Market Participation by Rural Households in a Low-Income Country: An Asset-Based Approach Applied to Mozambique

Duncan Boughton, David Mather, Christopher B. Barrett, Rui Benfica, Danilo Abdula, David Tschirley, and Benedito Cunguara

Abstract: *The transformation from a subsistence-oriented agricultural sector to one where farmers are integrated into product, input, and service markets is at the heart of many poverty reduction strategies. But this transformation is occurring painfully slowly in Africa. To speed up the process, significant investments are being made in public goods such as roads and market information to promote farmer-to-market linkages. This paper examines the relationship between assets and market access for different types of crop market in Mozambique using a Heckman two-stage regression model and data from a nationally representative rural household survey conducted in 2002. Evidence of increasing returns to household assets in all crop market types is explored further using a non-parametric approach. The evidence indicates that only a small proportion of Mozambican smallholders currently have a sufficient asset base to participate profitably in crop markets. We conclude that while investment in public goods is a necessary condition for transformation to occur, attention must also be given to facilitate growth in household assets.*

Market participation is both a cause and a consequence of economic development. Markets offer households the opportunity to specialize according to comparative advantage and thereby enjoy welfare gains from trade. Recognition of the potential of markets as engines of economic development and structural transformation gave rise to a market-led paradigm of agricultural development during the 1980s (Reardon and Timmer 2006) that was

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accompanied by widespread promotion of market liberalization policy agendas in Sub-Saharan Africa (SSA) and other low-income regions. Furthermore, as households' disposable income increases, so does demand for variety in goods and services, thereby inducing increased demand-side market participation, which further increases the demand for cash and thus supply-side market participation. The standard process of agrarian and rural transformation thus involves households' transition from a subsistence mode, where most inputs are provided and most outputs consumed internally, to a market engagement mode, with inputs and products increasingly purchased and sold off the farm (Timmer 1988, Staatz 1994).

Despite two decades of experience with market liberalization in SSA, structural transformation is progressing agonizingly slowly and with very unequal distribution of the limited welfare gains (Barrett et al. 2007). Part of this appears due to sharp differences in the apparent returns to participation in different markets, differentiated by commodity, function (e.g., storage, transport, retailing), and barriers to entry (Barrett 1997, Barrett et al. 2005, Haggblade et al. 2005). Individual household members, if not entire households, often move out of agriculture altogether rather than move from subsistence agriculture to commercialized agriculture (Mazumdar 1987, Lucas 1994). But with rapid outmigration, urban areas may not be able to provide adequate employment or social services fast enough to support their rapidly growing unskilled labor forces, with the risk of increasing urban (absolute, as well as relative to rural) poverty and squalor. Since investments in services to encourage people to remain in rural areas often meet with at best partial success, the identification of ways to increase the returns to agriculture through market participation, and thereby provide incentives for more households to remain in rural areas while their children build up the necessary human capital to facilitate a socially viable transition into other sectors, is a research challenge of critical importance.

This paper explores patterns of household agricultural market participation in Mozambique, a country at an early stage in the structural transformation of its rural economy. We take an asset-based approach, hypothesizing that household participation in crop markets will be associated with asset endowments, and that participation in higher return markets may require different asset portfolios (amount and types of asset) than does participation in less remunerative markets. Toward that end, we study three distinct types of crop market: (1) spot markets for a basic food staple, maize (characterized by low barriers to entry, high transactions costs

and low returns); (2) contract production of a relatively undifferentiated commodity—cotton—for a known buyer (characterized by potential barriers to entry, moderate risk of financial loss, low transactions costs); and (3) contract production of a quality-differentiated product, tobacco (similar characteristics to (2) but with higher potential financial returns and risk). Since endogeneity is an intrinsic problem when studying the relationships between assets and market participation we cannot infer causality. But if asset stocks are strongly associated with smallholder market entry, especially into more remunerative markets, this carries potentially important implications for governments and their private sector, civil society, and donor partners who make investments and design programs that seek to increase smallholder market participation. Simply put, if the asset-poor are unlikely to participate actively in commercial markets, especially contract markets which offer greater expected returns, then efforts to stimulate increased smallholder agricultural commercialization may fail without complementary efforts to increase household wealth. Our study adds to a small but growing literature that raises this possibility (Cadot et al. 2006, Barrett 2007).

The paper's principal finding is that private household assets, especially land, but also livestock, labor and equipment, are strongly positively associated with crop market participation. Furthermore, earnings increase at a sharply increasing rate as one moves into the upper tail of the land distribution in Mozambique, for all crops, not just cash crops. Another important finding is that, while public goods such as infrastructure and market information are positively correlated with cash crop market participation, private asset holdings are even more strongly correlated. In contrast to cash crops, public goods are surprisingly insignificantly correlated with maize market participation. While the nature of the data limit the inferences one can make, these findings are consistent with recent evidence from Madagascar (Cadot et al. 2006) that private asset accumulation may be a prerequisite for smallholders' escape from subsistence production. Furthermore, female-headed households appear to be at significant risk of exclusion from cash crop contract farming opportunities even when controlling for differences in asset endowments, signaling that there are more than mere wealth barriers to taking advantage of the opportunities afforded by liberalized agricultural markets.

Three important policy and policy research implications arise from these findings. First, more attention needs to be given to policies and programs that address missing rural financial markets and other factors, such as limited access to animal traction, that seem to constrain smallholder private

asset accumulation. Second, investments in roads and market information to improve crop market access for smallholders may not be sufficient *by themselves* to result in broad-based increases in crop market participation at this early stage of Mozambique's smallholder agricultural development. However, increased investment in the complementary public good of agricultural research may be very important to raise crop productivity and thereby reduce minimum asset thresholds for crop market participation. This is an important hypothesis that is not presently testable given available data. Finally, given the importance of land access and utilization for crop market participation and the difficulty of changing the institutions that govern smallholders' land access, not all smallholders are likely to be commercially viable in the short to medium term (Carrillho et al. 2003).[1] For those households that cannot build the necessary asset portfolios to escape poverty through crop market participation, there will need to be policies and programs that enable more remunerative household participation in off-farm labor markets and non-farm entrepreneurial opportunities.

The rest of the paper is organized as follows. The next section reviews the relevant literature that guides the conceptual framework presented in section 2. Sections 3 and 4 present empirical results. The final section identifies, within the limits of the data, implications for development policy and programs, as well as for future research.

1 Literature Review

In this section we review three recent strands in the literature concerned with the determinants of market participation and poverty. Although private asset holdings have been recognized as a key determinant of market participation or exclusion, systematic assessment of the relationship between household asset portfolios and participation in different types of product market is an under-explored seam of policy-relevant knowledge. Our purpose here is not to attempt an exhaustive review, but rather to inform the conceptual framework and choice of econometric model for an asset-based approach to understanding market participation by smallholders that can address this gap in the literature.

The first and historically richest strand of literature concerns the determinants of small farmer participation in markets in semi-subsistence agrarian economies. This strand has focused primarily on (1) understanding the role of transactions costs and market failure in smallholder decision making and (2) resolving the econometric challenges to testing hypotheses concerning smallholder market participation in the presence of possible selection bias. Landmark theoretical contributions by de Janvry et al.

(1991) and Fafchamps (1992) develop formal household models to explain low smallholder supply response in the presence of food or labor market failure. A key conclusion of their work, empirically confirmed in a range of situations by von Braun et al. (1989), is that low productivity in food crop production, in the presence of food market failure, is a constraint to participation in cash crop markets. A corollary of this is that a wide spread between food purchase and sale prices makes cash crops relatively more profitable for net food sellers than net food buyers (Jayne 1994). Thus if net marketable food surplus is causally related to household endowments of productive assets such as land and labor, better endowed households should be more likely than poorer households to participate in cash crop markets because the returns to cash crops are then directly related to household endowments (e.g., land, livestock) that typically have a strong, positive effect on the likelihood of being a net seller of basic staples (Barrett and Dorosh 1996).

