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The Nature of Agricultural Markets: Output Marketing in Tanzania

by

Basile Boulay

Abstract

This paper uses the three available waves of data from the Tanzanian National Panel Surveys to study different agricultural markets. We use crop level data to analyse the factors influencing farmers' choice between selling to market or retaining output for household consumption, allowing for market differences across crops. We estimate probit models for each wave and crop (or crop categories). Results show that there is not a homogeneous market for all crops, and the entrance decision is driven by different factors. Contemporaneous and lagged prices as well as use of storage facility are important variables that influence the decision to enter a market differently across crops. Entering the markets for subsistence crops such as maize or cassava can be the result of economic distress, supporting a 'forced commerce' hypothesis. The market for export crops responds to price and expectation mechanisms and is closer to the conception of agricultural markets in standard theory.

JEL Classification: Q12, Q13, R20, O13

Keywords: Agricultural economics, Tanzania, applied econometrics, crop sales

Centre for Research in Economic Development and International Trade, University of Nottingham

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Outline

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1. Introduction

Frequent national plans and strategies have been launched to stimulate the agricultural sector and intensify cultivations in Tanzania. Most plans since 2000 (such as the *Agricultural Sector Development Strategy, ASDS,* or the *Agricultural Sector Development Program, ASDP*), are part of a more encompassing national plan named *National Development Visions 2025*, which aims at transforming Tanzania into a semi-industrialised economy with a productive agricultural sector by that year (Leyaro and Morrissey, 2013).

Despite agriculture being officially at the top of the political agenda, there is no comprehensive study of national patterns of production and output marketing in Tanzania using the recent National Panel Surveys (NPS). This paper aims at bridging this gap by studying output marketing for the main crops and categories of crops in Tanzanian agriculture, using the three available NPS waves (2008/2009, 2010/2011 and 2012/2013). The analysis aims at determining the factors that push farmers to enter the market for particular crops (or category of crops). Probit models are estimated at the crop (category) level. The main contribution is to show that the nature of the markets fundamentally differs across crops, thus making the point that markets are institutional structures that vary across crops. In particular, it is shown that the *rationales* for entering the markets differ across crops, and that the socio-economic factors associated with selection into the market are not homogeneous. A key result is that there is no such thing as 'the' agricultural market. Rather, there are many agricultural *markets*, each shaped by particular specificities.

The structure of this paper is as follows: section 2 reviews the literature on the agricultural sector in Tanzania and historical evolution. Section 3 provides a methodological background to the question. Section 4 presents the data sources and explains the main challenges the data presents. Section 5 reports results on the determinants of entering the markets for different crops and goodness of fit analysis. Section 6 presents the main conclusions and directions for future work.

2. Agriculture in Tanzania

Agriculture has been at the centre of political strategies in Tanzania since independence in 1961. The signing of the Arusha Declaration in 1967 symbolised the consolidation of the party of the Revolution (CCM) and its charismatic leader Nyerere. The declaration stressed the virtues of self-reliance as opposed to dependence upon foreign aid (in particular by pervious colonial powers). Agriculture was the main channel Nyerere envisaged to achieve self-reliance. Referred to as *Ujamaa,* farming communities were created, often through (forced) villagisation policies, in order to foster specialisation and offer a more efficient resources provision.

Today, while it is generally recognized that *Ujamaa* did not meet expectations and had numerous negative side-effects, the 'agricultural question' is still central in Tanzania, and the sector is going through a prolonged period of stagnation. Following *Ujamaa* (and Nyerere's withdrawal of power in 1985), a period of structural adjustment and market-friendly reforms were implemented, with heavy involvement of the IMF and World Bank (despite the initial support to *Ujamaa* by the World Bank). The dismantling of parastatals, removal of price marketing boards, progressive removal of inorganic fertiliser subsidies, were all measures aimed at 'getting prices right' and providing farmers with the 'right' incentives that would stimulate productivity and specialisation. Whilst *Ujamaa* did not meet expectations, it is clear that liberalisation did not deliver what it promised either (Skarstein, 2005).

The literature on recent performance of Tanzanian agriculture is relatively scarce. The picture that emerges is that liberalisation has not lived up to its promises, at least not to the extent that it was expected to in the aftermath of *Ujamaa* policies. A useful recap of the timing of events is provided in Isinika et al (2011), with the 'shift' occurring in two stages: heavy *market reforms* during the 1980s to 'get the prices right', followed by a decade that reflected the growing importance in standard economics of 'getting the Institutions right', largely shaped by the work of New-Institutionalist economists. Thus, apart from the dismantling of parastatals and removal of input subsidies associated with market reforms, Institutional reforms were also implemented. A major cornerstone of those reforms was the Land policy of 1995 and Land laws of 1999, which stressed the 'intrinsic' value of land, thus taking the normative stance that land markets should exist. Ultimately, both market and institutional reforms aimed at increasing farmers' productivity through changing the incentives structure.

There is no consensus on the effects of adjustment, especially at the crop level. According to Bryceson (2010), the phase of liberalisation was beneficial for cotton and coffee in the 1990s, with harvests regularly exceeding historical averages. However, the performance of the export sector today is still below the performance of the 1960s when looking at the *per capita volume of exports*, particularly so for cashew nuts, an important crop. Production of maize, the main staple crop, was greatly affected by liberalisation. Skarstein (2010) and Isinika et al (2011) argue that the removal of fertiliser subsidies made supply less available in the traditionally maize-producing remote regions of the country (such as the Ruvuma or Rukwa regions). The outcome of this was a large shift in maize producing regions from the remote Central and Western regions towards either Central regions with strong commercial base (such as Dodoma), or towards Northern regions which have more fertile land for maize (such as Arusha). This is because, they argue, liberalisation fundamentally changed the structures of farming profitability because of the changing costs for inputs and transport. Skarstein (2010) reports that over 1985-1998 (i.e., the liberalisation period), maize production in per capita terms fell by 22.5%. McKay et al (1997) have argued that liberalisation did not deliver its promises for several reasons. The first is that the change in incentive structures supposed to promote exports mainly affected the manufacturing sector. Second, a crucial condition for liberalisation is that farmers should have access to inputs and credit. In the case of Tanzania, access to fertiliser clearly declined. Thirdly, fallacy compositions can arise if similar countries liberalise at the same time, creating increases in supply on world markets pushing prices down.

In this context, it was argued that liberalisation policies neglected certain elements that were needed for a successful transformation. In particular, access to credit, inputs, better infrastructure etc. were considered to be important factors that liberalisation had not delivered properly. This led to what Isinika et al (2011) refer to as 'policy reversal', which is somewhat misleading in the sense that the aim was to complement liberalisation rather than reverse back to pre-liberalisation policies. The main changes were the re-introduction of subsidies for inputs, which can be justified in both efficiency and equity grounds (Minot and Benson, 2009). A voucher input system was recently launched in 2008 as part of the public strategy for agricultural development. The NAIVS (*National Agricultural Input Voucher Scheme*) provided subsidies for maize and paddy rice in form of a 50% discount on fertiliser and seeds for farmers, conditional on them being able to 'top-up' the remaining 50% of the price (Malhorta, 2013). Another feature of liberalisation is that it has largely increased price volatility (Barret, 2008 and Skarstein 2010) for poor farmers. Barrett argues that liberalisation has pushed many farmers back into subsistence due to the large spot market price volatility.

As a result, one of the crucial features in today's agricultural sector is that output growth is largely driven by extensification rather than intensification. There is no evidence that fertiliser usage is increasing over time (if anything, slight decreases are observed). Growth seems to take place through land expansion (Kirchberger and Mishili, 2011). This expansion is usually carried through clearing patches of forest land, which are often not as fertile as arable land, and constitute a real ecological and livelihood issue for the country. Therefore, it is crucial to assess the potential for intensification in Tanzanian agriculture. Although referring to neighbouring countries, Jayne et al (2010) argue that the issue of land is very rapidly changing in East Africa due to population pressure, and that land should no longer be considered as an 'unlimited' factor as it has often been in the past. Looking at the Katoro-Buserere area in Northern Tanzania, Bryceson (2010) reports anthropological evidence of growing land scarcity and the emergence of a *landless* class of farmers, affecting young generations mostly.

In that context, it is crucial to understand what are the factors pushing farmers to enter (or refrain from entering) the market. While the production side must be studied to understand what determines production, the sales side must be studied to identify economic behaviour of farmers. Studying the latter is also highly relevant from a policy perspective, since price and non-price factors influencing market participation are key elements of any agricultural policy. In case of large differences in the *nature* of markets across crops, such differences must also be accounted for by policies.

3. Background and methodological issues

While production *per se* is determined by physical factors, it is generally accepted that selling this production is to a large extent based on farmers' characteristics (age, education etc.) as well as the economic environment (infrastructure, existence of a market nearby etc.). Therefore, it is often posited that *selection into the market* is non-random and depends on socio-economic characteristics of peasants, themselves associated to market failures. Farmers' education, access to capital and certain inputs, social capital and proximity with different networks are considered to be key determinants in farmers' participation in the market. As such, sales behaviour is often modelled as a sample selection issue, with a Heckman selection model. It is assumed that farmers *self-select into marketing output*.

From a theoretical perspective, selection into markets is often seen as a problem grounded in transaction cost theories. High transaction costs are associated with market failures, particularly in SSA countries. Many transactions fail to take place because of an array of causes related to these failures: poor infrastructures, little access to information, or credit constraints to name just a few. The conventional view in standard theory is that market failures inhibit farmers' ability to respond to incentives, in particular *price* incentives. De Janvry et al (1991) offer a classic account of this view on market selection. They argue that market failures in rural economies are household specific, rather than commodity specific (with labour being included as a 'commodity'). According to them, as market failures increase, the resulting price bands within which peasant households do not sell increase, thus reducing the likelihood for those households to enter the market: self-sufficiency becomes a more advantageous option than engaging in the trading of factors (labour) or goods (agricultural output). These price bands are an increasing function of the gap between the price at which peasant households can *sell* factors or goods and that at which they can *buy* them (i.e. as market failures increase).

Many empirical papers follow this theoretical approach of transaction costs affecting market participation. A good example is the paper by Heltberg and Tarp (2002), studying supply response of farmers in Mozambique. Following Key et al (2000), they argue that marketing output involves two types of costs: *fixed costs* and *variable proportional transaction costs*. While participation into the market (i.e., positive selection) is determined by both fixed and variable costs, the quantity supplied only depends on the latter. As a result, fixed transaction costs can be seen as the necessary exclusion restrictions needed in the selection equation of a Heckman selection model. According to Heltberg and Tarp (2002, p.107): *'Measures of distance and transport are expected to influence variable transaction costs, whereas information variables affect fixed transaction costs'*. As such, they consider the following variable transaction costs measures: a dummy for ownership of transport, and the log of distances to the nearest railway station and the provincial capital. For fixed transaction costs, they use a dummy variable for ownership of TV/radio/phone, the maximum education of head of household, and district population density.

Given available information in the Tanzanian surveys, the following related measures are constructed (population density at the district level is not available from the datasets):

For fixed transaction costs:

- Dummies for whether farmers frequently listen to the radio, and frequently read newspapers (coded as 0 if the answer is 'never' or 'a few times a year only', and 1 if the answer is 'several times a month' or 'almost every day').
- Educational level of household head.

For variable transaction costs:

- The (log) distance, in Km, to the closest market. Since the focus is at the crop level, this measure is the *average* distance across plots.
- A dummy for transport ownership (owning at least one of: bicycle, motorbike, motor vehicle).

