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## Agricultural supply response and poverty in Mozambique

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Discussion Paper No. 2001/114

## **Agricultural Supply Response and Poverty in Mozambique**

Rasmus Heltberg and Finn Tarp\*

October 2001

### **Abstract**

This paper identifies the key causal factors behind farmers' marketing decisions in Mozambique. A two-step decision making process is modelled. Farmers decide, first, whether or not to participate in the market and, second, how much to market. The model is estimated using a Heckman switching regression approach. Marginal effects are calculated for the poor and the nonpoor and broken down into a market participation component and a quantity (sales value) component. The key importance of non-price factors such as technology, transport infrastructure, farm environment and area characteristics come out clearly. The marginal effects for the poor are not substantially different from those of the nonpoor, suggesting that differences in assets and area characteristics are more important than differences in underlying behaviour. Moreover, inducing farmers previously not in the market appears more important for total sales than focussing economic policy on those already in the market. To achieve pro-poor rural growth it is therefore essential to address explicitly the conditions of high-risk, low productivity and low capital endowments of poor farmers.

**Keywords:** agriculture, supply response, food marketing, Africa, Mozambique

**JEL classification:** Q12, Q18, O13

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‘... the costs of transacting are the key to the performance of economies. There have always been gains from trade ..., but so too have there been obstacles to realizing these gains ... [T]he costs of transacting ... are the key obstacles that prevent economies and societies from realizing well-being’. (North, 1989: 1319-20)

## 1. Introduction

Subsistence agriculture entails large inefficiencies in resource allocation that poor countries can ill afford. Subsistence farmers are among the poorest and most vulnerable of all groups. Integrating traditional smallholder peasants into the exchange economy is therefore important for stimulating growth, economic development, food security and poverty alleviation. The need for increased agricultural commercialization is nowhere as evident as in Sub-Saharan Africa (SSA). Large numbers of African households remain excluded from participating in the cash economy,<sup>1</sup> and risks and transaction costs far exceed those of any other region of the world (Delgado, 1995).

The supply response of African farmers and the merits of ‘pricism versus structuralism’ were hotly debated during the 1980s and early 1990s in the literature on structural adjustment in SSA.<sup>2</sup> It has for some time been clear that Africa needs to move beyond adjustment to development (Cornia and Helleiner, 1994), and agricultural commercialization has to play a crucial part in this process if it is to result in poverty alleviation and improved food security. Yet, much remains to be learned, both conceptually and empirically, about the commercialization process, its determinants and the role of transaction costs, especially at the household level (Mamingi, 1997).

One of the major contributions in this area of research is a volume of case studies edited by von Braun and Kennedy (1994). The links among commercialization, nutrition, poverty and gender are clearly illuminated, and attention is paid to how risk influences the proportion of land, farmers allocate to cash crops. Nevertheless, the impact of exogenous explanatory variables on marketing decisions is not modelled empirically. Modelling the decision to enter the output market is potentially important in situations where many households rely on subsistence farming. Transaction costs, risk and other factors create barriers or thresholds for households to participate in crop markets, and understanding in more depth the decisions involved is important for policy.

In this paper we model marketing behaviour as a two-step decision process: (i) the household decides whether or not to participate in the market, and (ii) establishes how much to sell. The model is estimated using a Heckman or switching regression approach, inspired by the work of Goetz (1992). Simultaneous modelling of marketing regime and amount traded marks a distinct step forward relative to standard empirical approaches adopted in the literature on agricultural supply response. Moreover, it is time to start

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<sup>1</sup> While it is argued here that commercialization is crucial for development, we agree with von Braun and Kennedy (1994: 366) that commercialization will not progress smoothly. There will be backlashes resulting from past and present policy failures. Similarly, it is essential that the poor are not adversely affected by commercialization policies.

<sup>2</sup> See Streeten (1987) for a general survey, whereas Tarp (1990) reviews agricultural price policy in Mozambique.

integrating the dispersed strands of development literature, normally referred to as ‘supply response’, ‘marketed surplus’, ‘agricultural development’, ‘commercialization’ as well as supply and demand analysis. An additional attractive feature of this approach is that it allows detailed break down of marginal effects from the regression into a market participation and a quantity (or sales value) component.

The empirical analysis relies on an interesting 1996-7 household data set for Mozambique. This nationally representative *Inquérito Nacional aos Agregados Familiares sobre as Condições de Vida* (IAF) is a general-purpose living standard survey that covers 8,289 households selected by stratified random sampling (Ministry of Planning and Finance, Eduardo Mondlane University, and IFPRI, 1998). Mozambique, one of the poorest countries in the world, is at a relatively early stage of the commercialization and development process. The population density is only around 20 per sq. km, and social and physical infrastructure is totally inadequate as a consequence of colonial heritage, war and policy failure (Arndt, Jensen and Tarp, 2000). Market segmentation is widespread, and the large peasant population is poorly integrated into food markets. Agricultural production systems are characterized by traditional labour-intensive and low-productive farming methods, and problems of poverty, food insecurity and aid dependence are widespread, even by SSA standards. Sustained output growth is required, and the only sustainable way the country’s many poor smallholders can share in the growth process is through increased participation in output markets.