Empirical analysis of the determinants of smallholder market participation has to deal with the econometric hazard of selection bias (Heckman 1979). The problem arises because households (or individuals) face different types of decisions in relation to market participation—a discrete decision over whether or not to participate in a given market as either a buyer or a seller, and a continuous decision as to how much to buy or sell conditional on market participation. Variables affecting the latter, continuous decision may affect the discrete participation decision while some factors—e.g., fixed costs of market participation due to transport costs or vendor license fees—that affect the discrete participation decision will not, in theory at least, affect the continuous decision. If unobserved preferences (e.g., risk aversion) or characteristics (e.g., liquidity constraints) affect both decisions, then regression estimates of the continuous choice will yield biased estimates absent correction for the first-stage participation choice.

To avoid the potential problem of selection bias, Goetz (1992) first estimated a reduced form probit model of market participation (as either buyer or seller) and then an endogenous switching regression model of purchase/sales behavior allowing for households to select themselves into buying and/or selling states. An alternative approach used by Key et al. (2000) estimates the structural supply functions and production threshold functions based on a censoring model with an unobserved censoring threshold. Either of these approaches allows for market nonparticipation without conflating the participation decision with the continuous decision of sales (or purchase) volume conditional on participation. They differ, however, as to whether households make simultaneous participation and

volume decisions—which might imply they are vulnerable to exploitation by traders—or if they make these decisions sequentially. Bellemare and Barrett (2006) offer a general model and corresponding econometric method that enables testing between these competing formulations.

Two recent studies of smallholder market participation in Mozambique are Heltberg and Tarp (2002) and Benfica et al. (2006). Heltberg and Tarp (2002) use Goetz's approach to estimate reduced form equations for market participation and value sold of food crops (as a group), cash crops (as a group), and total value of crops sales, using data from a 1996-97 Living Standards Measurement Survey (LSMS). Factors significantly affecting market participation included farm size per household worker, animal traction, mean maize yield, age of household head, climatic risk, transport ownership, and infrastructure. Explaining variation in the value of sales for food crops or cash crops was much less conclusive, and the authors recognize that aggregation of sales into food or cash crop groups may mask underlying causal mechanisms related to individual crop decisions. Benfica et al. (2006) use the same approach to investigate the determinants of participation of cotton and tobacco contract farmers in the Zambezi valley of Mozambique, and test for the existence of threshold effects in land holdings and educational attainment on smallholder earnings from tobacco. Participation in contract farming schemes was statistically significantly linked to household factor endowments and alternative income opportunities.

A second strand of the literature on smallholder market participation relates to contract farming schemes. Dorward et al. (1998) provide a comprehensive conceptual framework and set of empirical studies on the motivation and performance of interlocked credit and output markets as an induced institutional innovation in response to widespread rural financial market failure following market liberalization in SSA. Benfica et al. (2002) provide a similar conceptual framework and analysis for recent agro-industrial investments in Mozambique. Two important distinctions affecting farmer participation in interlinked credit and output markets that emerge from this research are: 1) the potential for involuntary exclusion of smallholders from participation in contract schemes; and 2) the potential for monopsony power on the part of a buyer in return for access to technology (inputs, credit and extension), resulting in lower financial returns and increased risk of financial loss for farmers. A key criterion for selection into contract farming schemes is whether a grower can signal the availability of complementary production assets to enable effective use of expensive inputs.[2]

The same concerns about exclusion have been raised about the rapid expansion of Foreign Direct Investment (FDI) in integrated value chains that are often, but not exclusively, driven by supermarkets and urbanization (Reardon and Barrett 2000, Reardon and Timmer 2005). The apparent exclusionary effects of FDI in integrated value chains implies that innovation in marketing channels does not necessarily resolve problems of market access for poorer farmers; obstacles can arise from economies of scale in production, since the fewer the number of producers needed to supply the chain the lower the transaction costs for the buyer. Or quality control requirements may require sunk costs beyond the reach of poorer suppliers.

A third strand of the literature relevant to smallholder market participation is the recent literature on poverty dynamics and poverty traps related to minimum asset thresholds. Carter and Barrett (2006) lay out the conceptual foundations for a dynamic asset poverty threshold that potentially separates those able to rise above the asset threshold and escape poverty from those caught in a low-level equilibrium, a "poverty trap." While examples of such poverty traps in agricultural systems are many and diverse, the interaction of markets and assets is often a common thread among them. In highly populated and land-scarce western Kenya, for example, farmers who have sufficient assets to be able to invest in tea as a cash crop are able to finance fertilizer to maintain soil fertility on their maize fields. But tea is a perennial that takes several growing seasons to become productive. Those farmers who cannot afford to forego income from the land tea occupies until the tea bushes reach maturity find themselves in a downward spiral of soil nutrient depletion, with maize yields declining over time (Barrett et al. 2006). A different type of poverty trap emerges in Madagascar, where a high proportion of poor rural households have to sell rice at low prices soon after harvest, only to purchase again later at much higher prices, due to lack of access to secure storage and credit in rural areas (Barrett 1996, Barrett et al. 2006, Moser et al. 2006), and where remunerative technologies do not get adopted by poorer farmers who lack adequate assets to self-provision for a few months, and who cannot take on the added risk associated with increased expected yields of nearly 80 percent (Moser and Barrett 2006).

Another example of a poverty trap is the vicious cycle of forced *ganyu* labor in Malawi (Dorward et al. 2004). The majority of rural households in Malawi lack sufficient land and capital to produce and/or store enough maize to see them through the hungry season. Since the hungry season coincides with the growing season, food-insecure households must divert

labor from their own production to work for the minority of households willing and able to hire them in return for food. The system is self-perpetuating as the same households find themselves food insecure in the next hungry season as a result of neglect of their maize fields.

Despite recognition in the recent literature of the potential role of minimum asset thresholds to escape from poverty, and the recognition that lack of assets may result in the exclusion of smallholders from new, remunerative market opportunities, such as contract production of high-value crops, little research has explicitly and systematically explored the relationship between smallholder asset portfolios and participation in different types of markets. In the next section we lay out a conceptual approach to the relationships between different asset portfolios and the ability of households to generate earnings from participation in different types of crop market, and then formulate specific questions to be explored in the subsequent empirical section using recent data from Mozambique.

2 Conceptual Framework and Empirical Questions

A simple model of household choice captures the core issues surrounding the impact of asset endowments on market participation. Consider a household that maximizes its utility, defined over consumption of a staple food, s, and a Hicksian composite of other tradables, x. It earns income from production, and possibly sale, of any or all of three crops—the staple and two cash crops, c1 and c2, respectively—and from off-farm sources, Y, which could be earned or unearned. Production of each crop is a function of flows of services provided by privately held quasi-fixed assets, including land, labor (both quantity and quality, as reflected in education and experience), livestock and other productive capital (e.g., irrigation, tractor), reflected in the vector A. Public goods and services, such as extension services and farmer associations that provide information or inputs, represented by the vector G, may likewise affect output.

The focus of this paper is the farmer's choice as to whether or not to participate in crop markets as a seller. We represent that choice by the indicator variable M, which takes value one if the household enters the market for a crop, and zero otherwise. Thus $M^{ss}=1$ if the household sells the staple crop (=0 if it does not), $M^{sb}=1$ if the household buys the staple crop, $M^{c1}=1$ if the household sells the first cash crop, and $M^{c2}=1$ if the household sells the second cash crop.[3] These choices will be guided by net returns to market participation. Each household faces a parametric market price for each crop—p^{sm}, p^{c1m}, and p^{c2m}, respectively—and transactions costs $\tau(Z,A,G,Y)$ that may depend on both public goods and services G

(e.g., radio broadcast of prices that affects search costs, extension service information on crop marketing strategies, distance to market), household-specific characteristics reflected in the vector Z (e.g., educational attainment, gender, age, all of which might affect search costs, negotiating skills, etc.), its assets A, and liquidity Y.

