Source: own calculations

Discussion

Our findings on the effect of land ownership on market participation corroborate those of Ohen *et al*. (2014) who found that households with more land have the capacity to cultivate more of the crop and expand their production to ensure adequate supply to the market. Farmers owning small farms may not be able to raise the necessary surplus to sell at the market. Furthermore, higher yields boost the farmer's likelihood to participate in the market because of the surplus above their household consumption needs. The novelty of our findings is that, contrary to popular belief that growing improved varieties can catalyse farmers to produce intentionally for the market, the reverse has been seen to be true. Indeed, growing improved rice varieties makes the farmer less likely to participate in the market, probably due to consumer preference for traditional aromatic varieties. Consumer preferences for specific rice types and qualities are often entrenched (Calpe, 2006), which limits the scope for substitution between different varieties.

When markets are perceived to be far, the farmer's decision to produce for the market is negatively affected. This is associated with the high transaction costs of selling in distant markets. Makhura *et al*. (2001) and Siziba *et al*. (2011) also found distance to market to have a negative and significant effect on both the farmer's decision to participate and the extent of farmer participation in the market. We would also expect a negative relationship between distance and the quantity sold, but our result shows the contrary. It may be that rice is sold in markets further away from the villages when the unit transport cost to travel is low, especially for wealthy farmers (Fafchamps and Hill, 2005). Moreover, farmers may not travel to the market if rice is bought from the villages by traders and millers. Indeed, Kilima (2006) indicates that much of the trade in rice is conducted by traders and not farmers. While moving from growing traditional to improved variety has a negative effect on the decision to participate in the market, once the first hurdle is crossed, this has a positive effect on the quantity sold to the market due to the higher yields attained from the improved varieties which translate into marketable surpluses for farmers. The higher yields imply the possibility to grow marketable crops (Smale *et al*., 1995).

The finding that cropped area and yield affect both the decision to market and the quantities that smallholder farmers actually sell is important as it supports the need for agronomic efforts to improve market-oriented rice production. Labour-saving technologies, such as tractors and power tillers, that can help farmers expand their cropped area are required. However, land expansion is not always achievable, especially where there are other demands on land such as expanding urban area and production of other crops. Rather, the yield enhancing practices can be more promoted, such as rice varieties that meet consumer preferences, and good agricultural practices, including the use of fertilisers and other inputs, that can help in increasing yield and thus enhancing market participation.

References

Abbott, J.C. (1993): Agricultural and food marketing in developing countries: Selected readings. Wallingford: CAB International.

Bellemare, M. and Barrett, C.B. (2006): An Ordered Tobit Model of Market Participation: Evidence from Kenya and Ethiopia, American Journal of Agricultural Economics **88** (2), 324-337. http://dx.doi.org/10.1111/j.1467-8276.2006.00861.x

Burke, W.J. (2009): Fitting and interpreting Cragg's tobit alternative using Stata. Stata Journal **9**, 584-592.

Calpe, C. (2006): Rice international commodity profile. Roma: FAO.

Cragg, J.G. (1971): Some statistical models for limited dependent variables with application to the demand for durable goods. Econometrica **39**, 829-844. http://dx.doi.org/10.2307/1909582

Dorward, A., Poole, N., Morrison, J., Kydd, J. and Urey, I. (2003): Markets, institutions and technology: Missing links in livelihoods analysis. Development Policy Review **21**, 319-332. http://dx.doi.org/10.1111/1467-7679.00213

Ehui, S., Benin, S. and Paulos, A. (2009): Policy options for improving market participation and sales of smallholder livestock producers: A case of Ethiopia. Paper prepared for the 27th Conference of the International Association of Agricultural Economists, Beijing, China, 16-22 August 2009.

Fafchamps, M. and Hill, R.V. (2005): Selling at the farmgate or traveling to market. American Journal of Agricultural Economics **87** (3), 717-734. http://dx.doi.org/10.1111/j.1467-8276.2005.00758.x

Gebremedhin, B. and Jaleta, M. (2010): Commercialization of smallholders: Does market orientation translate into market participation? Improving Productivity and Market Success (IPMS) of Ethiopian farmers project Working Paper 22. Nairobi: ILRI.