Four additional 'exclusion restriction' variables are considered. Availability of improved seeds in the nearest village captures local level of technology and any commercial integration effect, with the village being part of trading networks. The presence of a farmers' cooperative within the village captures networks effects, informational effect and the possibility for farmers to gather information regarding marketing practices. It may increase bargaining power of small-holders who do sell their output; Barrett (2008) notes the recent resurgence of farmers' cooperatives, partly as a result of processes of liberalisation which often created large price volatility in output prices. The third variable is whether anyone in the household is member of a saving or credit group (the so-called 'SACCOS'). This is expected to have an ambiguous effect. On the one hand, this clearly implies better access to capital and formal saving/lending institutions, which may facilitate selection into marketing some crops. On the other hand, it could reflect the fact that the household is 'disengaging' from agriculture (or at least, from output marketing) relative to households in which no one is a member of a saving group. One possible reason is that members of saving groups may be individuals employed in a formal job living in a household less reliant on agricultural production than other households. Finally, whether a household uses a storage facility is considered. This may proxy knowledge about prices and account for expectation mechanisms. Each of these variables has a clear rationale for affecting selection into agricultural markets.

Heltberg and Tarp (2002) only considers *total* farm sales, and therefore does not account for crop specificities. In practice, it is of interest to understand which crops are easily marketable, which are not, and to see which factors for which crops may push farmers to participate in the market. For example, since some crops like cassava are typical of subsistence or 'back-up' farming practices, one should not expect access to capital or credit to be strongly linked with market participation. On the other hand, crops such as coffee, which are mainly exported, require a minimum level of integration into commercial network, as well as a certain degree of risk management, given that coffee trees need several years before they reach maturity and harvests can be realised. This implies that modelling selection at the aggregate level, while picking up the importance of some socio-economic characteristics, will miss on the interactions between those factors and the particularities of each crop (or types of crops).

Heckman selection models are not estimated here for a number of reasons. The main aim is to understand what drives farmers to market a particular crop. While Heckman models ask the question *"conditional on selection into the market, what influences the amount supplied by farmers?"*, the question of interest here is *"what are the factors that push farmers to enter the markets?"*. Too much attention in the literature has been given to quantity equations corrected for selection, without questioning in depth the *rationales* for entering markets. More importantly, it is implicitly assumed that 'the market' is a homogeneous institutional structure and that entering it is the natural result of commercial integration from the 'more efficient' farmers (as opposed to less efficient small-scale/subsistence farmers). This partly stems from the fact that papers often look either at aggregate agricultural outputs (thus blurring crop specificities) or only at a given crop category, usually cereals or maize.

The processes of selection should be given equal attention. Before estimating selection-corrected quantity equations, one should have an idea of the *nature* of the market for each crop. There is no a priori reason to assume that entering the market is the same process across crops. To reflect this, probit models are estimated for a large set of crops and categories of crops. For each wave, a probit model is estimated including (among others) the variables used by Heltberg and Tarp (2002) and the additional four variables mentioned above (cooperative, saving groups, improved seeds and use of storage). Note that since the focus is at the crop level, both sales and harvests are given at the crop/farm level (i.e., across plots). This allows identifying which factors influence farmers' decisions to sell output for which crops.

4. Summary statistics and estimation strategy

4.1. Summary statistics and data construction

The datasets used in this study come from the three available waves of data of the Tanzanian National Panel Surveys (NPS) for the years 2008/2009, 2010/2011 and 2012/2013. Despite the very rich information these datasets contain, their use has been relatively scarce so far. These surveys are representative of the national population and cover all regions. The NPSs are integrated household surveys, and as such, contain very detailed information on agricultural production for households involved in the agricultural sector. The agricultural questionnaire provides valuable information regarding farming practices, agricultural production, and different types of inputs. Appendix 1 provides details on data construction for the price and storage variables as well as some stylized examples explaining specific features of the data and detailed summary tables.

Most farmers do not market any of their agricultural output, indicating the possibility of widespread subsistence farming. Further, it seems that large differences in marketing behaviour are linked with the patterns of adoption of variable inputs (hired labour and chemical fertiliser). Farmers using variable inputs seem more likely to engage in marketing output than farmers not using any variable inputs. We therefore create the following 4 categories of farming households:

- Group 1: farmers not using any variable inputs. These are assumed to be households most engaged in subsistence farming and home-consumption of output. They represent the majority of farmers
- Group 2: farmers only hiring labour (i.e., not using chemical fertiliser)
- Group 3: farmers only using chemical fertiliser (i.e., not hiring labour)
- Group 4: farmers hiring labour *and* using chemical fertiliser

Descriptive statistics are presented below for wave 1 for the main variables for groups 1 and 4, which are the two groups expected to be most different from each other. Results for waves 2 and 3 are reported in appendix 1. The variable *seller* gives the proportion of households selling *at least* part of output for one crop (i.e., if a farmer grows 2 crops but only markets one, he is classified as a seller). This allows identifying the proportion of farmers engaged in *total subsistence* with no market interaction at all.

Table 1: summary statistics: gr.1 wave 1

	mean	sd	min	max
Harvest (kg)	309	632.5	1	8800
Surplus (%)	0.21	0.3	0	1
Seller (0/1)	0.74	-	0	1
Price (TS)	308	294.3	2	3000
Sales (kg)	136	627.6	0	15000
Sales (TS)	30574	104482.8	0	1.90e+06
Family (days)	95	93.0	0	760
Organic fert (kg)	39	181.3	0	2000
N	4681			

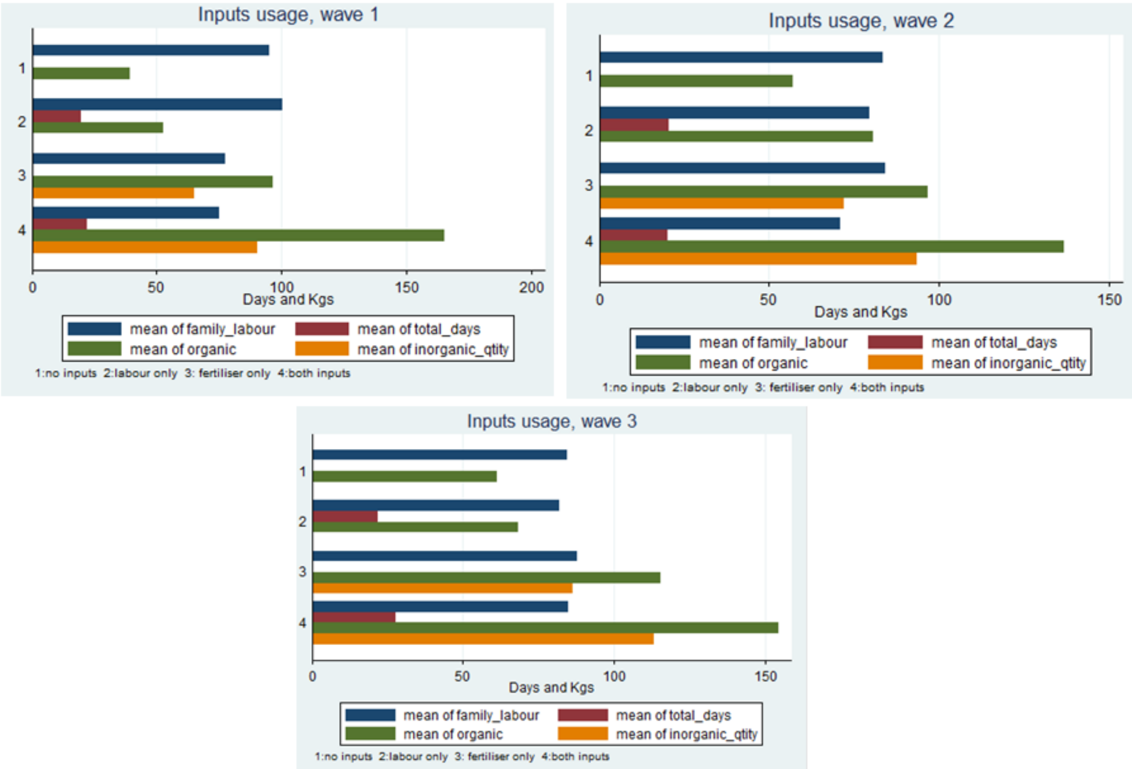
Table 2: summary statistics: gr4 wave 1

	mean	sd	min	max
Harvest (kg)	566	1018.4	1	9500
Surplus (%)	0.30	0.4	0	1
Seller (0/1)	0.82	-	0	1
Price (TS)	362	315.2	10	2500
Sales (kg)	508	3120.2	0	50880
Sales (TS)	1.09e+05	379319.5	0	3.41e+06
Family (days)	75	67.6	0	436
Organic fert (kg)	165	419.8	0	2000
Inorganic fert (kg)	90	128.3	1	800
Hired labour (days)	22	26.2	1	134
N	303			

These tables show that average harvest is much higher among group 4 than group 1 (83 % higher), which is expected. In terms of average farm-gate price, group 1 is clearly dominated in wave 1 (but experiences very strong increase in subsequent waves, see appendix 1). Although the surplus (the proportion of output which is marketed) is, as expected, higher for group 4 it is not markedly so. This may be a preliminary indicator that self-sufficiency in some crops can be an endeavour for farmers across groups. In wave 1, family labour is much more prevalent among farmers in group 1 (but this is not the case for wave 3, see appendix 1). An interesting variable to look at is usage of organic fertiliser, since it is often taken to be a proxy for animal power in the literature. These summary statistics show a very high gap between groups 1 and 4 regarding usage of manure. This may be a preliminary indicator that animal power (wealth) is much greater in group 4 than among farmers in group 1 (this effect is observed in all waves).

The set of graphs below plots usage of fixed inputs across groups and waves. The blue bar gives average number of days of family labour used per plot (fixed input), while the red one gives the number of days of hired labour per plot (variable input). The green bar shows the average amount or organic fertiliser used on a plot in Kgs (fixed input), while the orange bar gives the amount of inorganic fertiliser used on a plot in Kgs (variable input).

Graphs set 1: Inputs usage by waves and groups



The same picture does not emerge for the two fixed inputs. It is clear that organic fertiliser usage is increasing across groups in all waves, possibly reflecting the fact that as one move upwards across groups, farmers are less and less poor, which could be proxied by animal power. However, family labour seems to be much more prevalent across all groups. In wave 3, the mean appears very close across groups. One special feature of group 4 is that across waves it clearly dominates all other groups in terms of organic and group 3 in terms of inorganic fertiliser usage. On the other hand, note that there is not much difference between groups 2 and 4 in terms of hired labour.

Regarding farm size, two counteracting factors may influence its evolution over time. On the one hand, the (relative) absence of land market and reliance on customary law to allocate land in most regions may imply that farm size decreases over time because when households split land has to be reallocated between old and new households. On the other hand, there is a general trend of area expansion. In particular, there is now evidence that households expand their land by clearing patches of forest land to grow crops. Excluding farms over 100 acres, average farm size is 4.9, 5.7 and 6.1 acres for waves 1 to 3 respectively. Summary statistics by farmers groups reveal that this result holds even for group 1. This is interesting because the summary statistics tables show that average harvest is clearly declining over time. This can be explained by the fact that area expansion is made into patches of forest which have very poor soil fertility, reflecting a general trend of extensification rather than intensification.

However, the growth in farm size between waves 1 and 3 in group 1 has been much slower than that for group 4 (21% against 59%). This growth rate for group 4 is quite spectacular and suggests that very different patterns of land acquisition/accumulation may be at work across different groups/types of farmers.