We can represent the household's choice problem as follows:

$$\underset{M^i,s,x,A^i}{\text{Max}}\ U(s,x)$$

subject to a cash budget constraint

$$p^x x + (M^{sb} + M^{ss})p^{s*}s = (M^{sb} + M^{ss})p^{s*}f^s(A^s,G) + \sum_{i=1}^{2} M^{ci}p^{ci}f^{ci}(A^{ci},G) + Y$$

and an asset allocation constraint

$$A = A^s + A^{c1} + A^{c2},$$

and with the staple price determined by the household's net market position:

$$p^{s*} = p^{sm} + \tau(Z,A,G,Y) \qquad \text{if } s < f^s$$

$$p^{s*} = p^{sm} - \tau(Z,A,G,Y) \qquad \text{if } s < f^s$$

and $$p^{s*} = p^a \qquad \text{if } s = f$$

where p^a is the autarkic (i.e., non-tradable) shadow price that exactly equates household demand and supply.

Note that the transactions costs of market participation create a kinked price schedule reflecting the price band defined by market prices plus and minus those costs, reflecting the net prices for buyers and sellers, respectively (de Janvry et al. 1991). Solving the resulting optimization problem therefore requires evaluating the utility function under the optimal choices prevailing at the autarkic, buyer and seller prices under each of the twelve feasible combinations of M^{ss}, M^{sb}, M^{c1}, and M^{c2}.

Based on the structural model above, each of the choice variables can be represented in reduced form as a function of the exogenous variables A, G, Z, Y, p^{sm}, p^{c1m}, and p^{c2m}.[4] The question of interest to us is how participation in crop sales markets varies with private assets A and public goods and services G, so as to address the core policy questions: (1) whether market access depends fundamentally on households' initial endowments, in which case market-based development strategies may favor initially wealthier households unless policy interventions simultaneously or previously provide asset transfers to poorer households, and (2) whether one can reasonably expect increased smallholder market participation on the basis of increased provision of public goods and services, so that even

those with meager initial private asset endowments can be drawn into the market through improved public goods provision.

We might expect that the costs and returns of market participation, and thus the marginal response of participation and sales volumes to household asset endowments, to vary by market types. Smallholder farmers in SSA are primarily involved in two types of market: spot markets and markets for which credit and output markets are linked through some form of contract. Spot markets involve no contractual obligations prior to or after sale of a commodity, and generally have few requirements in relation to quality or quantity. The flexibility of such markets implies low barriers to entry, but also high transactions costs due to search and, because of uncertainty related to quantity and quality, the need for buyers to inspect individual lots. The combination of high transactions costs and low barriers to entry often implies low unit returns for smallholders.

Contract markets for crops in SSA have arisen primarily as a response to rural credit and input market failures rather than in response to transactions costs arising from uncertain quantities and/or quality. Consequently, input provision on credit is typically linked to purchase of output under monopsony conditions enforced by private contracts, market regulation, or both. The provision of inputs to smallholder growers on credit by the product buyer is motivated by buyers' investments in dedicated fixed assets and/or contract obligations that necessitate reliable access to raw material, often meeting a minimum quality standard. The need for the product buyer to ensure that costly inputs are well used by growers results in barriers to entry for smallholders. Those lacking requisite complementary inputs—adequate land, human capital, irrigation, machinery, etc.—may be poor risks for buyers. Contract markets can be further differentiated by quality requirements and other marketing conditions that may further increase the potential returns, but also increase the risk of financial loss for smallholders who participate. We hypothesize that the need for smallholders to overcome the barriers to entry in contract markets, and to manage the risk associated with quality-differentiated products, may imply a different portfolio or scale of assets than that required for participation in spot markets.

In the next section we explore the extent to which smallholder participation in different crop markets is associated with different asset holdings using data on rural household participation in three crop markets in Mozambique. Mozambique is relevant for four key reasons: (1) it is a highly liberalized market economy with minimal government intervention in markets and few market distortions compared to other countries in the region; (2) income from crop production represents 80 percent of total

income for the poorest 60 percent of rural households (Boughton et al. 2006); (3) the rural economy is at an early stage of structural transformation; and (4) investment in the agricultural sector, and in agricultural commercialization, is recognized by government, civil society, and donors as crucial to the national poverty reduction strategy. The specific crop markets we study are as follows:

- we use the case of maize, the most widely grown and marketed food staple in Mozambique, to evaluate whether participation in spot markets for staple food crops and participants' sales volumes are positively correlated with access to productive assets such as land, livestock and labor;
- we use the case of contract production of cotton, a relatively undifferentiated commodity, to evaluate whether asset endowments are typically higher among contract cash crop farmers than for food staple spot market participants, implying that the poorest smallholders are typically unable to participate, and to evaluate the extent to which earnings are correlated with access to extension and farmer associations as well as household-specific productive assets;
- we use the case of tobacco to examine how the additional demands of contract production for a quality-differentiated product are correlated with asset holdings. In addition to the assets needed to enter contract production of an undifferentiated commodity, such as cotton, we anticipate that asset entry barriers become greater, and that education as an indicator of management ability becomes an important determinant of participation and sales volume.

3 Data and Description of Markets

In this section we first describe the data and then provide a brief characterization of relevant crop markets in Mozambique. Data for our analysis come from the national agricultural sample survey known as the *Trabalho do Inquerito Agricola* (TIA). The TIA is a nationally representative rural household survey administered to approximately 4,900 randomly selected households in 80 of the 128 rural districts in Mozambique. The survey was carried out by the Ministry of Agriculture's Department of Statistics using a single shot recall survey undertaken during the period August to December after the peak crop marketing season. The survey instrument sought detailed information on all sources of household income from farm and non-farm income sources, including remittances, for the 2001/2 agricultural year. The survey is documented in Walker et al. (2004)

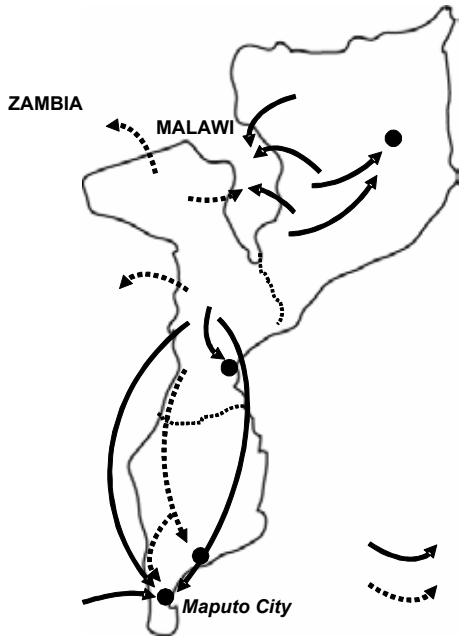
who used the income results to analyze the determinants of rural poverty. The use of cross-section data to explore the relation between assets and market participation requires great caution in the interpretation because of considerable potential endogeneity in asset holdings—e.g., today's land or livestock holdings could be the result of past crop marketing successes that also partly account for current marketing patterns—and the absence of credible instrumental variables. We therefore cannot make clear causal statements. But the data do reveal clear statistical associations between variables, and long-term observation of this and related systems give us confidence that there is a sound basis for the interpretations we make of these findings. Given the data limitations, we see ours as preliminary, suggestive findings that merit follow-up, ideally using panel data with natural controls (e.g., exogenous asset shocks). Nevertheless, the dearth of nationally representative rural household income data in Africa generally, and the critical importance of the questions posed for a country like Mozambique, make cautious empirical investigation a worthwhile endeavor despite the real limitations of these data.

For reasons of space we limit our overview to the most salient features of crop markets in Mozambique. Detailed recent empirical reviews of maize production and marketing can be found in Tschirley et al. (2006), and for cotton and tobacco contract farming arrangements consult Benfica et al. (2002, 2005, 2006).

Maize is the most widely marketed food staple, accounting for 84 percent of all cereals, and 44 percent of all food crops (cereals, roots and tubers, legumes and oilseeds) in value terms in 2002. Maize production and marketing patterns in Mozambique are driven largely by geography (figure 1). The central and northern regions dominate production and marketing of maize because of higher and more reliable rainfall patterns and the high proportion of all rural households who reside there.[5] Intra-regional trade, as well as exports to neighboring countries (Malawi, Zimbabwe, and Zambia), are both important. Sales take place between farmers and rural first assemblers who locate themselves along the major roads or town markets.