In the above context it is no easy task to set priorities for the use of scarce capital and human resources. This helps motivate this paper from which it emerges that promoting the inclusion of additional, hitherto subsistence-oriented farmers into food markets is more important to agricultural commercialization than stimulating farmers, who are already active in the market. The marginal effects of the poor appear slightly, but not substantially lower than those of the nonpoor, indicating that differences in farm assets, prices and area characteristics to a large degree can account for the observed lower marketing activity of the poor. The key policy implication is to focus on targeted efforts to build up farm capital, improve market access and diffuse new crop technologies, while also paying attention to smallholder’s investment incentives.

## 2. Theoretical framework

In this section we briefly identify the theoretical model that guides our empirical analysis. The reduced form equation for quantities traded—conditional on market participation—is also derived. We discuss the impact of transaction costs on market participation and suggest a reduced form relationship explaining the selection of marketing regime.

### 2.1 Analytical framework

Consider the following analytical framework adopted from Strauss (1984) and later relied on by Goetz (1992):

$$x_i^s = X^s(p, z_i^s)$$

$$x_i^c = X^c(p, [\alpha_i + f(p, z_i^s)], z_i^c)$$

where  $x_i^s$  is production of food by household  $i$ ,  $x_i^c$  consumption of food,  $p$  are goods prices,  $z_i^s$  fixed factors pertaining to production, *i.e.* characteristics of the household and its area,

$z_i^c$  household characteristics related to consumption,  $\alpha_i$  exogenous income sources and  $f(\cdot)$  farm profits, not accounting for the cost of family labour inputs. Marketed surplus is the difference between production and consumption, or

$$s_i = x_i^s - x_i^c = x^s(\square) - x^c(\square) = f(p, \alpha_i, z_i^s, z_i^c) = f(X_i)$$

Thus, marketed quantities depend on all the exogenous variables irrespective of whether they pertain to the household's production or consumption decision. The usual restrictions imposed by theory on standard supply and demand functions do not apply to marketed surplus. In particular, it is not necessary to estimate the complete system of demand and supply of all products (Sadoulet and de Janvry, 1995).

Denoting the absolute value of the marketed surplus  $|s|$ , Goetz (1992) shows that the elasticity of marketed surplus with respect to its price is

$$\frac{p}{|s|} \frac{\partial s}{\partial p} = \frac{x^s}{|s|} \frac{p}{x^s} \frac{\partial x^s}{\partial p} - \frac{x^c}{|s|} \frac{p}{x^c} \frac{\partial x^c}{\partial p}$$

The first term is the production elasticity weighted by the ratio of quantity produced to (the absolute value of) net market surplus; the second term is the consumption elasticity weighted by the ratio of quantity consumed to net market surplus. This shows that the elasticity of market supply will be large (and positive) when there is a large production elasticity and/or a small consumption elasticity, and where a small fraction of output is initially being marketed (*i.e.* where there is a large degree of subsistence farming with a potential to become for-the-market). Thus, subsistence economies have a huge growth potential provided subsistence farmers can be provided with adequate incentives (broadly interpreted) to start supplying the market.

## 2.2 Transaction costs and market participation

There are two fundamental economic reasons underlying rural autarchy. (i) Subsistence farmers avoid the margin between farm-gate and retail prices, and (ii) reliance on own production for subsistence needs is a risk management strategy in the face of fluctuating food prices, especially in the light of missing or imperfect credit and insurance markets (von Braun, Bouis, and Kennedy, 1994).

The challenge for empirical estimation of marketed surplus is to take account of the interrelationships among market participation, production and sales decisions. Supply response analysis will not generate reliable estimates of the true responsiveness to price and other determinants unless movements into and out of subsistence are accounted for. For policy analysis, it is also important to focus attention on policies to increase market participation (Sadoulet and de Janvry, 1995). In practice, this is done by estimating the marginal effects of the exogenous variables on both market participation and supply, based on a full sample of both market and subsistence farmers.

In a recent important contribution, Key, Sadoulet and de Janvry (2000) introduce the distinction between fixed or lump sum transaction costs, on the one hand, and variable, proportional or per-unit transaction costs on the other hand. They show that both fixed and variable transaction costs impact on market participation whereas supply decisions (amount sold), conditional on market participation, only depends on variable transaction costs. This implies that fixed transaction costs can be excluded from the quantity part of

the model, and that fixed transaction costs can be used econometrically to identify market participation:

$$\text{Probability}(\text{market participation}) = f_i(X_i, \tau_i).$$

Hence it is postulated that variables which explain traded quantities also explain the selection of marketing regime, while the fixed transaction cost that help determine market regime do not affect the amount traded conditional on being on the market.

Transaction costs are normally defined as all costs of entering into a contract, exchange or agreement: searching for trading partners, screening potential candidates, obtaining and verifying information, bargaining, bribing officials, transferring the product (including transport, storage and packaging cost), and monitoring, controlling and enforcing the transaction. At best, transaction costs are partly observable. No data are available on transaction costs in the data set used for this paper, however, as in most other data sets of this kind. Instead, we have to work with observable exogenous variables that are theoretically expected to help determine the size of transaction costs. Measures such as distance, type of transport available and information variables are examples of exogenous transaction cost determinants. Measures of distance and transport are expected to determine variable transaction costs, and information variables are expected to determine fixed transaction costs.