4.2. Estimation strategy

Probit models can be conceptualised in terms of an unobserved latent variable y^* (in this case, this can be the 'net utility' outcome from a cost-benefit analysis of entering versus not entering a market). What we do observe is whether a farmer enters the market or not:

$$\begin{cases} y = 1 \; if \; y^* > 0 \\ y = 0 \; if \; y^* = 0 \end{cases} \qquad (\mathbf{1})$$

A set of factors contained in vector **x** are believed to influence the decision to sell or retain output, so that:

$$\begin{cases} P(Y = 1|\boldsymbol{x}) = F(\boldsymbol{x}, \beta) \\ P\;(y = 0|\boldsymbol{x}) = 1 - F(\boldsymbol{x}, \beta) \end{cases} \qquad (\mathbf{2})$$

In the case of a probit model, *F(.)* is the standard normal distribution, so that:

$$P(Y = 1|\boldsymbol{x}) = \Phi(\boldsymbol{x}'\beta) \qquad (\mathbf{3})$$

The model estimated is thus the following:

$$P(Y = 1|\boldsymbol{x}) = \Phi\;(\alpha + \beta_1 \log(harvest)_{ic} + \beta_2 \log(price)_{ic} + \beta_3 group_i + \beta_4 region_i + \boldsymbol{\gamma}\;\boldsymbol{input_i} + \boldsymbol{\delta}\;\boldsymbol{HH_i} + \theta\;distance_i + \varepsilon_{ic}) \qquad (\mathbf{4})$$

The dependent variable is a binary outcome equal to 1 if household *i* sells crop *c*, and 0 otherwise. The error terms is assumed to have a normal distribution with mean zero. Harvest represents realised harvest of a given crop across all plots on which that crop is grown. The price regressor is farm gate price (either realized or imputed according the method described in appendix 1). The group variable is a categorical variable with group 1 as base group. The vector $\boldsymbol{input_i}$ is made of dummy variables for variables inputs (inorganic fertiliser and hired labour) and fixed inputs (organic fertiliser and family labour). These are dummies rather than continuous variables because inputs usage is provided at the plot level. Therefore, it is impossible to match a given use of inputs to a total crop harvest *across* plots (particularly when crops are intercropped). The vector $\boldsymbol{HH_i}$ is made of household level characteristics thought to influence market selection: these are the variables considered by Heltberg and Tarp (2002), the additional four variables created for the analysis (cooperative, storage use, saving group and improved seeds), farm size, and whether the crops has been intercropped. The variable on distance is the *average* plot distance for household i to the nearest village market. Standard errors are clustered at the farm level to allow for correlation between the sales of different crops within a same farm and estimation is made via maximum likelihood.

Probits including lagged prices for waves 2 and 3 are estimated for comparison with the baseline models. These augmented models 'complement' the baselines models but suffer from the drawback of much lower sample sizes (including lagged prices requires that farmers grow and market the same crop(s) in both waves). In those models, equation 4 also includes lagged prices as a regressor. Table 3 shows the difference in sample sizes at the aggregate level.

Table 3: Aggregate sample sizes with and without lagged prices[1]

	Wave 2	Wave 3
Sample size without lagged prices	N=6878 (*100%*)	N=9583 (*100%*)
Sample size with lagged prices	N=3654 (*53%*)	N=6950 (*73%*)

For each crop, marginal effects are derived to study the importance on marketing behaviour of the key regressors. Two different types of marginal effects can be obtained from a probit: the *average marginal effect* (AME), and the *marginal effect at the means* (MEM). The former calculates marginal effect for each observation in the data, and then averages these effects out. The latter calculates the marginal effect at the average value of the regressor considered. We follow Bartus (2005) in this paper by estimating AMEs rather than MEMs on the grounds that AMEs are more realistic than MEMs.

The fit of estimated models is then carefully assessed through goodness of fit analysis. Indeed, since the research focus is on whether households enter the market or not, models should be good enough at distinguishing between sellers and non-sellers for each crop studied.

5. Empirical results

5.1. Probit models at the crop/categories of crop level

For each crop, marginal effects for the main coefficients of interest are presented. The full results from maximum likelihood estimation are reported in appendix 3. A particularly important variable to look out in terms of marginal effects is the price variable. Table 4 presents logs and corresponding price levels that are useful when interpreting average marginal effects of prices.

[1] Sample size refers to crops at the household level (ex. A household cultivating 3 crops on 5 plots would have 3 entries in the data altogether).

Table 4: Price levels equivalent to log of prices

Price log	4	4.5	5	5.5	6	6.5
Price level in TS	55	93	148	245	403	665

Further, to interpret marginal effects of prices, graph set A2.1 in appendix 2 reports kernel densities of log of price across waves for all crops. Section 5.2. assesses the fit of the estimated Probit models by reporting several goodness of fit measures.

Maize

Table 5: marginal effects for maize[2]

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Harvest	0.169***	0.198***	0.209***	0.190***	0.190***
	(0.012)	(0.012)	(0.015)	(0.011)	(0.011)
Price	-0.102***	-0.055*	-0.075*	-0.163***	-0.161***
	(0.036)	(0.029)	(0.042)	(0.037)	(0.039)
Lag price			-0.007		-0.070***
			(0.038)		(0.023)
Storage use	0.019	-0.023	-0.030	0.025	0.009
	(0.026)	(0.028)	(0.035)	(0.024)	(0.025)
Farm size	-0.006***	-0.002	-0.004	-0.001	-0.001
	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
N	1145	1029	787	1387	1261

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

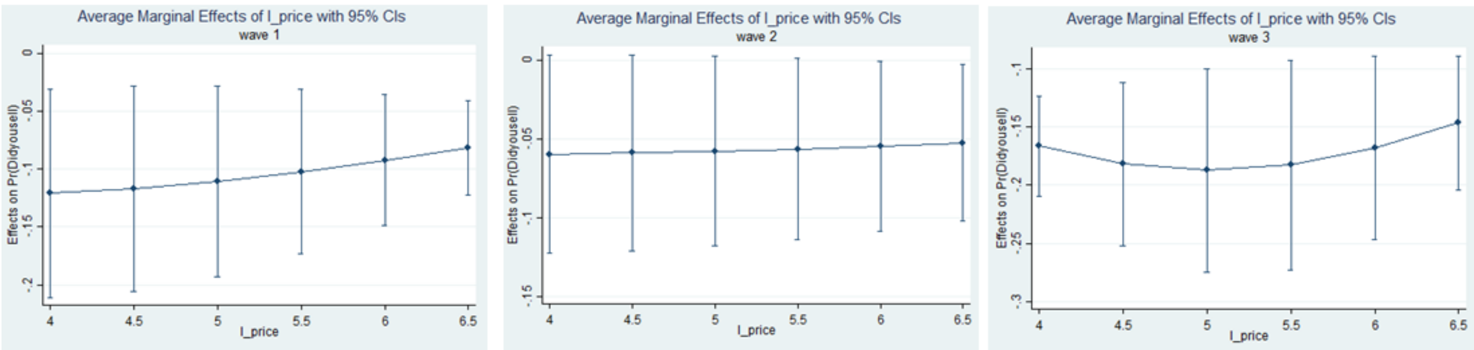
The immediate striking feature of marginal effects for maize is the negative price coefficients, particularly so for waves 1 and 3 (robust to the inclusion of lagged prices in models 3 and 5). This at first looks counterintuitive. Several reasons can explain this. The first one is that the price variable is inherently problematic due to the way missing prices have to be imputed (Heltberg and Tarp (2002) also stress that the price regressors in such cross-sectional estimations should not be overemphasized). Another reason is the possibility of a 'perverse supply response effect' where higher prices push farmers to retain production (to avoid paying higher prices as consumers in the market). Skarstein (2010) argues that economic liberalisation has created high volatility in maize price, and that wealthy producers able to store their output frequently do so.

[2] For tables 5 to 11: harvest, price and lagged price are in logs. Use of storage is a dummy variable, and farm size refers to total farm size in acres.

Yet another reason is outlined in Barrett (2008): the poorest farmers are often *net* buyers of the major staple crops, so that increases in prices may only benefit the minority of large-scale and commercially integrated farmers, while hurting the rest of them. This result is also consistent with Skarstein claim that 'forced commerce' is widespread in Tanzania, understood as a process in which poor farmers are forced to sell output at low prices after harvest to generate cash. Eventually, those poor households run out of food before next harvest and are forced to buy food on the market at much higher prices later in the year. In wave 3, both contemporaneous and lagged prices have a negative effect on selection into the market. In wave 2, average unit price for maize is 307TS, much higher than the average of 250TS for wave 1. In wave 3, it is very high at 452TS. Therefore, if forced commerce is a plausible hypothesis, then it is logical to observe a strongly negative cotemporaneous price in wave 3 (due to very high selling price) *and* a negative lagged price, since prices in wave 2 were already significantly higher than in wave 1. It is reassuring to see that the inclusion of lagged prices does not alter the results significantly. The marginal effect of using a storage facility is insignificant across waves, which is quite unexpected. Farm size does not matter either, except for a small effect in wave 1. However, it represents the marginal effect of increasing farm size by one acre (this does *not* refer to a one-acre increment in area devoted to maize only, but to a one-acre increment of the total farm size), so that small marginal effects are to be expected.

Marginal effects can also be calculated and plotted for different values of the regressors of interest. Given the kernel densities for maize prices, it seems useful to look at marginal effects of price between log(4) and log(6.4) (between 55 and 665TS).

Graphs 2: marginal effects of log of price for maize



This set of graphs show interesting insights. First, marginal effects of price are invariably negatively affecting market selection, even at high price levels. Second this effect gets smaller as price increases, especially for waves 1 and 3, both in terms of magnitude and significance. This means that while higher selling price may hurt farmers who are net buyers over the course of the year, this effect is mitigated as price strongly increases. For maize, the kernel densities show high densities at log of 5.5 (245TS) for waves 1 and 2 and log of 6 (403TS) for wave 3. For farmers facing those prices in waves 1 and 3, marginal effects of prices are significant and reduce the probability of *not* selling output. In the third wave, for farmers facing unit prices below average, marginal effects of price further *increase* the probability of not selling output. These farmers are likely to be the poorest ones, and hence be hurt by price increases according to the 'forced commerce hypothesis'.

Cassava

Table 6: marginal effects for cassava

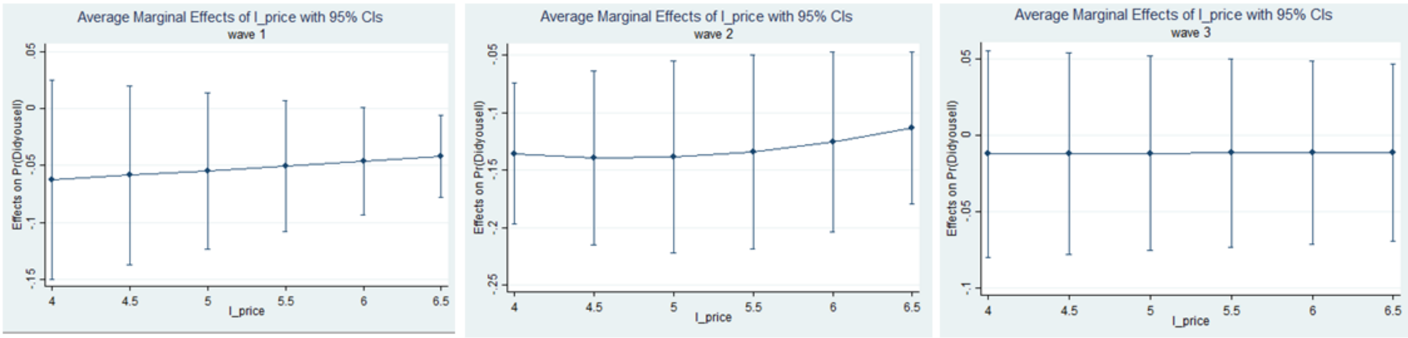
	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Harvest	0.099***	0.088***	0.071***	0.137***	0.131***
	(0.012)	(0.018)	(0.025)	(0.013)	(0.016)
Price	-0.054	-0.110***	-0.096**	-0.012	-0.005
	(0.035)	(0.032)	(0.042)	(0.032)	(0.037)
Lag price			-0.016		-0.004
			(0.042)		(0.017)
Storage use	-0.112***	0.108	0.127*	-0.028	-0.012
	(0.042)	(0.067)	(0.077)	(0.040)	(0.046)
Farm size	-0.001	0.002	0.008	-0.001	0.002
	(0.002)	(0.002)	(0.009)	(0.002)	(0.003)
N	489	384	224	577	422

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Cassava is known to be a distress or subsistence crop consumed by the poorest rural households. Thus, it is not surprising to see that, like maize, marginal effects of price are negative, although only significant for wave 2. The magnitudes of these marginal effects are larger in absolute value than for maize, which may suggest that the intensity of forced commerce is larger in wave 2. The fact that they are insignificant in waves 1 and 3 may reflect the fact that cassava sales do not respond systematically to price mechanisms, reinforcing the point that it is a subsistence crop. In models 3 and 5, lagged prices are not significant. In the first model, the storage dummy is associated with *not* marketing cassava, which indicates that households retain output whenever possible. Again, this is consistent with cassava being a staple subsistence crop. Farm size has no significant effect on entering the market.