Formal sector exports of maize are dominated by two main companies managing networks of rural warehouses with purchasing operations geared to the southern and eastern Africa food aid markets. An active informal sector export trade has historically provided significant competition to formal exporters, although the impact of recent border crossing restrictions limiting exports to formal participants is at present unknown. Periodic rural markets are rare.

Figure 1: Map of Mozambique showing regions and primary maize flows

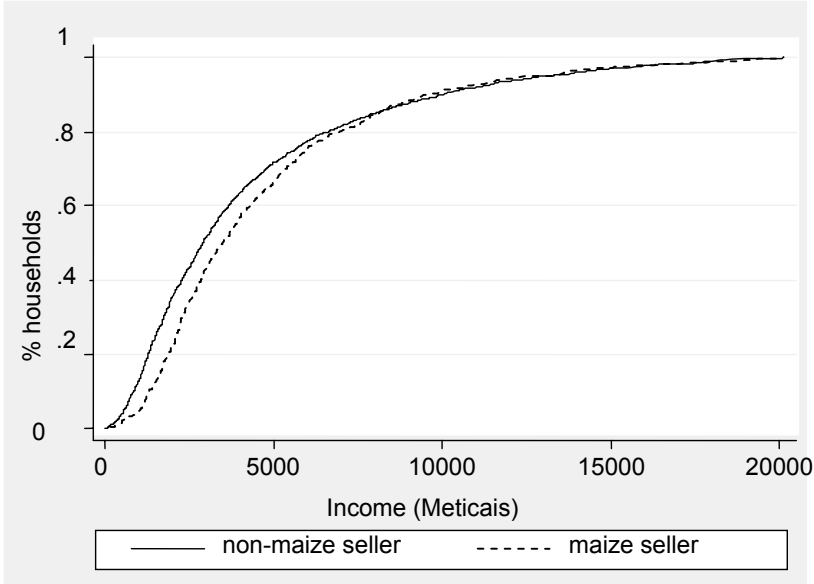


Source: Adapted from Tschirley et al. (2006)

Although maize is the staple food, not all rural households grow it and still fewer sell it. TIA data indicate that 74 percent of households in the northern region grew maize in 2001/2 with an average household production of 400kg, while 94 percent of households in the central region produced an average of 750kg maize grain each. Just over 30 percent of our sample of maize growing households sold maize in 2002, earning an average of 532 meticais per household (approximately $27). But a little less than one quarter of maize-selling households, equivalent to 6 percent of all households growing the crop, accounted for 70 percent of the total quantity sold. Net buyers of maize in rural areas are much more numerous than net sellers—over 50 percent of households in the north and almost 70 percent of households in the center. Figure 2 shows the cumulative distribution function (CDF) of total household incomes for maize sellers and non-sellers. This shows that maize sellers' incomes second order stochastically dominate those of non-sellers, with a higher mean and lower variance. But these differences are relatively modest.

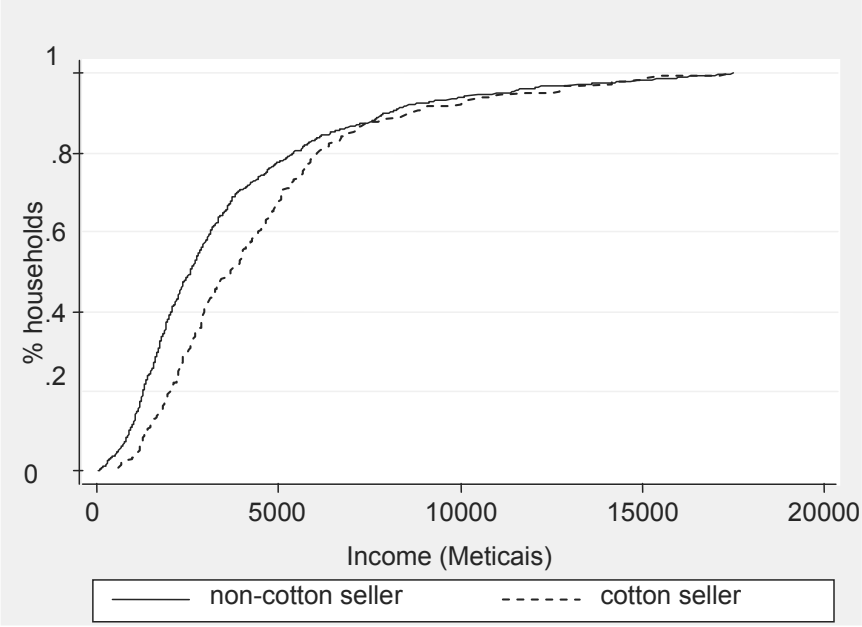
In 2002, cotton and tobacco accounted for 94 percent of annual smallholder field cash crops in value terms, and 43 percent of all smallholder

Figure 2: Household total income cumulative density functions for maize seller and non-seller households



cash crop sales (tree crops, fruit, vegetables, and field cash crops). Yet smallholder access to markets for cotton and tobacco is restricted to contract farming schemes, with only 7 percent of the national sample of rural households participating in cotton and almost 4 percent in tobacco schemes in 2001/2. Even in those districts where cotton companies operate contract farming schemes, only a little more than 17 percent of sample households participated in cotton markets in 2001/2, with average earnings of 1,342 meticais ($67) after repayment of input costs excluding hired labor. Tobacco contract farming is likewise somewhat spatially limited. Only 7 percent of the sample households who lived in districts where tobacco contract farming schemes operate participated in tobacco contracts in the 2001/2 season, earning an average of 3,331 meticais (approximately $167) per household after repayment of inputs but excluding payments to hired labor. Thus average household crop earnings appears inversely related to extent of market participation, suggesting higher entry barriers associated with higher expected earnings in contract schemes than in spot markets. Moreover, the differences between seller and non-seller total household incomes is even greater than that for maize, as shown by the CDFs of total household income for cotton market participants and non-participants

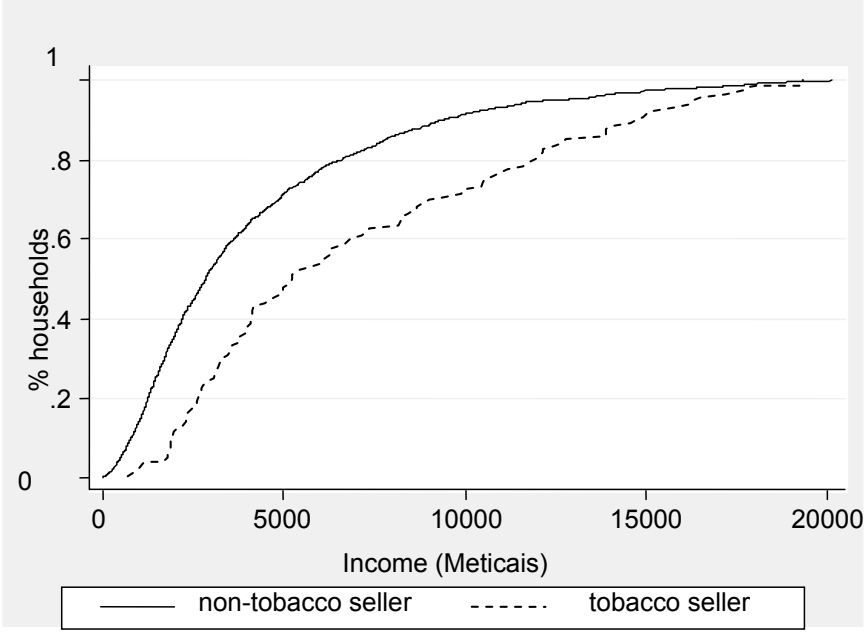
Figure 3: Household total income cumulative density functions for cotton seller and non-seller households



(figure 3) and tobacco market participants and non-participants (figure 4). Note that the household income gaps between market participants and non-participants grows as one moves from the spot market crop, maize, to the undifferentiated contract crop, cotton, to the quality-differentiated contract crop, tobacco. This ordering of household incomes and income differences between market participants and non-participants suggests a wealth bias in market access that motivates the more nuanced econometric work in the next section.