### 3. Estimation procedure

Using the framework of a Heckman or switching regression model (Maddala, 1983) the amount of output marketed can be estimated jointly with regime. We focus here on the value of sales of agricultural outputs as well as on the choice between autarchy and selling regime. Three regressions are run for: (i) total sales, (ii) marketing of food crops and (iii) marketing of cash crops, and each regression has both a selection and a value component.

The statistical model can be stated as follows:

$$s_i = \beta X_i + u_i$$

$$s_i \text{ is observed iff } \gamma X_i + \kappa \tau_i + e_i > 0$$

$$\text{corr}(u_i, e_i) = \rho \neq 0$$

where  $X$  is a vector of all the explanatory variables except fixed transaction costs ( $\tau$ ), and  $\tau$ ,  $\gamma$ ,  $\kappa$ , and  $\rho$  are parameters to be estimated. Subscript  $i$  indexes households and crop aggregation (total sales, sales of basic food crops, and sales of cash crops) is suppressed for notational simplicity.

The estimation method can be explained using the example of a two-step approach, although in practice a joint likelihood function is estimated. In the first step, selection into regimes S (selling) and B (autarchy) is modelled in separate probit-type equations, *i.e.* an equation for selling versus autarchy including fixed and proportional transaction costs as well as all other explanatory variables. In the second step, the determinants of traded value conditional on market participation are analysed. Hence, both regressors and parameters are allowed to vary across the two steps and across regimes. It is necessary to correct for

selectivity in the second step because selling households are non-random subsets of all the sampled households. Least squares without selectivity corrections would lead to invalid estimates of the parameters for the full sample. Unconditional marginal effects (*i.e.* for the full sample) cannot be derived from least squares parameters and the possibility that regressors might influence market regime and traded values differently would completely escape least squares analysis. The selection regression framework applied here therefore holds promise for future empirical work on agricultural supply response and marketing. The selection framework is especially promising in situations where transaction costs barriers are important and where a large proportion of producers (or consumers for demand analysis) live in autarchy as in the case of Mozambique.

As mentioned, the actual estimation is not performed in two steps, but as a quasi maximum likelihood procedure which jointly estimates the parameters of the selection and the marketing equation. Reported standard errors are based on the Huber-White estimator of variance. These standard errors are robust against many types of mis-specification of the model. Covariance between the probability of participation and the quantity traded (the  $\tau$ 's) are captured by modelling the joint likelihood of market participation and traded values. The price variables used as regressors are the village mean unit values of maize and groundnut, the most important food and cash crop, respectively. These unit values are defined as purchased value divided by the amount purchased. The village means are formed after removing the top and bottom 2.5 percent of the distribution and deflating the observations to account for seasonal price swings during the sampling period. If no village observation is available, the mean for the *posto administrativo* is used instead. Consumer values are used because consumption data are so much more frequent than sales data and because a careful previous adjustment exercise (documented in Ministry of Planning and Finance et al., 1998) has created consumption value and quantity data that are cleaned to account for non-standard measurement units.

## 4. Results

### 4.1 Descriptive statistics

Table 1 shows some descriptive statistics regarding market participation of the survey households for different crop categories. The table shows the proportion of rural and urban households that sell crop output, disaggregated into basic food, cash crops, horticultural crops and fruits as well as the mean sales value in Meticaís (where the mean is formed over the sellers only). It is evident that rural households are more likely to be sellers than urban households, and that the average value of their sales is higher. The only exception is horticultural crops, where the average urban seller sells more, no doubt due to easier market access and better prices for these perishable goods.

The livelihood of the vast majority of Mozambicans is based around the *machamba* (farm plot). Yet, while 94 percent of rural households operate some land (the mean is 2.4 ha. per household), only 29 percent sell any crop output (see Table 1).<sup>3</sup> The most important commercial crops are basic food crops (such as maize, beans, cassava and rice) followed

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<sup>3</sup> All descriptive analyses in this paper apply the population sampling weights (called expansion factor) that resulted from the sampling stratification procedure of IAF. Regressions are unweighted.



by cash crops (mainly groundnut and cotton). In contrast, fruit crops (cashew, mango and banana) are sold by many but in small quantities and is not a major cash earner. Horticultural crops are not frequently sold. In rural areas, the average annual value of sales is 447,000 Meticais (Mt) per selling household, corresponding to US\$40 at the time of the survey. This is a very low amount by any standard, testifying to the low degree of commercialization and lack of general economic development in the country. A farm survey, known as TIA, carried out roughly at the same time, did find larger market participation rates and average sales values (Heltberg 2000), so it is possible that the figures in Table 1 underestimate the true picture somewhat. On the other hand, in the IAF survey careful attention was paid to sampling, and it is not clear if TIA did the same.

Table 1  
Participation in food markets

	Rural		Urban	
	% sellers	Mean sales value (MT)	% sellers	Mean sales value (MT)
Basic food	14.3%	187,958	2.5%	178,226
Cash crops	7.1%	520,031	0.9%	84,185
Horticultural crops	1.5%	165,783	1.0%	232,308
Fruit crops	11.5%	70,992	3.3%	13,757
All output	29.2%	446,785	6.1%	233,538

Source: Authors' calculations based on IAF data set.

Note: households are weighted by sampling weights.