In waves 1 and 2, increases in selling price significantly decrease the likelihood *not* to sell. However, in wave 1, note that the effect is only significant when prices reach log 6, or approximately 403TS per Kg, which is a high selling price for cassava. This implies that in wave 1, price has no significant effect for the majority of farmers (see kernel density in appendix). In wave 2, marginal effects are all significant, and give a picture qualitatively comparable to that for maize: price increases may hurt (poor) sellers, but this effect strongly decreases once prices reach high levels. In wave 3 however, the effects are insignificant, implying that prices 'do not matter'. The picture that emerges is one of very limited price responsiveness.

Graphs 3: marginal effects of log of price for cassava



Beans

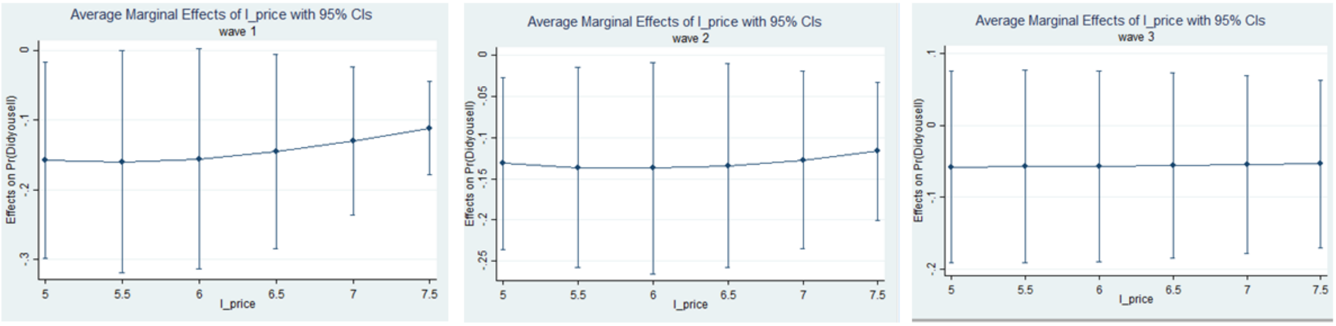
Table 7: marginal effects for beans

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Harvest	0.205***	0.217***	0.233***	0.206***	0.223***
	(0.022)	(0.018)	(0.027)	(0.016)	(0.017)
Price	-0.146**	-0.133**	-0.122*	-0.055	-0.090
	(0.072)	(0.061)	(0.073)	(0.063)	(0.083)
Lag price			-0.068		0.036
			(0.078)		(0.050)
Storage use	0.087	0.011	-0.001	-0.022	0.003
	(0.057)	(0.061)	(0.085)	(0.044)	(0.052)
Farm size	-0.001	0.001	-0.000	0.002	0.003
	(0.004)	(0.004)	(0.009)	(0.003)	(0.003)
N	397	315	195	454	342

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In terms of average marginal effects, effects of harvest are higher in magnitude for beans than for maize or cassava, which reflects the fact that since beans are a cash crop, once farm production reaches a certain threshold it is logical to expect a higher effect on the probability of selling than for staple crops. However, marginal effects of prices are negative in waves 1 and 2, although the significance is weakened in wave 2 when lagged prices are included. One could expect that this is because farmers decide to store their output to sell later at higher price. However, none of the marginal effects for storage are significant.

Graphs 4: marginal effects of log of price for beans



In wave 1, marginal effects of prices are only significant from log of 6.5 (approximately 665TS per kg), which is a high selling price. In wave 2, they are insignificant. This possibly reflects the fact that beans are a highly cash generating crop, and that more farmers are 'already' selling their output so that price effects at the margin are limited. However, summary statistics reveal this is not the case since in no wave does the proportion of sellers exceed 40%. Beans therefore give a rather contrasted picture: high selling price but limited price effects and low proportion of sellers.

Export crops[3]

Table 8: marginal effects for export crops

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Harvest	0.065***	0.024	0.041*	0.077***	0.062***
	(0.013)	(0.018)	(0.022)	(0.010)	(0.010)
Price	0.047**	-0.033	-0.087	0.055***	0.027
	(0.024)	(0.039)	(0.057)	(0.019)	(0.017)
Lag price			0.154**		0.048***
			(0.072)		(0.015)
Storage use	0.200***	0.239***	0.293***	0.212***	0.172***
	(0.056)	(0.083)	(0.113)	(0.045)	(0.040)
Farm size	-0.004	-0.003	-0.006	0.000	0.000
	(0.003)	(0.004)	(0.006)	(0.002)	(0.002)
N	318	326	200	494	383

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

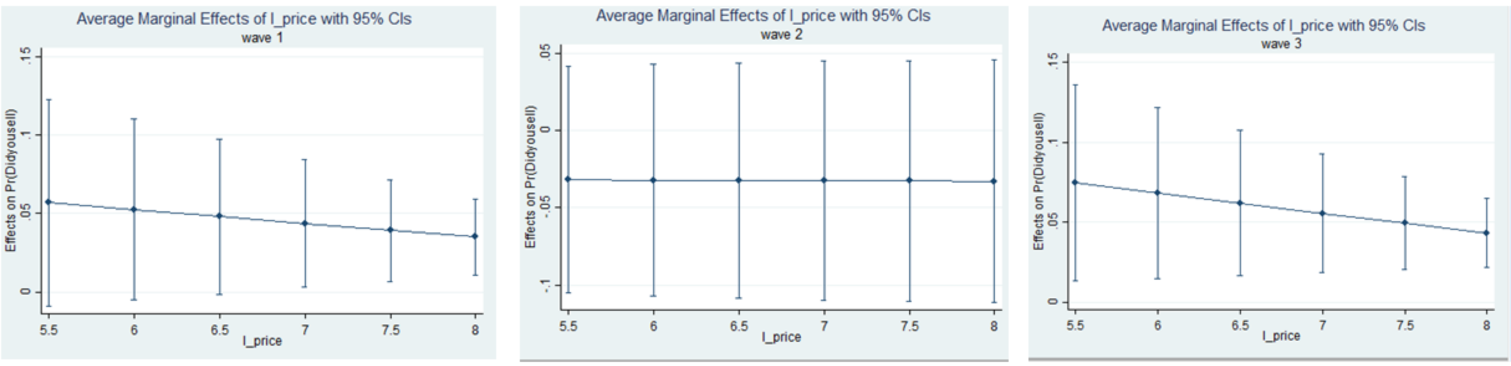
[3] Export crops include: simsin, cashewnut, cotton, sisal, coffee, tea, cocoa, cardamom and cloves.

A crucial difference for export crops is that the price marginal effects are *positive* and significant in waves 1 and 3, which may be expected for cash crops. Lagged prices are positive and significant for waves 2 and 3 (contemporaneous prices are insignificant); entering the market for export crops may be shaped by farmers' expectations (maybe some type of adaptive expectations could be at work). The positive and significant coefficients can partly be explained by the rise in coffee world prices after 2008 (coffee being the second most important export crop after cashewnut, making up between 23 and 26% of observations in that category depending on the waves).

An important result is that the storage dummy in all models is highly significant and has a large positive magnitude, and the effect gets even stronger when including lagged prices. Consistent with positive and significant price coefficients, the fact that farmers using storage facilities are more inclined to participate in the market may reflect stronger influence of price expectation mechanisms on the decision to sell for those farmers. This sharply contrasts with the picture for maize and cassava where storage is negatively or insignificantly related to entering the market. In the case of farmers growing both staple and export crops, the former can be retained for household consumption and the latter sold onto the market.

Whenever significant, in waves 1 and 3, the average marginal effects of log of harvest are much smaller in magnitude than for the previous crops. This is quite logical: since export crops are mainly grown to be sold, harvest *at the margin* should not impact the probability of selling significantly. On the other hand, for crops which are usually partly consumed and partly sold (such as maize), an increase in harvest at the margin is more likely to affect positively the probability of selling, because once a certain level of household consumption is reached, anything over it can be sold, or because there may be a 'switch price' at which households decide to sell.

Graphs 5: marginal effects of log of price for exports



With the exception of wave 2 (where lagged prices seem to be the driving force), marginal effects are positive and decreasing, unlike for all other crops previously considered, although only significant at high level of prices in wave 1: from log(6.5), or about 665TS per Kg . This can be expected from the kernel densities reported in the appendix: most of the distribution of prices is located between log(6) and log(7.5), or in levels between 403TS and 1808TS per kg, which are high selling prices compared with other crops. In wave 3, although all marginal effects are significant, this also explains why confidence intervals get smaller and smaller as price increases. Thus, this set of graphs clearly shows that increases in prices for export crops have a positive significant effect on the probability of selling, *at the margin*. In the second wave, the marginal effects at different price levels are all insignificant; confirming previous results that wave 2 is very different from waves 1 and 3 for export crops.

Vegetables and cash crops[4]

Table 9: marginal effects for vegetables and cash crops

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Harvest	0.151***	0.137***	0.134***	0.145***	0.143***
	(0.011)	(0.016)	(0.026)	(0.011)	(0.017)
Price	0.003	0.030	-0.006	0.066***	0.064**
	(0.024)	(0.020)	(0.027)	(0.019)	(0.028)
Lag price			0.098**		0.017
			(0.042)		(0.022)
Storage use	-0.063	0.063	0.005	0.046	0.010
	(0.039)	(0.050)	(0.068)	(0.037)	(0.047)
Farm size	-0.004	-0.005*	-0.002	-0.005***	-0.006**
	(0.003)	(0.002)	(0.004)	(0.002)	(0.002)
N	938	668	271	1111	639

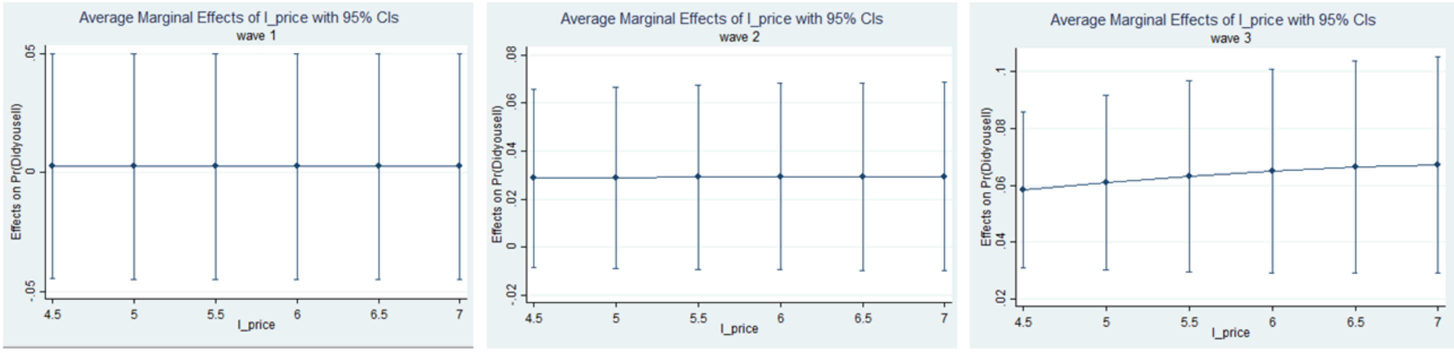
Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As for export crops, whenever significant, contemporaneous price marginal effects are positive (wave 3). In wave 2, lagged prices are positive and significant. These results imply that the commercial logic behind selling those crops may be more developed than for other crops such as maize, and some process of price expectation may also be at work. The average marginal effects of harvests are quite strong and stable over time (the picture is quite similar to beans in that respect, also consistent with the insignificance of marginal effects for storage). In wave 2 in the baseline model and in both models for wave 3, the average marginal effects of farm size are *negative* and

[4] Vegetables and cash crops include: sweet and Irish potatoes, cowpeas, pigeon peas, Bambara nuts, sunflower, groundnuts and sugarcane.

significant, but as explained in the case of maize, one should expect small marginal effect of farm sizes.