Smallholder cotton production in Mozambique has a long history dating back to colonial times. Production plummeted with the nationalization of commercial cotton companies following independence in 1975, and continued to decline during the civil war that followed. During the late 1980s, in anticipation of peace, joint-venture companies (JVCs) with geographical monopsonies (concessions) were formed between the government and private companies to promote the recovery of the sector and provide security, infrastructure maintenance, and income opportunities to isolated rural communities, especially in the northern region. Many cotton JVCs have experienced financial trouble since the mid-1990s

Figure 4: Household total income cumulative density functions for tobacco and non-seller households



because of low international prices for cotton, high operating costs, and credit repayment problems due to side-selling where multiple firms operate in the same geographical area. Cotton productivity and prices at the farm level in Mozambique have been among the lowest in the region (Boughton et al. 2003) and three major companies have exited the sector in the past decade. Government has responded by encouraging new operators to enter the sector, undertaking studies of how to improve value-chain performance, and investing in crop diversification and cotton seed improvement pilot activities in collaboration with donors.

Investment in the tobacco sector is much more recent than cotton, beginning in the late 1990s and spurred on by the collapse of Zimbabwe's tobacco sector. Tobacco has proved more profitable on average for small farmers, despite monopsony arrangements, due to higher world market prices of tobacco relative to cotton. The number of smallholders engaged in tobacco contract farming, and quantities produced, have grown rapidly. Nevertheless, claims by farmers of abuse of quality grading by company buying agents have been widespread. These problems appear to have been exacerbated following the exit of one of the major tobacco export

companies following allegations of political interference in the allocation of company geographical areas of operation.

4 Econometric Results

Because maize, tobacco, and cotton sales are only observed for a subset of the sample population, the potential exists for the sample selection problem referred to as incidental truncation, i.e., households with sales observations are likely not to be a random sub-sample of the population. To address this concern, we employ the standard Heckman sample selection model (two-step version) first applied to these problems by Goetz (1992), and previously used in the Mozambican context by Benfica et al. (2006).[6]

With a Heckman two-step approach, one first estimates a probit model of participation in the relevant market as a function of both those variables that likely also determine crop sales volumes, conditional on market participation, as well as one or more exclusion restriction variables (Wooldridge 2006). Our exclusion restriction variables focus on factors affecting a household's level of dependence on crop income as an income source and factors that might affect perceptions of risk relating to market participation. These variables include access to non-crop income sources associated with livestock revenues, off-farm salary, and wage earnings, and earnings from natural resource extraction activities. The exclusion restrictions we employ are similar to those used by Benfica et al. (2006) in their analysis of the determinants of contract farming participation in the Zambezi River Valley region of Mozambique. The second step is an OLS regression of the log of net crop sales value on the reduced form regressors plus the inverse Mills ratio (IMR) derived from the first-stage probit regression, which controls for the probability of market participation so that the remaining regressors are explaining sales volumes conditional on a given probability of market participation.

As motivated by the model developed in section 2, we estimate the reduced form equations for market participation and log of sales revenues conditional on market participation, focusing on household assets and characteristics, public goods, and prices as explanatory variables. For cotton and tobacco, however, we do not include price as an explanatory variable because farmers working with same company face the same announced price for any given grade—thus there is no variation within sites in these data—and farmers have no alternative market for their production. Descriptive results (means and standard errors) for all variables included in the regressions, as well as the significance level of tests of difference between means for each variable for sellers and non-sellers, are presented in table 1.

Table 1: Descriptive results of rural household sales of maize, cotton, and tobacco, Central and Northern Mozambique, 2002

	Maize					Cotton					Tobacco				
	Non-sellers		Sellers			Non-sellers		Sellers			Non-sellers		Sellers		
Variable	Mean	S.E.	Mean	S.E.	MT[a]	Mean	S.E.	Mean	S.E.	MT[a]	Mean	S.E.	Mean	S.E.	MT[a]
Maize/Cotton/Tobacco sales value (contos)			540.32	42.92				1365.02	103.35				3248.44	536.17	
Ln(sales value)			5.45	0.07				6.73	0.06				6.64	0.16	
HH headed by female	0.235	0.011	0.178	0.017	***	0.236	0.013	0.113	0.022	***	0.255	0.011	0.125	0.027	***
Education of HH head (years)	2.25	0.07	2.28	0.10	*	2.20	0.07	2.08	0.13		2.23	0.06	2.22	0.20	
Education of HH head, squared (years)	10.55	0.50	10.45	0.66	***	10.01	0.54	8.15	0.69	**	10.61	0.45	9.93	1.50	***
Age of HH head (years)	41.11	0.37	39.60	0.50	**	40.54	0.45	39.94	0.91		40.82	0.34	41.43	1.28	
Age of HH head, squared (years)	1887.1	33.84	1768.6	44.41	**	1850.2	40.40	1781.3	82.10		1869.4	31.20	1927.1	124.90	
HH received info from extension agent	0.147	0.016	0.178	0.019		0.139	0.011	0.254	0.029	***	0.154	0.009	0.278	0.038	***
HH member is in agricultural association	0.038	0.006	0.041	0.008		0.035	0.006	0.064	0.018		0.036	0.005	0.075	0.022	
HH has pump or gravity irrigation	0.003	0.001	0.005	0.003											
HH reports yield loss to maize that season	0.419	0.022	0.314	0.023	***										
HH owns cattle or donkey for animal traction	0.009	0.003	0.014	0.003		0.008	0.002	0.011	0.003		0.012	0.002	0.033	0.014	***
HH owns tractor	0.000	0.000	0.000	0.000											
Medium-small Tropical livestock units	0.759	0.042	0.823	0.060		0.655	0.032	0.917	0.078	***	0.700	0.031	0.973	0.155	*
MS TLU squared	2.846	0.245	2.721	0.463		2.164	0.245	3.140	0.603		2.763	0.317	3.683	1.434	
District median maize sales price, farmgate	2.280	0.031	2.314	0.034											
Distance to nearest tarred road (km)	63.0	6.9	72.2	9.0		82.3	2.5	100.9	5.2	***	60.2	1.6	65.3	6.1	*
HH owns a bike	0.270	0.015	0.359	0.020	***	0.220	0.013	0.309	0.031	***	0.270	0.011	0.490	0.044	
HH owns a radio	0.504	0.013	0.540	0.021											
Village received price info	0.469	0.026	0.490	0.028											
HH owns radio * Village received price info	0.243	0.016	0.293	0.022	**										
Total area (ha)[b]	1.600	0.073	1.868	0.130	**	1.366	0.034	2.416	0.151	***	1.577	0.056	2.160	0.119	***
Total area, squared (ha)	5.654	1.501	9.870	3.552		3.421	0.206	11.435	2.727	***	7.663	2.046	7.153	0.849	
No. of adults in HH (age 15-59)	2.430	0.034	2.347	0.044	*	2.211	0.030	2.335	0.063	*	2.356	0.028	2.469	0.082	
No. of adults, squared	7.439	0.231	6.597	0.271	**	5.938	0.175	6.800	0.457	*	6.959	0.184	7.076	0.499	
HH has skilled wage income	0.055	0.006	0.041	0.008	*	0.049	0.007	0.016	0.008	***	0.045	0.005	0.040	0.016	**
HH has S.E. income - other	0.292	0.016	0.288	0.021		0.233	0.013	0.268	0.030		0.305	0.011	0.345	0.042	**
HH has S.E. income - resource extraction	0.198	0.016	0.216	0.021		0.201	0.012	0.116	0.021	***	0.201	0.010	0.248	0.039	*
HH has livestock income	0.334	0.014	0.398	0.021	***	0.341	0.015	0.301	0.031		0.323	0.011	0.432	0.043	
No. of observations	2,062		935			1,331		290			2,247		163		

Source: TIA02. Notes: a. MT = t-test of difference between means of sellers and non-sellers; * significant at 10%, ** significant at 5%, *** significant at 1%; b. Total area = household area in annual crops + permanent crops + fallow

Household assets included as explanatory variables are total land area (under annual crops, permanent crops, and fallow), labor, ownership of animal traction, ownership of equipment (tractor, bike, radio, irrigation), and years of education of the household head.[7] For household characteristics we include whether the household is headed by a female, the age of the household head, and whether any household member belongs to an agricultural association. We allow for simple nonlinear effects by including quadratic terms of the continuous variables land, labor, age and education. We also control for unobserved location-specific effects using district dummy variables. Since maize is a primary food crop that is susceptible to drought, we include a dummy variable to indicate whether the household reported maize yield loss due to climatic shock.