## 4.2 Regression results

In Table 2, the regression results for market participation and sales value are shown for the rural sample of IAF<sup>4</sup>. There are three regression models, i.e. for (a) the log of total sales, (b) the log of food crop sales, and (c) the log of cash crop sales. The results for each model are reported in two columns. First, the column labeled quantity models the log of the annual value of sales given market participation. Second, the selection column shows the results of the marketing probability model. The results are as follows. The price of maize, the most important food crop, does not have any significant effects. The mean price of groundnuts, the most important cash crop, has a positive and significant effect on the quantity of total sales, while other parameters for groundnut price are not significant.

Three variables are included to characterize the capital endowment of the farm: Farm size measured as land per household worker (aged 14-60), log number of trees and a dummy for ownership of traction equipment. They are positive and significant in several of the equations. Farm size, for example, is positive and significant for total output sales (both market participation and sales), as well as for food and cash crop market participation

<sup>4</sup> Since data on most village-level characteristics and transaction cost determinants are unavailable for urban areas, the regression analyses in this paper are confined to rural households.

individually. Number of trees has significant positive effects on total sales (both equations) and on food crop market participation. The dummy for traction ownership is positive and significant only for total sales value. This shows that it is primarily those farmers who are relatively well-endowed with agricultural capital and land who commercialize.

Household background characteristics are captured by dependency ratio (the number of dependants below 14 and above 60 per household member of working age), log age of the household head and by a dummy for households in which any member has paid employment. Age of head indicates the position of the household in the life cycle, while the dummy for paid employment is included to control for exogenous income earning opportunities (off-farm employment is relatively rare in Mozambique and unevenly distributed according to education and place of residence). Dependency ratio is not significant anywhere. Age of head is found to impact negatively and in a significant manner on the probability of market participation in all three models, but not on quantity sold. This finding may be explained by variation in cash need, variation in farming ability across the life cycle, or both. Paid employment has significant negative effects on market participation for both total output and cash crops. This may be due to different livelihood strategies for households depending on their access to employment—those without a job find it more pertinent to sell some output in order to meet cash needs.

Geographical factors are captured by the log of mean province maize yield (an important technological variable), by a dummy for risky areas (defined as districts prone to drought, flood or both), and by dummies for the Northern and for the Central region. Maize yield has positive and significant impacts on market participation for both cash crops, food crops and all output as well as on total sales value. Dummy for risky areas has negative and significant impacts on market participation in all three models as well as on the value of total sales. Hence, improved food crop productivity can drive commercialization of all crops, because it frees up labour and land resources previously tied up for subsistence purposes to be employed for market production instead. Likewise, living in a risky region is clearly associated with less commercialization. The likely reason is the need to self-insure against climatic risk. In environments where insurance and credit markets are virtually absent, farmers' risk aversion leads to adoption of safe, low-yielding technologies in order to reduce ex ante production risk as argued by Arndt and Tarp (2000). The dummies for the northern and central provinces take on mostly negative signs, four of which are significant, indicating the lower degree of market integration in these areas.

Variable transaction costs are captured by a dummy for ownership of transport (bicycle, motorcycle or car), by the log distance to a railway station and by the log distance to the provincial capital. Transport ownership has the expected positive and significant effect on sales value and market participation for all output combined and on cash crop market participation. Distance to railway has the expected negative and significant effects on total sales (both value and participation) and on food market participation. Surprisingly, the opposite is found for distance to the provincial capital, where significant positive effects are found for market participation in all three models and for total sales value. Since provincial capitals tend to be important market centres, transaction cost considerations would make one expect market participation to decrease, not increase, with distance. However, it is likely that better off-farm employment opportunities (in addition to those captured by the dummy for those currently holding a job) for households close to the provincial capitals may account for their smaller reliance on output sales markets.

Table 2  
Regression results (Heckman model)