Graphs 6: marginal effects of log of price for vegetable and cash crops



While average marginal effects of log of prices are insignificant in the first 2 waves, a mild increasing effect is at work in wave 3. Marginal effects are positive significant and increasing as price increases, but price responsiveness is sluggish. Moving from a selling price of 245 TS per kg (log(5.5)) to one of 403TS (log(6)) (i.e., an increase in selling price of 64%) only triggers an increase in the probability of selling of less than 7%.

Cereals and rice crops[5]

Table 10: marginal effects for cereals and rice crops

	(1)	(2)	(3)	(4)	(5)
	Wave 1	Wave 2	Wave 2 lags	Wave 3	Wave 3 lags
Harvest	0.122***	0.195***	0.199***	0.171***	0.181***
	(0.019)	(0.016)	(0.023)	(0.013)	(0.015)
Price	-0.023	-0.054	-0.072	-0.016	-0.006
	(0.044)	(0.061)	(0.067)	(0.038)	(0.043)
Lag price			0.120**		0.031
			(0.059)		(0.038)
Storage use	0.078*	0.066*	-0.000	-0.009	-0.018
	(0.043)	(0.039)	(0.048)	(0.037)	(0.041)
Farm size	-0.009***	-0.003	-0.003	-0.005**	-0.003
	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)
N	510	473	258	631	468

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[5] Cereals include: sorghum, bulrush millet, finger millet and wheat.

For cereals and rice crops, prices do not seem to matter when entering the market, whether contemporaneous or lagged, except for a positive and significant marginal effect of lagged prices in wave 2. Thus, there may only be some limited process of price expectation formation for cereals and rice. In the first two waves, using storage is positively associated with entering the market, although only significant at the 10% level. However, unlike for export crops, price coefficients are not significant, so that use of storage cannot be linked to processes of formation of price expectations. The average marginal effects of prices at different price levels are all insignificant and graphs are not reported.

Fruit crops [6]

Table 11: marginal effects for fruit crops

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Harvest	0.077***	0.112***	0.120***	0.119***	0.125***
	(0.006)	(0.007)	(0.009)	(0.005)	(0.007)
Price	-0.006	-0.010	-0.025	-0.001	-0.005
	(0.014)	(0.013)	(0.020)	(0.011)	(0.014)
Lag price			-0.000		-0.001
			(0.019)		(0.012)
Storage use	-0.027	-0.100	-0.031	-0.080	-0.035
	(0.077)	(0.063)	(0.080)	(0.093)	(0.123)
Farm size	0.004	-0.002	-0.009**	-0.001	-0.000
	(0.003)	(0.001)	(0.004)	(0.001)	(0.001)
N	1657	1620	833	2243	1576

Standard errors in parentheses: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The striking feature of fruit crops is that apart from the harvest coefficient, few variables are significant. Fruit trees may not form part of a clear farming strategy, rather households pick up and sell fruits whenever other harvests are bad, or as a complement to those other harvests (fruits represent 'minor' crops for most farmers, except for a few fruit plantations).

[6] Fruits include: bananas, mangos, coconuts, Jack fruits, avocados, papaws, pineapples, oranges, guavas and lemons.

5.2. Assessing the fit of Probit models

For inference, the fit of estimated probit models should be good enough to capture the data in terms of who enters the market and who doesn't. Several goodness of fit measures are used to assess to fit of the models: *pseudo-R^2*, the percentage of correctly classified outcomes, the level of sensitivity (correctly classified 'successes'), the level of specificity (correctly classified 'failures'), as well as the area under the ROC (*receiver operating characteristic*) curve. The ROC curve is a graphical representation of the performance of Probit models, plotting sensitivity against one minus specificity for every possible cut-off. The closer it is to 1, the better the fit of the model. The fit of 'augmented Probit models' (including lagged prices) is also considered and reported in appendix 2. Table 12 explores goodness of fit measures of the baseline models.

Table 12: Fit of estimated baseline Probit models (default probability cut-off of 0.5)

	Pseudo R^2	LROC	% Sensitivity	% Specificity	% Correct
Maize					
Wave 1	0.27	0.84	50	91	79
Wave 2	0.28	0.80	57	87	77
Wave 3	0.34	0.88	64	91	83
Cassava					
Wave 1	0.25	0.83	43	95	84
Wave 2	0.23	0.82	38	96	82
Wave 3	0.27	0.84	40	94	82
Beans					
Wave 1	0.26	0.83	58	87	77
Wave 2	0.40	0.90	74	88	82
Wave 3	0.40	0.89	74	88	82
Exports					
Wave 1	0.31	0.88	95	35	86
Wave 2	0.14	0.73	76	57	67
Wave 3	0.37	0.89	96	46	88
Cereals/rice					
Wave 1	0.29	0.84	63	87	78
Wave 2	0.43	0.90	76	87	81
Wave 3	0.37	0.88	74	88	82
Cash/vegs					
Wave 1	0.25	0.82	68	79	74
Wave 2	0.19	0.78	64	77	72
Wave 3	0.23	0.80	59	82	73
Fruits					
Wave 1	0.13	0.74	29	93	75
Wave 2	0.21	0.80	38	94	79
Wave 3	0.20	0.79	36	94	80

Note: LROC refers to are under the ROC curve (the closer to 1 the better), sensitivity represents % of correctly predicted ones, and specificity represents % of correctly predicted zeros

Table 13: Fit of estimated baseline Probit models (alternative probability cut-offs)

	Cut-off	% Sensitivity	% Specificity	% Correct
Maize				
Wave 1	0.30	76	75	75
Wave 2	0.35	76	74	75
Wave 3	0.35	79	81	80
Cassava				
Wave 1	0.25	72	78	77
Wave 2	0.25	78	69	71
Wave 3	0.25	69	80	77
Beans				
Wave 1	0.35	80	73	75
Wave 2	0.40	80	82	81
Wave 3	0.40	81	81	81
Exports				
Wave 1	0.80	84	73	82
Wave 2	0.55	65	67	66
Wave 3	0.80	86	79	85
Cereals/rice				
Wave 1	0.40	75	79	77
Wave 2	0.45	80	82	81
Wave 3	0.40	81	80	80
Cash/vegs				
Wave 1	0.45	74	73	73
Wave 2	0.45	69	72	71
Wave 3	0.40	71	72	72
Fruits				
Wave 1	0.30	65	70	69
Wave 2	0.25	74	68	70
Wave 3	0.25	74	71	72

Note: LROC refers to are under the ROC curve (the closer to 1 the better), sensitivity represents % of correctly predicted ones, and specificity represents % of correctly predicted zeros

One crucial element when assessing the fit of estimated probit models is the probability cut-off at which one passes from an outcome of 'failure' to one of 'success'. This cut-off is independent of the estimates. A probit regression estimates a probability as a function of the regressors specified. Wherever this probability falls with respect to a given probability threshold is a separate question. The default probability cut-off is 0.5; however, depending on the research question and the proportions of zeros and ones in the data, this threshold can (and should) be adjusted. Intuitively, whenever the data shows a high proportion of zeros, one can expect a probit model to struggle more at predicting ‘successes’ than ‘failures’ and vice versa when the data is instead mostly made of ones. For crops such as maize or fruits, where the proportion of entries marketed is largely below 50%, the standard 0.5 cut-off is set too high for the model to accurately predict sellers (one would expect a much *lower* sensitivity than specificity). The opposite happens for crops largely marketed, such as export crops. For those, the standard cut-off is too ‘loose’ because it misclassifies the minority of non-sellers (one can expect much *higher* sensitivity than specificity). By plotting sensitivity and specificity levels at all possible cut-offs, it is possible to select more adequate cut-offs and see how the performance of the estimated probit model is improved. Table 13 provides goodness of fit measure with chosen alternative cut-offs for each crop.

With these cut-offs, the models perform better: while the proportion of correctly classified outcomes is roughly the same as with the 0.5 cut-off, the gap between sensitivity and specificity is drastically reduced, particularly so for crops which are heavily sold or retained. For instance, in wave 1 for maize, sensitivity is 76% and specificity 75%, as opposed to 50% and 91% with the standard cut-off.

For export crops, the performance if also increased with alternative cut-offs. Wave 2 is ‘different’ from other waves because the proportion of sellers of export crops declined quite heavily (61% sellers in wave 2, as opposed to 87% for both waves 1 and 3), which explains why the alternative cut-off is not set far from the standard 0.5 one. One explanation is that while coffee producers may want to sell to benefit from international prices, they do not do so because the private traders they sell to buy coffee at much lower prices (i.e., maintaining a high degree of arbitrage). The data backs up this interpretation: between waves 1 and 2, average coffee harvest increased by 45% (from 154 to 225 Kg), while coffee sales decreased by 49% (from 147 to 75 Kg).

For cash and vegetable crops, the alternative cut-off is *below* 0.5, which runs against *a priori* expectations, reflecting the fact that those crops are not heavily sold (about 30% of sellers per wave). Yet, they share some feature with more commercial crops (the lagged-price models show price responsiveness over time). This category seems to provide a middle-ground scenario, between the more extreme ones represented by maize and export crops respectively. For fruit crops, alternative cut-offs are set very low, drastically improving the models’ ability to detect sellers. This implicitly means that no special characteristic is required to break into the fruit market, which is consistent with the idea that fruits are sold by poor farmers along roads, or in small markets.

6. Discussion and conclusions

The main result that emerges when studying marketing behaviour at the crop level in Tanzania is that the market for agricultural output is not homogeneous, i.e. there is no single market. There appears to be a dichotomy between the market for staple and subsistence crops (maize and cassava), and that for cash-generating export crops (coffee, simsin etc.), and cash/vegetables crops to a lesser extent.

For maize and cassava, entering the market may be the result of economic distress. Whenever price coefficients are negative this may reflect the absence of price expectation mechanisms and the 'distress' nature of those markets. This implies that the majority of those farmers would be hurt by higher prices, especially if they happen to be net buyers over the course of the year, as argued by Skarstein (2010) and Barrett (2008). A similar conclusion is reached by Alene et al (2008) in the context of maize marketing in Kenya, although they do not seem to question the nature of the maize market and the possibility of forced sales. When, in addition, the storage variable is negative and significant (for cassava in wave 1), this suggests that farmers able to store their output do so to keep it for household consumption, which is consistent with negative price coefficients. On the other hand, for export crops, use of storage facility, together with positive price coefficients reflects the importance of price expectation mechanisms. Export markets are (at least partly) dependent on international prices, so that it is logical to expect stronger expectation processes than for staple crops.

A corollary to this result is that autarky may not be typical of the poorest farmers, as is often assumed. Bryceson (2010) reports that in the Katoro-Buserere settlement farmers endeavour self-sufficiency by growing their own consumption crops and selling rice as a cash crop. Barrett (2008) also argues that self-sufficiency is not a feature of the poorest rural households.

One should not assume that the dichotomy between 'forced commerce' on the one hand, and 'rational voluntary commerce' on the other can effectively be used to understand all crop marketing in Tanzania. Indeed, another important result is that for all crops 'in between' subsistence crops and export crops, the picture is not as clear. Thus, while a single view of the market seems inadequate, so does a Manichean one. For beans, cereals and rice, and fruit crops, none of the above scenarios seem to be accurate. For vegetables and cash crops there seems to be an 'intermediate case', with clear price responsiveness and possibly price expectations mechanisms, but with a proportion of sellers lower than expected.

The picture is also more complex than this simple dichotomy because most farmers are located in groups 1 and 2 *no matter which crops one looks at*. In other words, even for export crops, the vast majority of farmers are non-users of variable inputs, or labour hirers only. This means that *within* the same groups, different rationales for entering different markets can in principle co-exist. The group of farmers not using variable inputs may be more heterogeneous than initially thought.