Jagwe, J., Machethe, C. and Ouma, E. (2010): Transaction costs and smallholder farmers' participation in banana markets in the Great Lakes Region of Burundi, Rwanda and the Democratic Republic of Congo. African Journal of Agricultural Research **6** (1), 1-16.

Jaleta, M., Gebremedhin, B. and Hoekstra, D. (2009): Smallholder commercialisation: processes, determinants and impact. Discussion Paper No. 18. Nairobi: ILRI.

Jari, B. and Fraser, G.C.G. (2009): An analysis of institutional and technical factors influencing agricultural marketing amongst smallholder farmers in the Kat River Valley, Eastern Cape Province, South Africa. African Journal of Agricultural Research **4** (11), 1129-1137.

Kilima, F.T.M. (2006): Are price changes in the world market transmitted to markets in less developed countries? A Case of sugar, cotton, wheat, and rice in Tanzania. IIIS Discussion Paper No. 160. Dublin: Trinity College Dublin.

MAFC (2009): National Rice Development Strategy, United Republic of Tanzania. Dar es Salaam: Ministry of Agriculture Food Security and Cooperatives.

Makhura, M.N., Kirsten, J. and Delgado, C. (2001): Transaction costs and smallholder participation in the maize market in the Northern Province of South Africa, in proceedings of the Seventh Eastern and Southern Africa Regional Maize Conference, Nairobi, Kenya, 11-15 February 2001, 463-467.

Musah, A.B., Bonsu, O.A.Y. and Seini, W. (2014): Market participation of smallholder maize farmers in the upper west region of Ghana. African Journal of Agricultural Research **9** (31), 2427-2435. http://dx.doi.org/10.5897/AJAR2014.8545

Namazzi, S., Ekere, W., Kyazze, F.B. and Bareeba, F. (2015): Determinants of participation of smallholder farmers in marketing of grain amaranth in Kamuli District, Uganda. Journal of Agricultural Economics and Development **4** (5), 075-082.

Ohen, S.B., Umeze, G.E. and Cobham, M.E. (2014): Determinants of market participation by cucumber farmers in Odukpani Local Government Area, Cross River State, Nigeria. Journal of Economics and Sustainable Development **5** (2), 188-196.

Reyes, B., Donovan, C., Bernsten, R. and Maredia, M. (2012): Market participation and sale of potatoes by smallholder farmers in the central highlands of Angola: A Double Hurdle. Selected paper prepared for presentation at International Association of Agricultural Economists Triennial Conference, Brazil, 18-24 August, 2012.

Siziba, S., Nyikahadzoi, K., Diagne, A., Fatunbi, A.O., Adekunle, A.A. (2011): Determinants of cereal market participation by sub-Saharan Africa smallholder farmer. Journal of Agricultural and Environmental Studies **2** (1), 180-193.

Smale, M., Heisey, P.W. and Leathers, D. (1995): Maize of the ancestors and modern varieties: the microeconomics of high-yielding variety adoption in Malawi. Economic Development and Cultural Change **43** (2), 351-368. http://dx.doi.org/10.1086/452154

Stryker, J.D. (2013): Developing competitive rice value chains, in M.C.S. Wopereis, D.E. Johnson, N. Ahmadi, E. Tollens and A. Jalloh (eds), Realizing Africa's Rice Promise. Wallingford: CAB International, 324-331. http://dx.doi.org/10.1079/9781845938123.0324

Tobin, J. (1958): Estimation of relationships for limited dependent variables. Econometrica **46**, 24-36. http://dx.doi.org/10.2307/1907382

von Braun J. and Kennedy, E. (1994): Agricultural commercialization, economic development, and nutrition. Baltimore MD: Johns Hopkins University Press.

Yen, S.T. and Jones, A. (1996): Individual cigarette consumption and addiction: a flexible limited dependent variables approach. Health Economics **5**, 105-117. http://dx.doi.org/10.1002/(SICI)1099-1050(199603)5:2<105::AID-HEC188>3.0.CO;2-I.