	Sales of					
	All crops		Food crops		Cash crops	
	Quantity	Selection	Quantity	Selection	Quantity	Selection
Log maize price	-0.071 (0.32)	0.031 (0.28)	-0.161 (0.59)	-0.203 (1.68)	-0.314 (0.42)	-0.157 (0.79)
Log groundnut price	0.361 (2.62)**	0.057 (0.76)	0.069 (0.58)	0.016 (0.18)	-0.267 (0.69)	0.175 (1.80)
Farm size per household worker	0.133 (2.75)**	0.099 (4.15)**	-0.013 (0.10)	0.104 (3.32)**	-0.113 (0.78)	0.135 (3.49)**
Dependency ratio	-0.023 (0.11)	0.087 (1.00)	-0.216 (0.82)	0.09 (0.89)	0.564 (1.15)	-0.13 (1.06)
Log number of trees	0.268 (3.08)**	0.368 (15.10)**	-0.108 (0.93)	0.084 (4.07)**	-0.177 (1.71)	0.043 (1.41)
Traction ownership dummy	0.5 (2.22)*	0.111 (1.06)	0.421 (1.17)	0.214 (1.75)	-0.422 (0.65)	0.102 (0.48)
Log age of household head	-0.102 (0.76)	-0.151 (2.16)*	0.31 (1.00)	-0.186 (2.41)*	0.66 (1.75)	-0.254 (2.83)**
Any member has paid job	-0.061 (0.39)	-0.268 (3.51)**	0.38 (1.57)	-0.114 (1.30)	0.574 (0.85)	-0.434 (2.99)**
Log of mean maize yield in Province	0.674 (2.00)*	0.814 (4.46)**	-0.005 (0.01)	0.679 (2.87)**	-1.632 (2.12)*	0.81 (3.19)**
Dummy for risky area	-0.901 (2.97)**	-0.774 (4.30)**	0.272 (0.29)	-0.805 (3.23)**	-0.023 (0.03)	-0.627 (2.59)**
Northern region dummy	-0.176 (0.29)	-0.548 (1.72)	-0.16 (0.14)	-0.947 (2.40)*	-1.492 (1.03)	-0.074 (0.16)
Central region dummy	-0.743 (1.57)	-0.337 (1.40)	-0.838 (1.45)	-0.391 (1.36)	-0.625 (0.50)	-0.884 (2.42)*
Transport ownership dummy	0.356 (2.37)*	0.235 (3.14)**	0.151 (0.63)	0.121 (1.57)	-0.266 (0.56)	0.348 (3.40)**
log Distance to railway	-0.138 (2.25)*	-0.109 (3.15)**	0.047 (0.29)	-0.119 (3.31)**	-0.293 (1.67)	-0.052 (0.92)
log Distance to Province capital	0.268 (2.19)*	0.205 (2.80)**	-0.154 (0.30)	0.377 (3.65)**	0.03 (0.09)	0.241 (2.40)*
Own radio, TV or telephone?		0.013 (0.24)		0.133 (2.30)*		0.075 (1.35)
Maximum education of household head		0.105 (1.60)		0.034 (0.47)		-0.008 (0.10)
District population density		-0.001 (0.41)		-0.001 (0.39)		0.002 (0.97)
Constant	8.717 (3.51)**	-0.568 (0.48)	13.604 (5.44)**	0.872 (0.64)	20.406 (3.25)**	-0.9 (0.46)
Observations	5385	5385	5385	5385	5385	5385

Source: Authors' calculations

Note: \*significant at 5% level; \*\*significant at 1% level.

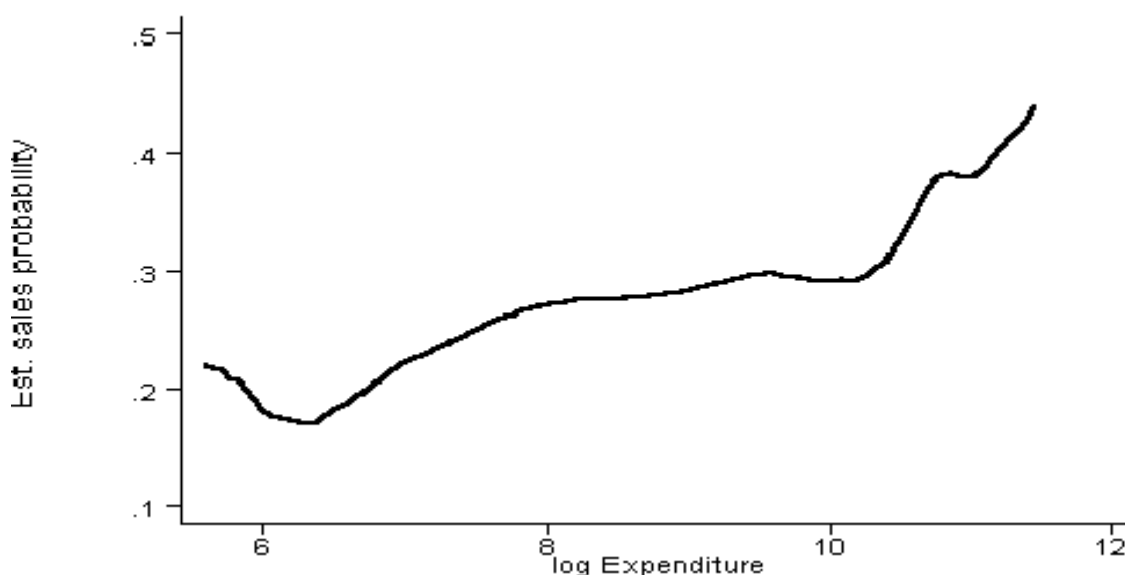
Fixed transaction costs (the  $\tau$  variables), can be measured by variables that describe households' access to and ability to process market information. Recall that fixed

transaction costs have a lump sum nature so they are not supposed to affect each individual transaction but rather the probability of participating in markets. Fixed transaction costs are captured in our data by a dummy for ownership of radio, telephone or TV (for access to information), by the maximum education level of the household head (for the ability to process information) and by the district population density (a proxy for the density of informational networks). Ownership of radio, TV or telephone has a significant positive effect on food crop market participation. Education of the household head and district population density are not significant. Thus, the proxies included here to help capture fixed transaction costs do not give very good results, and one would ideally like to have better proxies or even direct measurements of fixed transaction costs. Results will have to be interpreted with caution.

### 4.3 Market participation and poverty

Non-parametric or kernel density regression techniques can be used to explore how market participation depends on the income level of the household (Deaton, 1997). Thus, from the regressions in Table 2 the estimated marketing probabilities were recovered. The conditional distribution of these marketing probabilities is plotted against household per capita expenditure using a standard Epanechnikov kernel and a bandwidth of 0.6. Figure 1 shows that the overall marketing participation increases quite strongly with expenditure. Thus, the estimated marketing probability increases from around 0.2 at the lower end of the rural expenditure distribution to over 0.4 at the highest end. For cash crops, the story is even more dramatic as can be seen from Figure 3, with up to five times higher marketing probability for the best off relative to the poorest.