For Tanzania, the variables (exclusion restrictions) used by Heltberg and Tarp (2002) for Mozambique are mostly insignificant in explaining selection into given crops or categories of crops (they are also largely insignificant in their paper). However, this study has shown the importance of other variables affecting output marketing, notably lagged prices and the use of a storage facility.

Further research should study in more details differences across types of farmers. In particular, the group of farmers not using any variable inputs is probably much more heterogeneous than originally thought. Another important next step is to look into more details at how entering the market for different crops varies *within* the same households to distinguish between co-existing household farming strategies.

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Appendix 1 *Data construction and summary statistics*

A main challenge associated with the agricultural module is that data are collected at different observational levels. Some information is provided at the household/plot level (eg: *How much fertiliser did you use on this plot?*), while other information is given at the household/plot/crop level (eg: *How much of crop X did you harvest on plot Y?*). Further, some information is only provided at the household/crop level (eg: *How much of crop X did you sell?).* These different levels of observation between harvest of a given crop and sales of that same crop constitute an obvious challenge when it comes to matching harvest with sales.

Example 1: suppose a farmer cultivates two plots. For simplicity, assume only maize is grown on both and that 100 Kg of maize are harvested on the first plot and 200 Kg on the second. It is only known that total sales of maize amount to 150 Kgs; one does not know if the proportion marketed varied across the two plots (because, perhaps, of differences in quality and/or inputs).

One of the major concerns with the NPSs is the absence of price variables. In particular, no farm-gate price (i.e., the price at which a farmer sells output) is reported. Farm gate prices are thus constructed by dividing total sales by physical sales in Kg for crops *entirely* or *partially* marketed. Sales are given at the *crop* level (and not at the *crop/plot* level). Whenever a farmer grows a crop he/she sells on several plots, it is reasonable to assume that farm-gate price for that crop is independent of which plot it comes from. The measure is therefore the realized farm-gate price. With most farmers not marketing at all some crops (usually subsistence crops such as cassava or cooking bananas), this creates missing values in the price series. Average district prices for each crop are computed using farm-gate prices for those farmers who do market the crops; this is used as the potential farm-gate price for the district. In cases where the crop is not marketed anywhere in the district, regional average prices are computed. These district or regional average farm-gate prices are then imputed as potential farm-gate prices for those farmers not marketing some crop. One implication is that potential farm-gate prices are the same for all farms in a district whereas the realised farm-gate prices are specific to the farm that markets output. Example 2 clarifies this issue, constructing a stylized hypothetical example.

Some studies would also consider market prices. The information available on market prices in the NPS datasets does not provide useful measures of farm-gate prices. Market prices are typically much higher than farm-gate prices, implying that they include marketing costs and trader's margins. Furthermore, market prices are reported for highly disaggregated processed agricultural products. For instance maize can be sold raw, as grains, processed or as flour, all at very different market prices. Furthermore, many market prices are missing at the district level so it is more appropriate to use constructed farm-gate prices.

Example 2: Suppose the following set of households:

- Household 1 lives in district 1 of region 1. It produces 100 Kg of cassava, retaining 50 Kg for home consumption, and marketing 50 Kg for a total value of TS 50.000. Further, it produces 200 Kg of bananas but retains it all for home consumption.
- Household 2 lives in district 1 of region 1. It produces 150 Kg of cassava, and 20 Kg of bananas all retained for home consumption.
- Household 3 lives in district 2 of region 1. It produces 50 Kg of cassava, all sold for TS 100.000, and 50 g of bananas, all sold for TS 25.000.
- For the sake of the example, suppose further than region 1 is only made of those 3 households and that it only has 2 districts.

Table A1.1 below shows farm-gate prices for this example. Figures in bold are realized, while figures in italic are imputed (potential).

Table A1.1: farm-gate prices for example 3

Household	District	Region	Price Cassava (kg)	Price Banana (kg)
1	1	1	**1000**	*500*
2	1	1	*1000*	*500*
3	2	1	**2000**	**500**

Finally, the variable represented storage refers to usage of a storage facility to store crop *at the interview date*. The surveys do not ask whether households *own* a storage facility or not. Instead, they ask whether any of the crop output is in storage. This implies that we cannot know whether households who happen not to have crop output in storage own a storage facility or not. Therefore, the storage variable should *not* be interpreted as a proxy for access to capital.

Table A1.2: summary statistics: gr.1 wave 2

	mean	sd	min	max
Harvest (kg)	286	540.8	1	9000
Surplus (%)	0.19	0.3	0	1
Seller (0/1)	0.71	-	0	1
Price (TS)	442	472.0	0	3000
Sales (kg)	129	444.0	0	7200
Sales (TS)	47043	215007.4	0	5.00e+06
Family (days)	83	75.2	0	609
Organic fert (kg)	57	235.9	0	2000
N	5734			

Table A1.3: summary statistics: gr.1 wave 3

	mean	sd	min	max
Harvest (kg)	278	503.0	1	8200
Surplus (%)	0.21	0.3	0	1
Seller (0/1)	0.77	-	0	1
Price (TS)	492	401.3	2	3000
Sales (kg)	141	509.5	0	15000
Sales (TS)	68933	303892.3	0	8.23e+06
Family (days)	84	82.8	0	1170
Organic fert (kg)	61	249.8	0	2000
N	7236			

Table A1.4: summary statistics: gr.4 wave 2

	mean	sd	min	max
Harvest (kg)	570	852.7	4	5600
Surplus (%)	0.24	0.3	0	1
Seller (0/1)	0.80	-	0	1
Price (TS)	413	389.2	1	2795
Sales (kg)	328	933.0	0	9200
Sales (TS)	1.45e+05	741086.0	0	1.29e+07
Family (days)	71	65.8	0	315
Organic fert (kg)	137	404.4	0	2000
Inorganic fert (kg)	93	91.7	1	500
Hired labour (days)	20	23.7	1	154
N	373			

Table A1.5: summary statistics: gr.4 wave 3

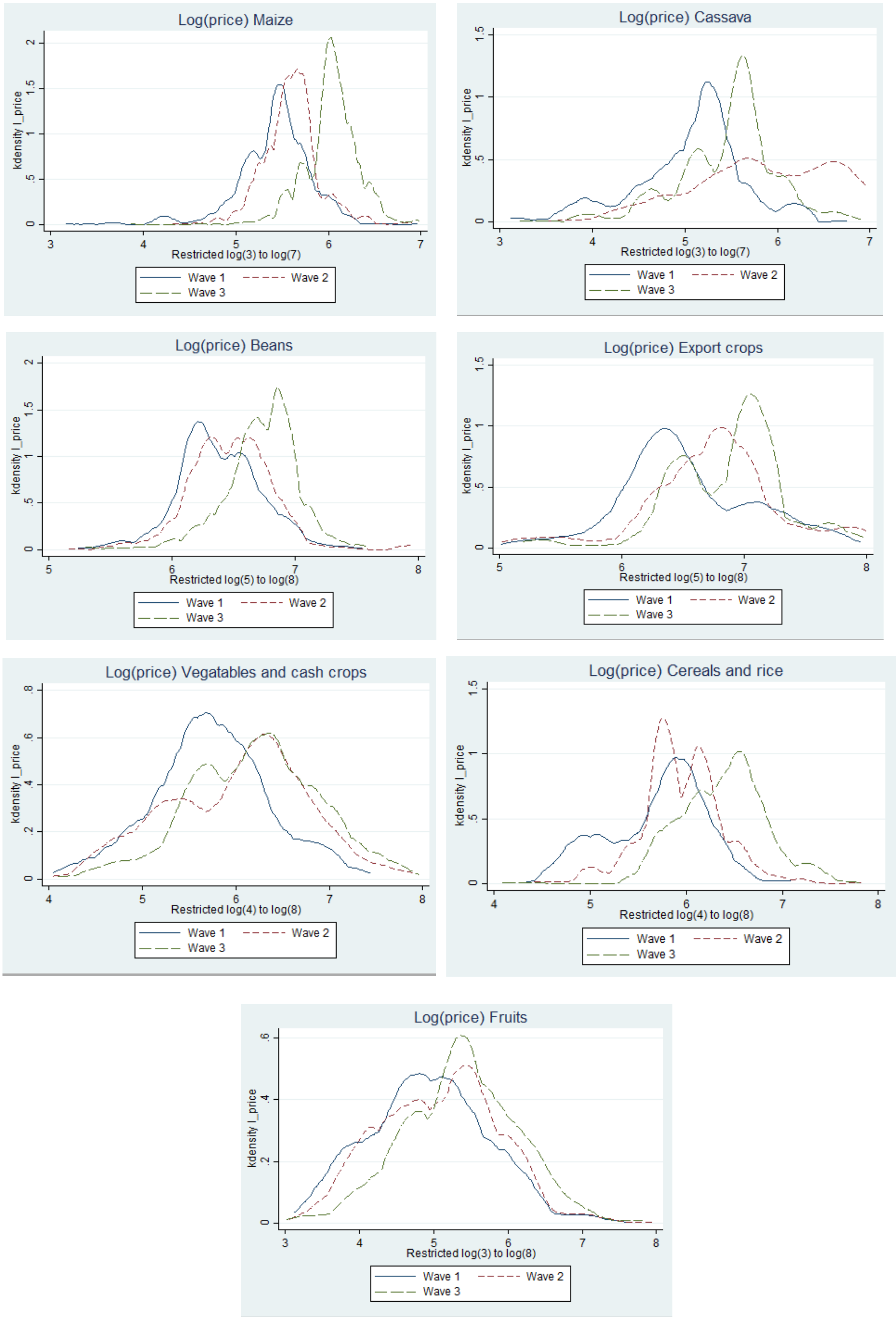
	mean	sd	min	max
Harvest (kg)	633	1102.2	4	10000
Surplus (%)	0.28	0.4	0	1
Seller (0/1)	0.83	-	0	1
Price (TS)	532	392.8	25	3000
Sales (kg)	476	1224.6	0	10000
Sales (TS)	2.32e+05	621060.3	0	4.88e+06
Family (days)	85	102.2	0	746
Organic fert (kg)	155	411.6	0	2000
Inorganic fert (kg)	113	147.9	1	950
Hired labour (days)	28	30.6	1	156
N	487			

Appendix 2 *Assessing the fit of Probit models*

Table A2.1: goodness of fit measures of lag-augmented Probit models (cut-off of 0.5)

	Pseudo R^2	LROC	% Sensitivity	% Specificity	% Correct
Maize					
Wave 2 lags	0.27	0.83	61	83	75
Wave 3 lags	0.34	0.87	63	91	81
Cassava					
Wave 2 lags	0.26	0.82	50	95	83
Wave 3 lags	0.25	0.83	36	95	82
Beans					
Wave 2 lags	0.39	0.88	68	82	76
Wave 3 lags	0.44	0.90	79	86	83
Exports					
Wave 2 lags	0.20	0.78	75	65	71
Wave 3 lags	0.40	0.91	98	37	91
Cereals/rice					
Wave 2 lags	0.47	0.91	78	87	83
Wave 3 lags	0.40	0.90	76	86	82
Cash/vegs					
Wave 2 lags	0.25	0.83	84	67	77
Wave 3 lags	0.22	0.80	70	72	71
Fruits					
Wave 2 lags	0.22	0.80	50	87	75
Wave 3 lags	0.20	0.79	41	93	78

Graph set A2.1: Kernel densities of log price



Appendix 3 *Full output tables of probit models*

Full tables for the Probit models in the appendix provide material for a comparative discussion of factors influencing market participation across crops.

The group dummies are a particularly interesting variable to look at because they give a clear indication of which type of farmers is likely or not to enter markets. For maize, being a member of groups 3 or 4 (i.e., being a farmer using chemical fertiliser) makes it much *less* likely to supply maize onto the market than a farmer in group 1 in wave 2. This seems consistent with the fact that the dummy for inorganic fertiliser use is insignificant across waves. It is also consistent with the proportion of farmers storing maize in wave 2 being much lower in group 1 than in other groups (22% for group 1 as opposed to 42% for group 4).

For cassava, the fact that none of the group dummies are significant suggests that selling cassava is predominantly a feature of poor farmers from group 1. Indeed, there is very little variation in groups for cassava. For instance, in wave 2, farmers in group 1 make 75% of observations.