Public goods included as explanatory variables are farmers' self-reported access to information from an extension agent, access to market price information, distance to the nearest paved road, and membership in an agricultural association. Extension coverage is very limited in Mozambique, with less than one in six households having access to an extension agent (whether public, NGO, or cotton/tobacco company). In principle, access to an extension agent provides access to information that can increase crop productivity, although the specific type of information received is not recorded by the TIA survey instrument. Note that we do not include access to extension in the probit model for cash crops as company extension workers are often involved in the identification of participants. Similarly, access to market price information in principle may help reduce price risk and/or improve farmer returns through bargaining power. Distance to the nearest tarred road is a relevant proxy for the transport costs to terminal markets as the sparse major road network in Mozambique means that transport to the main road is a large proportion of the total transport costs. Membership in an association is an additional channel of relevant information for increased returns to crop production and marketing, and tobacco and cotton companies often pay a small price premium for association members. Although membership in an association might be viewed as a club good rather than a public good, at this stage of Mozambique's development farmer associations commonly have public good characteristics since their establishment and operations require considerable external support due to literacy and capital constraints.

4.1 Maize Spot Market Participation Results

First stage probit model results (table 2) indicate that some private household assets have a positive and statistically significant effect on

the probability of household maize market participation as a seller. The coefficients on available land area are highly significant for both the linear (positive) and quadratic (negative) terms, indicating a diminishing marginal effect on maize market participation as land area increases over the whole range of the data. Income from livestock is also strongly positively and statistically significantly correlated with maize market participation. One possible explanation is that the ownership of livestock reduces the risk of food insecurity (recall that maize is the primary cereal staple) since the household has an asset that can be traded for food if an unforeseen shortage occurs. Livestock income may also proxy for greater access to and incorporation of organic manure into plots, thereby increasing maize productivity and the probability of generating a marketable surplus. Local maize prices also had a strong positive and highly significant effect on the probability of market participation as a seller. Among the non-asset household characteristics, female-headed households and households with older heads were significantly less likely to sell. As might be expected for a key food staple, households that experienced maize yield loss are significantly less likely to sell maize. The joint tests of regressors for demographic and private assets are highly significant, while the joint test for those representing public goods and services is insignificant.

For the second-stage OLS estimates (table 2), the inverse Mills ratio (IMR) is not significant, signaling that the covariates that condition sales volumes operate independently of the probability of spot market participation. A broader range of private assets is positively and significantly associated with the value of net maize sales than for the discrete decision to sell. Land area and ownership of a bike are both positively and significantly associated with value of sales at higher than the .01 level, with land having a more pronounced effect on sales volume conditional on maize market participation than on the probability of market participation. Ownership of animal traction is significant at the .05 level. Animal traction increases the amount of land that can be cultivated with a given amount of labor and, like bike ownership, can reduce the cost of transporting maize to a tarred road or the point of sale. The price of maize also has a strongly and significantly positive effect on maize sales at the one percent level. Higher maize prices can be expected to lead to a higher volume of maize sales both because cultivation effort responds positively to expected prices and because most households have the capability to substitute own-produced cassava for maize in their diet when the terms of trade encourage such substitution. Just as female-headed households are significantly less likely than male-headed households to sell maize, so also is the expected sales

Table 2: Regression results of rural household sales of maize, cotton, and tobacco, Central and Northern Mozambique, 2002

	Maize		Cotton		Tobacco	
	Probit 1=HH sold maize	OLS ln(value of maize sold)	Probit 1=HH sold cotton	OLS ln(value of cotton sold)	Probit 1=HH sold tobacco	OLS ln(value of tobacco sold)
HH headed by female	-0.159**	-0.264**	-0.566***	-0.15	-0.434***	-0.54
	(2.23)	(2.01)	(3.94)	(0.83)	(3.24)	(1.15)
Education of HH head (years)	-0.036	0.044	0.002	-0.134	0.015	0.237*
	(1.02)	(1.22)	(0.04)	(1.62)	(0.26)	(1.80)
Education of HH head, squared (years)	0.001	-0.004	-0.020*	0.025*	-0.008	-0.032*
	(0.16)	(0.89)	(1.79)	(1.66)	(0.92)	(1.97)
Age of HH head (years)	-0.025**	0.004	0.006	0.001	-0.012	-0.035
	(2.31)	(0.25)	(0.30)	(0.07)	(0.57)	(0.85)
Age of HH head, squared (years)	0.000*	0.000	0.000	0.000	0.000	0.001
	(1.65)	(0.23)	(0.76)	(0.08)	(0.58)	(1.21)
HH received info from extension agent	0.141	0.061		-0.142		0.602
	(1.51)	(0.55)		(1.23)		(1.37)
HH member is in agricultural association	0.062	0.170	0.300	0.283	0.284	0.444
	(0.33)	(0.76)	(1.34)	(1.19)	(1.38)	(0.94)
HH has pump or gravity irrigation	0.425	-0.297				
	(0.76)	(0.71)				
HH reports yield loss to maize that season	0.242***	-0.222				
	(3.15)	(1.53)				
HH owns cattle or donkey for animal traction	0.139	0.669**	-0.145	0.931**	0.908**	0.109
	(0.50)	(2.50)	(0.39)	(2.46)	(2.32)	(0.13)
HH owns tractor	1.626*	0.406				
	(1.92)	(0.32)				
Medium-small Tropical livestock units	0.024	0.075	0.096*	0.040	0.113*	0.089
	(0.72)	(1.38)	(1.68)	(0.67)	(1.66)	(0.45)
MS TLU squared	-0.003	-0.002	-0.006**	0.000	-0.006	-0.010
	(1.05)	(0.54)	(2.16)	(0.00)	(0.89)	(0.56)
District median maize sales price, farmgate	0.359***	0.859***				
	(3.67)	(6.20)				
Distance to nearest tarred road (km)	0.001	0.002*	0.004**	-0.007***	-0.002	-0.015**
	(0.97)	(1.77)	(2.02)	(3.32)	(1.30)	(2.50)
HH owns a bike	0.055	0.292***	0.260**	0.322**	0.038	0.422
	(0.85)	(3.23)	(2.08)	(2.21)	(0.36)	(1.27)
HH owns a radio	-0.068	0.117				
	(0.87)	(1.25)				

Table 2 (cont.)

	Maize		Cotton		Tobacco	
	Probit 1=HH sold maize	OLS ln(value of maize sold)	Probit 1=HH sold cotton	OLS ln(value of cotton sold)	Probit 1=HH sold tobacco	OLS ln(value of tobacco sold)
Village received price info	-0.035	-0.051				
	(0.34)	(0.37)				
HH owns radio * Village received price info	0.15	-0.042				
	(1.12)	(0.22)				
Total area (ha)^2	0.123***	0.185***	0.371***	0.104	0.256***	0.316
	(4.48)	(3.24)	(6.07)	(0.90)	(3.57)	(1.39)
Total area, squared (ha)	-0.002***	-0.003***	-0.011***	-0.008*	-0.018**	-0.009
	(3.74)	(2.82)	(3.94)	(1.91)	(2.37)	(0.56)
No. of adults in HH (age 15-59)	-0.033	0.081	-0.066	0.109	0.324**	0.236
	(0.50)	(0.71)	(0.63)	(1.35)	(1.96)	(0.38)
No. of adults, squared	-0.004	-0.009	0.006	0.005	-0.052**	-0.027
	(0.58)	(0.61)	(0.56)	(1.20)	(2.18)	(0.27)
HH has skilled wage income	-0.084		-0.459		-0.152	
	(0.55)		(1.42)		(0.62)	
HH has S.E. income - other	-0.038		-0.097		-0.004	
	(0.59)		(0.78)		(0.04)	
HH has S.E. income - resource extraction	0.137		-0.408***		0.318***	
	(1.38)		(2.74)		(2.63)	
HH has livestock income	0.163***		-0.323***		0.143	
	(2.64)		(2.78)		(1.25)	
Inverse Mills Ratio		-0.082		-0.721*		0.344
		(0.15)		(1.90)		(0.34)
Constant	-0.957**	2.791***	-7.326***	7.547***	-7.551***	1.429
	(2.22)	(3.69)	(13.74)	(5.97)	(11.47)	(0.32)
Joint test of demographics (p value)	0.001	0.320	0.000	0.000	0.003	0.363
Joint test of private physical assets (p value)	0.000	0.000	0.000	0.000	0.000	0.002
Joint test of public assets (p value)	0.669	0.428	0.071	0.002	0.200	0.041
Joint test of exclusion restrictions (p value)	0.065		0.001		0.027	
Observations	2,997	935	1,621	290	2,410	163
R-squared		0.42		0.48		0.74