Figure 1  
Nonparametric regression of total sales probability



For marketing of food crops, however, the picture is slightly different. From Figure 2 it can be seen that the contrast between rich and poor is not very large, and the probability of selling food crops even drops over part of the range. One can hypothesize that since food crops are grown by almost everybody, selling a bit of maize from the granary is one of the only cash earning opportunities of the poor in times of need. The implication is that

poverty oriented efforts to integrate and expand smallholder crop markets should not neglect basic food crops.

Figure 2  
Nonparametric regression of food sales probability



#### 4.4 Marginal effects of the poor and the nonpoor

If the poor are to be able to share in and benefit from economic growth, it is important that their degree of market integration be increased. Hence it is vital to understand the factors underlying the systematic differences in market integration for various crops across smallholders' welfare level. Conceptually, there are two ways in which supply response can depend on welfare level or poverty status. One, the assets, technologies and incentives available to the poor and the nonpoor may differ. This is for example the case if the poor find themselves unable to share in market-based growth for lack of labour or land. Or, two, the behavioural responses (controlling for assets, technologies and incentives) may vary between the poor and the nonpoor. This is for example the case if risk aversion or lack of entrepreneurial talent or knowledge stop the poor from taking advantage of market opportunities.

In the following, we investigate these possibilities by comparing (i) average endowments, technologies and incentives of the poor and the nonpoor, and (ii) marginal effects of the poor and the nonpoor.<sup>5</sup> Marginal effects show the change in supply that would be induced by a marginal change in the exogenous variables. We ran the regression for total sales separately for the poor and the nonpoor sub-samples (results are reported in Table 3). It can be seen that although there are several quantitative differences, in qualitative terms the determinants of commercialisation do not appear substantially different between the poor and the nonpoor. In order to better facilitate comparison, marginal effects for each sub-

<sup>5</sup> Separation into the group of poor and nonpoor households was done in previous and unrelated work using the Cost of Basic Needs method of setting the poverty line by Ministry of Planning and Finance et al. (1998). National headcount poverty is 69 percent and in rural areas it is 71 percent.

sample are derived and used to investigate if the poor exhibit different behavioural responses than the nonpoor.

Figure 3  
Nonparametric regression of cash crop sales probability



Before discussing these results, it will be useful to clarify the concept of marginal effect, or elasticity of supply within the context of the Heckman or switching regression model. Marginal effects summarize the information embedded in the selection and value parameters, including cases where these have opposite signs, allowing the researcher to quantify the impact of different explanatory variables. For selection models, a number of different marginal effects can be derived which differ in interpretation, causing some confusion in the literature (McDonald and Moffitt, 1980). Marginal effects depend on regime selection and the appropriate choice hereof depends on the particular interpretation of interest. These marginal effects are: (i) the marginal change in the probability of participating in the market as derived from the selection equation; (ii) the change in desired marketed quantities (for the full sample) that can be derived directly from the estimated parameters in the quantity equation; (iii) the conditional marginal effects (*i.e.* given market participation), using information only for those already in the market; and (iv) the unconditional marginal effects. The unconditional elasticities of supply and demand are derived for the entire sample (as opposed to only those at the market), and they show the impact of parameters on observed (as opposed to ‘desired’) quantities. As unconditional effects refer to the expected change in actual quantities traded on markets they are of key policy interest and are in focus in this paper.

Table 3  
Regression results for poor and nonpoor (Heckman model)

	Sales of all crops			
	poor subsample		nonpoor subsample	
	Quantity	Selection	Quantity	Selection
Log maize price	-0.331 (1.40)	-0.055 (0.44)	0.322 (1.26)	0.177 (1.23)
Log groundnut price	0.339 (2.19)*	0.102 (1.28)	0.438 (3.42)**	-0.019 (0.20)
Farm size per household worker	0.069 (1.36)	0.079 (2.96)**	0.184 (2.63)**	0.116 (3.31)**
Dependency ratio	0.243 (0.87)	0.199 (1.52)	-0.012 (0.04)	0.126 (0.90)
Log number of trees	0.314 (2.83)**	0.37 (12.79)**	0.129 (0.77)	0.368 (12.21)**
Traction ownership dummy	0.194 (0.73)	0.114 (0.83)	0.719 (2.31)*	0.061 (0.50)
Log age of household head	0.019 (0.11)	-0.093 (1.11)	-0.061 (0.27)	-0.242 (2.18)*
Any member has paid job	-0.103 (0.56)	-0.266 (3.22)**	-0.041 (0.15)	-0.27 (2.38)*
Log of mean maize yield in Province	0.746 (2.06)*	0.773 (3.99)**	0.519 (0.88)	0.864 (3.46)**
Dummy for risky area	-0.945 (2.63)**	-0.742 (3.90)**	-0.616 (1.12)	-0.842 (3.48)**
Northern region dummy	-0.349 (0.53)	-0.38 (1.19)	0.241 (0.28)	-0.901 (2.07)*
Central region dummy	-0.935 (1.96)*	-0.217 (0.89)	-0.309 (0.51)	-0.548 (1.66)
Transport ownership dummy	0.222 (1.30)	0.229 (2.89)**	0.492 (2.15)*	0.221 (1.92)
log Distance to railway	-0.127 (1.77)	-0.102 (2.75)**	-0.143 (1.43)	-0.122 (2.88)**
log Distance to Province capital	0.222 (1.74)	0.158 (2.14)*	0.259 (1.43)	0.285 (2.83)**
Own radio, TV or telephone?		0.053 (0.80)		-0.039 (0.44)
Maximum education of household head		0.025 (0.18)		0.128 (1.73)
District population density		-0.002 (1.29)		0.002 (0.65)
Constant	10.716 (3.90)**	-0.453 (0.35)	4.833 (1.79)	-0.855 (0.53)
Observations	3488	3488	1897	1897

Source: Authors' calculations

Note: \*significant at 5% level; \*\*significant at 1% level.