For beans, farmers in group 2 seem to be significantly more likely to enter the market than farmers in group 1. Given that beans are a cash generating crop with high average selling price (especially in wave 3 as shown by the kernel densities), this implies that users of hired labour are more prone to enter the market for cash crops (while poorer farmers are more prone to enter the markets for staple and subsistence crops). However, no significant effect is found for groups 3 and 4, or for other waves.

For vegetables and cash crops, In waves 2 and 3 (but not in models using lags), being in group 2 significantly increases the probability of entering the market, while in wave 3, the opposite happens for members of group 3, pointing towards the possibility that these crops are labour intensive. However, in columns 2 and 4, both the group 2 dummies are *positive and significant* while the labour dummies are *negative and significant*, which seems contradictory. One possibility is that farmers in group 2 are significantly more likely to sell output than those in group 1 (55 and 42% of sellers for group 2 as opposed to 39 and 37% for group 1 for waves 1 and 2 respectively), but at the same time, payment of hired labour in agricultural output rather than wage reduces the probability of selling. In the lagged models however, the group dummies lose significance and so does the labour dummy in wave 2.

For cereals and rice, group dummies are insignificant. This may be because the vast majority of growers are in groups 1 and 2 (as for cassava). Further, the labour dummies are insignificant, which implies there is not a strong difference between groups 1 and 2.

For several crops, ownership of a mean of transport is negative and significant in wave 3 (maize, beans, rice and cereals). While this seems counterintuitive at first, it can reflect greater off-farm employment opportunities, and hence off-farm income sources that render output marketing less of a need. A similar effect may be reflected by a positive effect of distance to market on the probability of selling (cassava wave 3). Heltberg and Tarp (2002) observe a similar effect for Mozambique, and argue these positive coefficients may pick up a labour market effect, namely greater off-farm job opportunities in urban areas.

Whenever significant, having a household member in a saving group seems *negatively* linked with marketing crop. This may indicate less reliance on agricultural income, so that those households do not need to market their output as much as other households. It reinforces the point that seriously cash-constrained farmers engage in forced sales, while non (or less) constrained farmers hold onto their surpluses longer. One reason for this is that prices are typically lower straight after harvest (when 'forced commerce' sales occur) than they are later in the year, a few months before the next harvest.

Table A3.1: Maximum likelihood estimates for maize[7]

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Main variables					
Harvest	0.688***	0.762***	0.770***	0.813***	0.809***
	(0.060)	(0.062)	(0.072)	(0.065)	(0.068)
Price	-0.416***	-0.213*	-0.275*	-0.696***	-0.684***
	(0.149)	(0.111)	(0.157)	(0.166)	(0.169)
Lag price			-0.026		-0.299***
			(0.139)		(0.097)
Inorganic fertiliser	0.045	0.304	0.161	-0.252	-0.270
	(0.268)	(0.212)	(0.220)	(0.255)	(0.274)
Hired labour	-0.056	-0.230	-0.135	0.002	0.048
	(0.167)	(0.173)	(0.206)	(0.143)	(0.151)
Storage use	0.078	-0.090	-0.112	0.108	0.037
	(0.108)	(0.109)	(0.128)	(0.104)	(0.107)
Saving group	-0.109	-0.641***	-0.517*	-0.356	-0.343
	(0.221)	(0.234)	(0.270)	(0.223)	(0.239)
Farm size	-0.024***	-0.008	-0.013	-0.006	-0.005
	(0.009)	(0.008)	(0.009)	(0.005)	(0.004)
Group dummies					
2.group	0.191	0.272	0.198	0.142	0.145
	(0.175)	(0.193)	(0.232)	(0.159)	(0.168)
3.group	-0.148	-0.464**	-0.370	0.357	0.362
	(0.304)	(0.235)	(0.244)	(0.277)	(0.296)
4.group	0.152	-0.582*	-0.522	0.462	0.472
	(0.313)	(0.304)	(0.331)	(0.306)	(0.327)
Other variables					

7 For tables A3.1 to A3.7, harvest, price and lagged price are in logs. The inorganic, organic and hired labour variables are dummies. The use of storage, saving group membership, presence of a cooperative and availability of improved seeds are also dummies.

Transport	-0.181*	-0.131	-0.149	-0.295***	-0.323***
	(0.101)	(0.103)	(0.116)	(0.094)	(0.099)
Radio	0.213*	-0.202*	-0.150		
	(0.121)	(0.106)	(0.122)		
Newspaper	-0.004	0.137	-0.031		
	(0.122)	(0.143)	(0.162)		
Head educ	0.115	-0.060	-0.086	0.046	0.095
	(0.096)	(0.099)	(0.112)	(0.074)	(0.079)
Intercrop	-0.158	-0.095	-0.089	-0.090	-0.081
	(0.099)	(0.106)	(0.119)	(0.093)	(0.096)
Organic fertiliser	0.000	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance	0.053	0.005	-0.011	0.063	0.072
	(0.049)	(0.044)	(0.051)	(0.046)	(0.048)
Cooperative	0.041	-0.070	-0.086	-0.118	-0.131
	(0.100)	(0.101)	(0.116)	(0.095)	(0.099)
Improved seeds	-0.318***	-0.139	-0.108	-0.008	-0.027
	(0.118)	(0.109)	(0.126)	(0.098)	(0.102)
Constant	-1.958**	-2.860***	-2.354*	-1.634	0.135
	(0.978)	(0.783)	(1.275)	(1.126)	(1.248)
Region dummies	Yes	Yes	Yes	Yes	Yes
N	1145	1029	787	1387	1261

Clustered standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3.2: Maximum likelihood estimates for cassava

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Main variables					
Harvest	0.448***	0.358***	0.290***	0.644***	0.616***
	(0.061)	(0.080)	(0.107)	(0.072)	(0.082)
Price	-0.247	-0.448***	-0.392**	-0.055	-0.022
	(0.161)	(0.141)	(0.181)	(0.150)	(0.176)
Lag price			-0.066		-0.018
			(0.169)		(0.080)
Inorganic fertiliser	-0.545	-0.311	-0.316	0.347	0.480
	(0.452)	(0.448)	(0.571)	(0.465)	(0.542)
Hired labour	0.574**	0.094	0.241	-0.601**	-0.472
	(0.234)	(0.256)	(0.359)	(0.293)	(0.319)
Storage use	-0.508***	0.438	0.518	-0.132	-0.056
	(0.192)	(0.275)	(0.319)	(0.191)	(0.215)
Saving group	-0.106	0.060	0.297	-0.258	-0.533
	(0.335)	(0.345)	(0.485)	(0.309)	(0.442)
Farm size	-0.006	0.010	0.032	-0.005	0.011
	(0.007)	(0.010)	(0.038)	(0.009)	(0.013)

Group dummies					
2.group	-0.066	0.013	0.136	0.447	0.438
	(0.245)	(0.305)	(0.397)	(0.310)	(0.337)
3.group	0.354	0.127	0.000	-0.058	-0.843
	(0.592)	(0.611)	(.)	(0.594)	(0.706)
4.group	0.069	-0.974	-0.689	0.534	0.435
	(0.697)	(0.792)	(1.052)	(0.617)	(0.799)
Other variables					
Transport	-0.085	0.216	0.234	0.117	0.002
	(0.161)	(0.165)	(0.217)	(0.147)	(0.172)
Radio	-0.231	-0.338*	-0.228		
	(0.198)	(0.185)	(0.247)		
Newspaper	0.201	-0.229	-0.573		
	(0.182)	(0.268)	(0.384)		
Head educ	-0.005	-0.107	-0.086	0.067	0.129
	(0.123)	(0.133)	(0.172)	(0.110)	(0.131)
Intercrop	0.374**	-0.023	0.058	0.000	-0.111
	(0.179)	(0.204)	(0.260)	(0.173)	(0.190)
Organic fertiliser	0.001*	0.001	0.003***	-0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Distance	0.067	-0.124	-0.089	0.151**	0.241**
	(0.082)	(0.085)	(0.104)	(0.076)	(0.095)
Cooperative	-0.048	-0.348*	-0.266	0.061	0.136
	(0.169)	(0.187)	(0.261)	(0.160)	(0.186)
Improved seeds	0.190	0.241	0.010	-0.154	-0.044
	(0.169)	(0.182)	(0.233)	(0.166)	(0.201)
Constant	-2.323*	0.186	0.134	-2.010	-3.701**
	(1.189)	(1.410)	(2.222)	(1.342)	(1.849)
Region dummies	YES	YES	YES	YES	YES
N	489	384	224	577	422

Clustered standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3.3: Maximum likelihood estimates for beans

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Main variables					
Harvest	0.759***	0.961***	1.005***	0.916***	1.044***
	(0.108)	(0.125)	(0.169)	(0.107)	(0.122)
Price	-0.541**	-0.591**	-0.527*	-0.244	-0.420
	(0.275)	(0.279)	(0.320)	(0.281)	(0.384)
Lag price			-0.294		0.166
			(0.336)		(0.231)

Inorganic fertiliser	-0.228	0.547*	0.618	0.580	0.939**
	(0.332)	(0.331)	(0.388)	(0.362)	(0.405)
Hired labour	-0.072	-0.399	-0.421	0.129	0.339
	(0.310)	(0.320)	(0.396)	(0.259)	(0.289)
Storage use	0.322	0.049	-0.006	-0.099	0.016
	(0.216)	(0.272)	(0.365)	(0.194)	(0.241)
Saving group	-1.048***	-0.089	-0.063	-0.713*	-0.911*
	(0.348)	(0.316)	(0.530)	(0.409)	(0.531)
Farm size	-0.004	0.004	-0.001	0.007	0.015
	(0.015)	(0.019)	(0.039)	(0.011)	(0.013)
Groups dummies					
2.group	0.142	0.961***	0.865*	-0.086	-0.481
	(0.330)	(0.366)	(0.446)	(0.285)	(0.334)
3.group	0.534	0.538	0.411	-0.627	-1.277***
	(0.383)	(0.351)	(0.467)	(0.406)	(0.459)
4.group	0.495	-0.437	-0.854	-0.602	-1.378***
	(0.451)	(0.506)	(0.626)	(0.488)	(0.518)
Other variables					
Transport	-0.136	-0.246	-0.106	-0.376**	-0.456**
	(0.171)	(0.203)	(0.277)	(0.171)	(0.195)
Radio	-0.496**	-0.238	-0.433		
	(0.196)	(0.215)	(0.280)		
Newspaper	-0.120	-0.167	-0.176		
	(0.210)	(0.261)	(0.372)		
Head educ	0.143	0.197	0.155	0.229	0.213
	(0.170)	(0.203)	(0.250)	(0.143)	(0.160)
Intercrop	-0.291	0.058	0.152	0.147	0.210
	(0.215)	(0.278)	(0.334)	(0.195)	(0.238)
Organic fertiliser	-0.000	-0.000	-0.001	-0.000	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Distance	-0.007	0.057	-0.060	0.018	0.099
	(0.089)	(0.086)	(0.116)	(0.077)	(0.092)
Cooperative	0.023	0.063	0.023	0.184	0.195
	(0.176)	(0.208)	(0.287)	(0.172)	(0.205)
Improved seeds	0.293*	0.070	0.195	-0.417**	-0.285
	(0.177)	(0.227)	(0.281)	(0.191)	(0.231)
Constant	0.813	-2.121	-0.417	-2.275	-3.239
	(1.832)	(2.104)	(3.049)	(2.212)	(2.896)
Region dummies	YES	YES	YES	YES	YES
N	397	315	195	454	342

Clustered standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3.4: Maximum likelihood estimates for export crops