Notes: Robust t statistics in brackets; * significant at 10%; ** significant at 5%; *** significant at 1%; Joint test of demographics = female headed household, head's education, head's education squared, number of adults, and number of adults squared; private physical assets = own pump irrigation, cattle/donkey for animal traction, own tractor, MSTLU, MSTLU squared, own bike, own radio, total area, total area squared; public assets = extension, association, distance, village receives price information, village price*radio; exclusion restrictions = skilled wage income, SE income (other and resource), and livestock income

quantity lower (by 26 percent) for female-headed households.

The joint tests of regressors for private asset variables are highly significant, while those for demographic variables and public goods that can potentially facilitate market access are not. The policy and programmatic implication of these results is not that public investments in market access have no role to play in increasing market participation, but that, with current levels of production technology, increased private asset endowments appear necessary for households to be able to take advantage of the reasonably open-access maize markets in Mozambique and any associated public investments in improving market information flow or physical access to markets.

4.2 Cotton Contract Farming Participation Results

As in the case of maize market participation, first stage probit results for cotton (table 2) indicate that private asset endowments are positively and significantly correlated with cotton market participation. Like maize, the coefficients on available land area are highly significant for both the linear (positive) and quadratic (negative) terms, indicating a diminishing marginal effect on participation over the range of the data. Land's marginal effect on cotton market participation is more than twice that on maize market participation over the whole land distribution, indicating that land holdings are far more important to diversification into higher-return cash crops than to sales of maize staple crop surpluses. Ownership of a bike is also positively correlated with cotton market participation at the .05 level. Female-headed households are significantly less likely to participate in cotton contract farming than male-headed households.

The positive and highly significant coefficient estimate on distance between the village and a tarred road may appear counterintuitive at first glance. Why should farmer propensity to participate in cotton contract farming increase with remoteness? Benfica et al. (2006) find that participation in cotton farming is negatively correlated with off-farm income opportunities. Such opportunities become less remunerative as the cost of market access increases. This explanation is also consistent with the negative and significant coefficients on household access to livestock income and income from natural resource extraction activities. The joint tests of regressors for demographic and private assets are highly significant, while the joint test for those representing public goods and services is significant only at the .10 level.

For the second-stage OLS results, the IMR is significant at the 10 percent level, indicating that selection effects are important. Household ownership of animal traction or a bicycle are positively correlated with

cotton earnings, as they were with maize sales. Household human capital, as measured by the education of the household head, has a convex and weakly significant effect, but the net effect is counter-intuitively negative over the range of the data. This result may reflect the difficulty that household heads with very limited education encounter in successfully managing pesticide applications, especially in the presence of ineffective extension services (note the negative sign on the statistically insignificant coefficient estimate for extension).[8] Distance from the village to nearest tarred road is highly significant but now with a negative sign, reflecting the lower quality of service provision by cotton companies in more remote areas (e.g., late collection of raw cotton, late delivery of pesticides and application equipment, poor supervision of extension workers).[9] Joint tests for all three groups of regressors—demographic, private assets, and public goods—are highly significant.

4.3 Tobacco Contract Farming Participation Results

For the first-stage probit regression (table 2), private assets are again positively and statistically significantly associated with the propensity of farmers to participate in tobacco contract farming. Tobacco farming is more labor intensive than cotton, and the input package provided on credit is much more expensive, so we would expect companies to be more selective in regard to choice of farmers with whom they contract. Similarly, farmers have to be able to take the risk of higher financial losses if the crop fails. The estimated coefficients on both land area and labor availability are statistically significant and concave but increasing over the range of the data, with far greater marginal effects than for maize market participation and, in the case of labor endowments, statistically significantly greater than for cotton market participation as well. Ownership of animal traction also has a positive and statistically significant correlation with tobacco participation. Since tobacco has only been introduced relatively recently, and the companies do not provide long-term credit for animal traction purchase, the risk of this association being endogenously determined is low. Self-employment income from natural resource extraction and livestock income also have positive and statistically significant coefficient estimates. Such income sources obviate liquidity constraints, enabling the household to absorb the risk of financial loss inherent in tobacco farming and to hire additional labor at peak periods. Once again, female-headed households are significantly less likely to participate in tobacco contract farming once one controls for other factors. The joint tests of regressors for demographic and private assets are highly significant, while the joint test statistic for those representing public goods and services is not significant.

For the second-stage OLS regression (table 2), education is statistically significant at the 10 percent level, with positive but diminishing effects over the range of the data. This may reflect the role that education plays in helping household heads meet the more complex management requirements of relatively larger smallholder contract tobacco farming operations (e.g., the management of seedbeds and planting labor to ensure that seedlings are transplanted at the optimal age becomes increasingly complex as area expands). As in the case of cotton, the value of sales is significantly and negatively associated with distance from the tarred road, indicative of a decreasing quality of service provision in more remote (and therefore more expensive to service) locations. Joint tests of regressors indicate that private assets are highly significantly correlated with tobacco sales while public assets are significant at the .05 level.

To summarize, the econometric results consistently indicate that private assets—labor and animal traction, but especially land—are statistically significantly associated with smallholder participation in all three crop markets. Furthermore, a broader range of private assets—including livestock and equipment—is significantly associated with participation and/or sales volume for the contract production of cash crops compared to maize sales on the spot market, and level of education is positively associated with value of production for the quality-differentiated cash crop (tobacco). Amongst variables representing public investments, distance to the nearest tarred road is negatively associated with sales of both tobacco and cotton. The higher difficulty and cost of servicing remote locations could well result in a lower quality of service provision that adversely affects crop output. Lack of timeliness in input delivery can have negative effects on quantity produced, while lack of timeliness in crop evacuation can have negative effects on quality. The consistency of these results across markets and crops suggests both the central importance of private assets to smallholders' capacity to take advantage of commercial market opportunities and their potential complementarity with public goods in regard to stimulating broader-based crop market participation or marketed supply expansion. The other strikingly consistent result is that female-headed households are significantly disadvantaged in terms of both participation in and level of earnings from crop markets. Since contemporary policy dialogues on strategies for stimulating smallholder agricultural commercialization largely overlook these apparent asset and gender barriers to commercial agricultural market entry—and their far greater effect on higher return contract cash crops than on spot market staple crop sales—these findings are potentially important, even given

the natural caveats associated with such estimation using cross-sectional data.