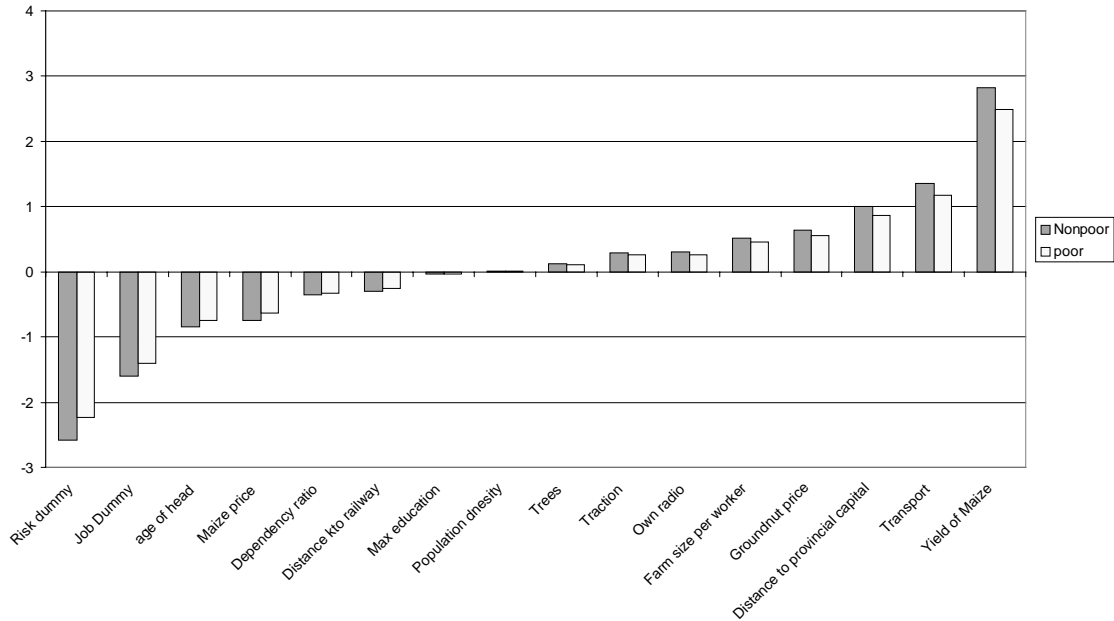
Huang, Raunika and Misra (1991) show that for any variable  $x$  in the  $X$  vector, the unconditional marginal effect can be derived as

$$ME^x = \frac{\partial s}{\partial x} = \beta^x \Phi(\gamma X + \kappa \tau) + \gamma^x \phi(\gamma X + \kappa \tau) [X \beta + (\gamma X + \kappa \tau) \rho]$$

$$= \beta^x \cdot psel + \gamma^x \cdot \phi(xbsel) \cdot ycond$$

where  $\phi(\cdot)$  and  $\Phi(\cdot)$  denote the standard normal distribution and density functions, respectively and  $\tau^x$  and  $\tau^x$  are the estimated parameters for variable  $x$  in the quantity and selection part of the model, respectively. The first part of expression (6) represents the change in quantity in response to a change in  $x$  ( $\tau^x$ ) weighted by the probability of being in the market ( $psel$  in *Stata* language); the second part represents the change in the probability of being on the market ( $\tau^x \tau(xbsel)$ ) weighted by the expected value traded if on the market ( $ycond$  in *Stata* terminology). In this paper all marginal effects are evaluated at the mean of the data. Note that since the  $\tau$  variables do not appear in the quantity part of the model, only part 2 of the equation can be calculated.

Figure 4  
Marginal effects for poor and nonpoor (total sales value)