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Main variables					
Harvest	0.394***	0.073	0.129*	0.495***	0.547***
	(0.085)	(0.054)	(0.072)	(0.078)	(0.105)
Price	0.282*	-0.097	-0.278	0.355***	0.237
	(0.145)	(0.118)	(0.183)	(0.124)	(0.151)
Lag price			0.489**		0.420***
			(0.235)		(0.137)
Inorganic fertiliser	-1.176***	-0.925**	-1.200**	-0.072	0.109
	(0.431)	(0.385)	(0.491)	(0.372)	(0.500)
Hired labour	0.078	-0.027	0.153	0.284	0.044
	(0.313)	(0.225)	(0.289)	(0.250)	(0.369)
Storage use	1.203***	0.712***	0.929**	1.372***	1.512***
	(0.343)	(0.256)	(0.381)	(0.309)	(0.356)
Saving group	0.367	0.557*	0.380	0.151	0.534
	(0.523)	(0.296)	(0.325)	(0.470)	(0.777)
Farm size	-0.027	-0.010	-0.019	0.003	0.002
	(0.018)	(0.013)	(0.019)	(0.013)	(0.018)
Group dummies					
2.group	-0.016	0.244	0.461	-0.056	0.261
	(0.380)	(0.259)	(0.337)	(0.268)	(0.374)
3.group	0.431	0.535	0.558	-0.706	-1.152*
	(0.456)	(0.428)	(0.606)	(0.546)	(0.647)
4.group	0.000	0.554	0.400	0.000	0.000
	(.)	(0.579)	(0.753)	(.)	(.)
Other variables					
Transport	-0.015	-0.165	-0.405*	-0.200	-0.233
	(0.223)	(0.172)	(0.235)	(0.186)	(0.241)
Radio	-0.230	0.095	-0.337		
	(0.262)	(0.191)	(0.265)		
Newspaper	0.435	-0.091	-0.065		
	(0.309)	(0.236)	(0.285)		
Head educ	-0.109	0.096	-0.121	0.105	0.074
	(0.204)	(0.147)	(0.204)	(0.150)	(0.177)
Intercrop	0.449	-0.266	0.041	0.080	-0.064
	(0.298)	(0.183)	(0.263)	(0.221)	(0.302)
Organic fertiliser	0.000	-0.001***	-0.001**	0.001*	0.001*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Distance	0.056	-0.120	-0.165*	0.224**	0.136
	(0.088)	(0.078)	(0.100)	(0.094)	(0.113)
Cooperative	-0.317	-0.113	-0.212	-0.317*	-0.570**
	(0.234)	(0.167)	(0.219)	(0.189)	(0.254)

Improved seeds	-0.691**	-0.210	0.018	-0.170	-0.125
	(0.278)	(0.176)	(0.237)	(0.211)	(0.281)
Constant	-4.351***	1.488	-2.638	-5.352***	-6.746***
	(1.627)	(1.407)	(2.511)	(1.302)	(1.615)
Region dummies	YES	YES	YES	YES	YES
N	318	326	200	494	383

Clustered standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3.5: Maximum likelihood estimates for vegetables and cash crops

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Main variables					
Harvest	0.517***	0.432***	0.459***	0.494***	0.473***
	(0.047)	(0.059)	(0.106)	(0.045)	(0.065)
Price	0.009	0.093	-0.022	0.223***	0.212**
	(0.083)	(0.063)	(0.093)	(0.064)	(0.092)
Lag price			0.337**		0.057
			(0.148)		(0.073)
Inorganic fertiliser	0.147	-0.071	-0.831**	0.777***	0.643*
	(0.282)	(0.214)	(0.386)	(0.255)	(0.348)
Hired labour	0.269*	-0.420**	-0.444	-0.414***	-0.398**
	(0.158)	(0.179)	(0.273)	(0.138)	(0.183)
Storage use	-0.216	0.199	0.016	0.158	0.032
	(0.135)	(0.158)	(0.233)	(0.125)	(0.154)
Saving group	-0.243	-0.010	0.226	-0.469**	-0.235
	(0.222)	(0.221)	(0.371)	(0.195)	(0.263)
Farm size	-0.012	-0.015*	-0.006	-0.018***	-0.019**
	(0.009)	(0.008)	(0.015)	(0.007)	(0.008)
Group dummies					
2.group	0.055	0.491**	0.064	0.406***	0.215
	(0.166)	(0.197)	(0.301)	(0.145)	(0.196)
3.group	-0.344	0.079	0.348	-0.655**	-0.750*
	(0.341)	(0.239)	(0.408)	(0.295)	(0.397)
4.group	-0.032	0.058	0.434	-0.425	0.282
	(0.391)	(0.285)	(0.477)	(0.308)	(0.439)
Other variables					
Transport	-0.005	0.065	0.030	0.033	-0.067
	(0.109)	(0.125)	(0.196)	(0.099)	(0.131)
Radio	-0.160	-0.094	-0.135		
	(0.122)	(0.137)	(0.227)		

Newspaper	0.033	0.269*	-0.016		
	(0.134)	(0.162)	(0.246)		
Head educ	0.126	-0.083	-0.375**	0.056	0.035
	(0.103)	(0.111)	(0.187)	(0.078)	(0.105)
Intercrop	-0.104	0.196	-0.027	0.156	0.233
	(0.118)	(0.145)	(0.220)	(0.109)	(0.143)
Organic fertiliser	-0.000	-0.000	-0.000	-0.000***	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance	0.023	0.062	0.055	0.107**	0.100
	(0.053)	(0.055)	(0.089)	(0.048)	(0.062)
Cooperative	-0.035	-0.081	0.123	-0.032	0.052
	(0.112)	(0.125)	(0.226)	(0.099)	(0.128)
Improved seeds	0.077	-0.100	-0.166	0.023	0.141
	(0.127)	(0.132)	(0.244)	(0.106)	(0.138)
Lag price			0.337**		0.057
			(0.148)		(0.073)
Constant	-2.019***	-2.764***	-3.152**	-4.063***	-4.296***
	(0.700)	(0.696)	(1.507)	(0.644)	(0.907)
Region dummies	YES	YES	YES	YES	YES
N	938	668	271	1111	639

Clustered standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3.6: Maximum likelihood estimates for rice and cereals crops

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Main variables					
Harvest	0.455***	0.876***	0.974***	0.709***	0.780***
	(0.083)	(0.103)	(0.147)	(0.073)	(0.088)
Price	-0.085	-0.240	-0.353	-0.068	-0.024
	(0.163)	(0.276)	(0.331)	(0.155)	(0.186)
Lag price			0.588*		0.134
			(0.301)		(0.164)
Inorganic fertiliser	0.208	0.563	0.144	-0.109	0.125
	(0.408)	(0.376)	(0.511)	(0.409)	(0.432)
Hired labour	0.401	0.095	-0.043	0.119	-0.193
	(0.267)	(0.258)	(0.364)	(0.225)	(0.286)
Storage use	0.291*	0.297*	-0.000	-0.036	-0.077
	(0.158)	(0.176)	(0.235)	(0.152)	(0.178)
Saving group	0.203	-0.367	-1.770***	-0.200	-0.273
	(0.453)	(0.444)	(0.440)	(0.333)	(0.436)
Farm size	-0.032***	-0.015	-0.017	-0.019**	-0.014
	(0.012)	(0.010)	(0.014)	(0.009)	(0.010)
Group dummies					

2.group	-0.367	-0.103	0.043	-0.184	0.065
	(0.266)	(0.265)	(0.376)	(0.244)	(0.305)
3.group	-0.140	0.234	0.792	0.706	0.671
	(0.473)	(0.477)	(0.784)	(0.517)	(0.611)
4.group	-0.392	0.163	-0.324	0.321	0.476
	(0.571)	(0.627)	(0.747)	(0.525)	(0.600)
Other variables					
Transport	-0.003	0.059	0.042	-0.396***	-0.568***
	(0.147)	(0.173)	(0.227)	(0.134)	(0.160)
Radio	0.210	-0.059	-0.244		
	(0.163)	(0.164)	(0.220)		
Newspaper	-0.084	-0.381	-0.362		
	(0.222)	(0.257)	(0.401)		
Head educ	0.266*	0.263*	0.564***	0.179*	0.160
	(0.144)	(0.153)	(0.216)	(0.107)	(0.124)
Intercrop	0.365**	0.215	0.221	0.208	0.278
	(0.145)	(0.183)	(0.260)	(0.150)	(0.180)
Organic fertiliser	0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance	0.028	0.053	-0.003	0.065	0.048
	(0.072)	(0.095)	(0.123)	(0.060)	(0.070)
Cooperative	0.273*	-0.519***	-0.570**	-0.005	0.029
	(0.148)	(0.184)	(0.236)	(0.137)	(0.162)
Improved seeds	0.119	0.169	0.044	-0.410***	-0.384**
	(0.201)	(0.166)	(0.237)	(0.140)	(0.163)
Lag price			0.588*		0.134
			(0.301)		(0.164)
Constant	-4.657***	-4.950***	-7.256***	-4.091***	-5.532***
	(1.032)	(1.689)	(2.169)	(1.110)	(1.595)
Region dummies	YES	YES	YES	YES	YES
N	510	473	258	631	468

Clustered standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3.7: Maximum likelihood estimates for fruit crops

	(1) Wave 1	(2) Wave 2	(3) Wave 2 lags	(4) Wave 3	(5) Wave 3 lags
Main variables					
Harvest	0.261***	0.438***	0.432***	0.465***	0.461***
	(0.024)	(0.034)	(0.040)	(0.026)	(0.032)
Price	-0.021	-0.038	-0.089	-0.003	-0.019
	(0.047)	(0.051)	(0.072)	(0.044)	(0.051)
Lag price			-0.001		-0.003
			(0.067)		(0.043)

Inorganic fertiliser	-0.235	-0.145	-0.221	-0.242	-0.276
	(0.187)	(0.145)	(0.177)	(0.150)	(0.183)
Hired labour	0.082	0.071	0.181	0.000	-0.069
	(0.126)	(0.130)	(0.154)	(0.104)	(0.120)
Storage use	-0.090	-0.391	-0.112	-0.313	-0.128
	(0.262)	(0.249)	(0.287)	(0.362)	(0.454)
Saving group	0.092	0.046	0.276*	-0.111	-0.079
	(0.181)	(0.128)	(0.163)	(0.166)	(0.187)
Farm size	0.015	-0.009	-0.032**	-0.003	-0.001
	(0.010)	(0.006)	(0.013)	(0.003)	(0.003)
Group dummies					
2.group	0.102	-0.068	-0.200	0.036	0.090
	(0.141)	(0.149)	(0.188)	(0.121)	(0.141)
3.group	0.258	-0.140	-0.107	-0.375*	-0.301
	(0.255)	(0.181)	(0.236)	(0.216)	(0.252)
4.group	0.259	-0.088	-0.092	0.033	-0.102
	(0.264)	(0.278)	(0.348)	(0.240)	(0.284)
Other variables					
Transport	-0.062	0.199**	0.196*	-0.201***	-0.174**
	(0.088)	(0.086)	(0.116)	(0.075)	(0.084)
Radio	-0.069	-0.006	-0.007		
	(0.107)	(0.102)	(0.129)		
Newspaper	-0.147	-0.328***	-0.537***		
	(0.106)	(0.115)	(0.163)		
Head educ	-0.082	-0.072	-0.186*	-0.063	-0.099
	(0.076)	(0.079)	(0.103)	(0.059)	(0.066)
Intercrop	0.134	-0.179	-0.322**	0.016	-0.051
	(0.122)	(0.117)	(0.152)	(0.110)	(0.131)
Organic fertiliser	-0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance	0.030	-0.009	0.020	0.006	-0.012
	(0.042)	(0.036)	(0.052)	(0.036)	(0.040)
Cooperative	-0.034	-0.110	-0.081	-0.052	-0.021
	(0.091)	(0.086)	(0.112)	(0.074)	(0.084)
Improved seeds	0.011	0.135	0.258**	0.041	0.030
	(0.094)	(0.096)	(0.126)	(0.084)	(0.094)
Constant	-0.680	-0.699	-0.724	-2.436**	-2.582**
	(0.727)	(0.810)	(1.024)	(1.009)	(1.171)
Region dummies	YES	YES	YES	YES	YES
N	1657	1620	833	2243	1576

Clustered standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$