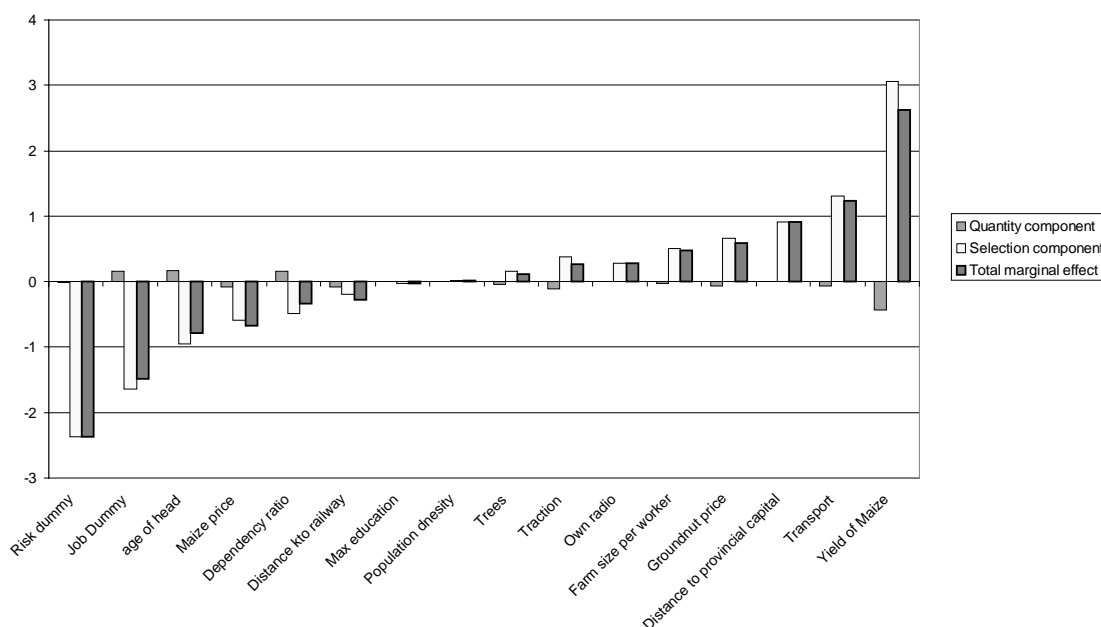
The unconditional marginal effects associated with the regression results for total sales are shown in Figure 4 the poor and the nonpoor subsamples.<sup>6</sup> The largest effects on commercialization come from the following variables in descending order of importance (and with sign of impact in parenthesis): yield of maize (+), risky area dummy (-), dummy for off-farm employment (-), ownership of transport equipment (+), distance to provincial capital (+), age of the household head (-), price of maize (-), price of groundnuts (+) and farm size per worker (+). This suggests that the quantitatively most important factors for

<sup>6</sup> As these marginal effects are estimated from cross-section data, they are essentially short-run in nature. Since agriculture may respond with considerable lags, long-run supply elasticities will be more elastic with respect to prices and other factors than in the short run (Binswanger, 1990).



commercialization are those that relate to the area such as risk and yield and to household endowments of farm capital and land.

Figure 5  
Marginal effects broken into components



By comparing the total MEs for the poor and the nonpoor, it can be seen that the marginal effects of the nonpoor are larger in absolute terms than those of the poor, but the difference is not substantial. This suggests that the underlying behavioural relationships may not be very different depending on poverty status. Observed differences seem to a larger extent to be caused by variations in endowments and to geographical and technological differences among the areas in which the poor and the nonpoor typically live. When looking at the means of the exogenous variables across poverty groups (not shown), it is interesting that the mean for maize yields is higher while the mean of the risk dummy is lower for the nonpoor. Since these two variables have large marginal effects, these area-based differences between the poor and the nonpoor may account to an important degree for variation in commercialization. The policy implication is that support for smallholder asset building and improvements in technology and in market access targeted to the poor are likely to pay off.

Another interesting decomposition of the marginal effects consists of breaking them down into a quantity component (the first part of the equation) stemming from the response of farmers already on the market and a participation component (part 2 of the equation) stemming from those who would enter/exit the market in response to changes in the exogenous variables. Part 1 and part 2 are directly comparable in magnitude. The decomposition, shown in Figure 5 for the full sample brings out an interesting implication of the regression results. Part 2 of the marginal effects, the weighted entry/exit component, is substantially larger than part 1, the quantity component for almost all regressors. The implication of this finding is that the additional market supply that can be generated from farmers already on the market appears substantially less than the supply that can be generated by inducing subsistence peasants to start marketing a portion of their production.

The policy implication is that successful commercialization policy will bring a large proportion of the peasant population into the realm of markets (through for example improved technology, infrastructure and more farm assets). This actually appears more important than stimulating those who are already integrated in the market.

## 5. Conclusions

In this paper, we have applied the Heckman or switching regression framework to explain the determinants of the likelihood and the extent of smallholder market participation within the Mozambican context of widespread poverty and subsistence production.

This paper demonstrates that policies to expand smallholder commercialization can contribute in a significant manner to the incomes of the rural poor. Among these policies, improved agricultural technology, access to markets, better risk management and expansion of basic physical and human capital appear to be crucial, along with appropriate price signals. Thus, it is clear that policy makers cannot afford to ignore non-price factors such as technology, transport infrastructure, farm endowments and area characteristics in agricultural development programs. It was also found that including additional, hitherto subsistence-oriented farmers into agricultural output markets seems more important than stimulating farmers, who are already in the market, to supply extra output. Factors such as crop yield, risk, farm assets and land were the most important for smallholder commercialization. In order to expand participation in agricultural output markets and reduce poverty it is, therefore, vital to overcome the obstacles of risky low yield environments, lack of basic farm assets and high transaction costs. For this, proper investment incentives combined with targeted support for smallholder asset building is called for.

Finally, poor and nonpoor farmers do not seem to respond differently to incentives. Estimated marginal effects are quite similar for the two groups. Yet, the poor in Mozambique are more likely to live in high-risk and low-yield areas, and own less basic farm capital goods. To achieve pro-poor rural growth, addressing these factors and expanding the productivity and market integration of basic food crops is essential.

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