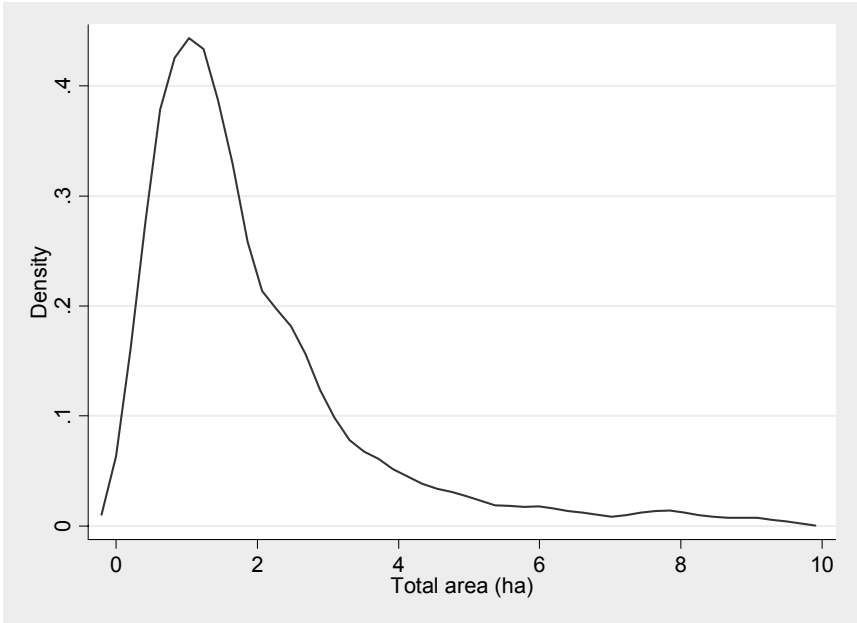
4.4 Is There Evidence for a Land Access Threshold for Crop Market Participation?

Because a household's arable land assets, defined as area under annual crops, permanent crops, and fallow, were positively and highly significantly associated with market participation in all three crops and had a significantly stronger effect on participation in higher return cotton and tobacco contract markets than in maize spot markets, we now explore further how market participation and/or the value of sales for each of the three crop market types varies over the range of land assets. We explore these using non-parametric (kernel) regression of the indicator variable for market participation (=1 if the household sells) or of the logarithm of net sales revenue for the crop in question on land holdings. Unlike the preceding multivariate regressions, this simple bivariate regression does not control for variation in other assets and attributes of households. Although these regressions thus suffer obvious omitted variable bias, they provide a consistent estimation of the unconditional relation between land holdings and crop marketing patterns and, moreover, by relaxing the parametric specification restrictions of the selection models just estimated, they permit less restrictive identification of regions of potential locally increasing returns, i.e., where one might look for especially sharp increases in the likelihood of market participation or in marketed sales volumes.

We first look at the relationship between land assets and market participation. Figure 5 shows the Rosenblatt-Parzen nonparametric kernel density estimates of the distribution of land holdings. The overwhelming majority of households have four or fewer hectares, with the mode, median, and mean all under two hectares, and a long right tail reflecting positive skewness in the land distribution in Mozambique, as in most countries. Less than one percent of households operate eight or more hectares in this sample. This is important to note for comparison with the next two graphics, which depict the Nadaraya-Watson nonparametric regression of the two dependent variables on land holdings, shown over the same conditioning domain.

Figure 6 shows a clear ordering of market accessibility among the three crops, with maize having the highest level of household participation at all levels of land holdings, followed by cotton, with tobacco the least accessible. For all three crops, the probability of household participation is very modestly increasing over the bulk of the land distribution, but at

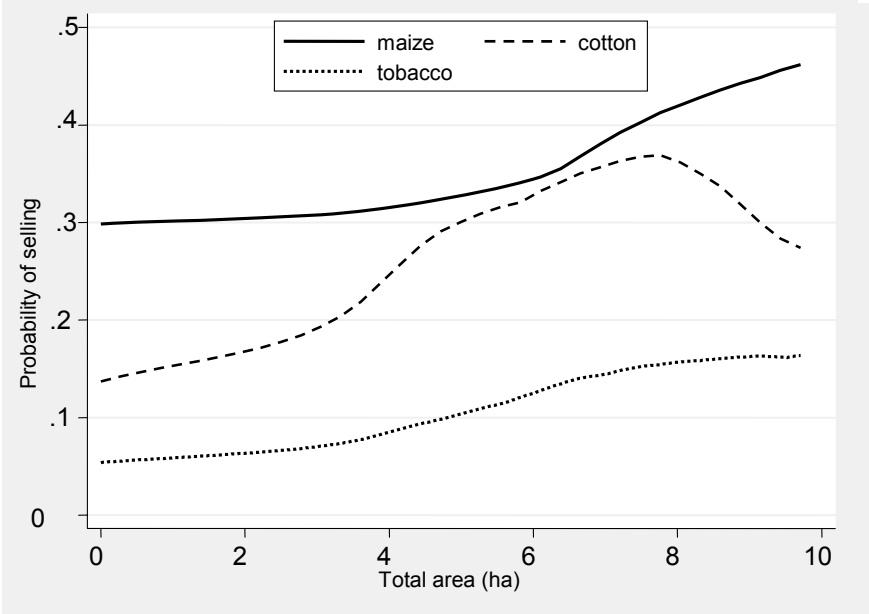
Figure 5: Household land distribution



an increasing rate as one moves beyond four hectares into the upper ten percent or so of the land distribution (except for expected cotton market participation falling at the very upper tail of the distribution, where meager sample size makes for imprecise estimation). One stark conclusion from this analysis is that the majority of households do not exploit landholdings that fall within the range of sharply increasing market participation for any of the three crops. So movement within the lower three-quartiles of the land distribution has negligible unconditional effect on market participation in any of the three crops.

We now turn to the relationship between net sales value and land holdings for the three different crop markets. Figure 7 plots the expected log value of net sales for each crop over the land distribution. All are increasing in land holdings and exhibit an S-shape indicative of a region of sharply increasing returns. In each case, the increase in slope commences between three and four hectares, in the upper quartile of the land distribution. As expected, maize has a lower predicted value of net sales over the entire range of land holdings, as compared to cotton and tobacco. Expected cotton net sales modestly exceed those of tobacco up to roughly four hectares, after which expected net sales of tobacco increase especially rapidly. Tobacco yields

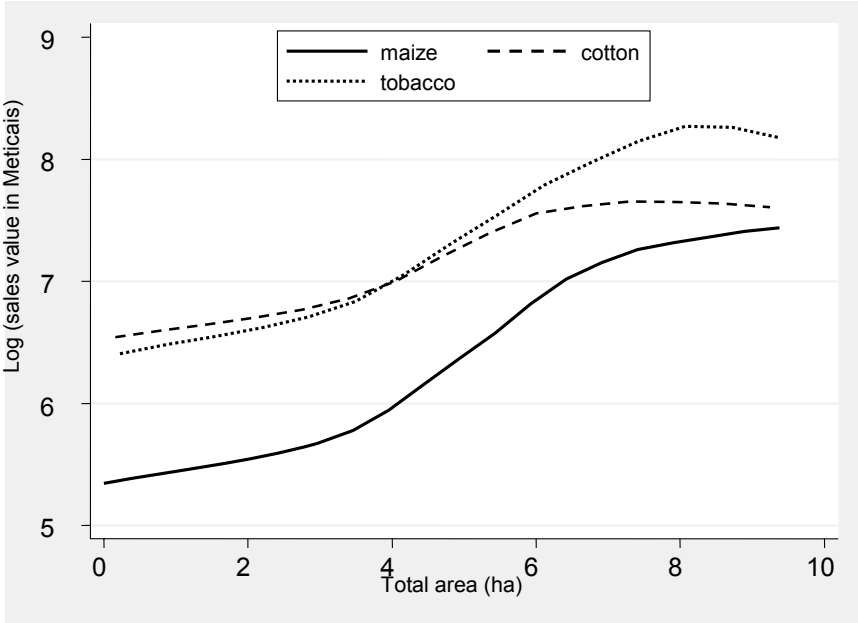
Figure 6: Probability of selling crops, by household land holdings



the greatest income per hectare for the largest farms; cotton yields most for the smallest farms. Maize earnings per hectare are sharply lower than cash crop net earnings over the entire land distribution.

What might account for increasing returns among households with land holdings greater than the three to four hectare range? A recent participatory rapid appraisal conducted by the authors with groups of cotton farmers in Nampula and Cabo Delgado provinces of Mozambique provides some insights. Farmers were asked to divide themselves into groups based on cotton yields, and groups with higher yields also tended to cultivate larger areas of cotton. The main reason given for different yields among groups was the ability to weed on time, especially first weeding. In Mozambique, weed control is primarily performed using a hand hoe and therefore requires high labor inputs per hectare. Farmers who are able to hire additional labor for weeding at the right time by paying laborers in cash achieved the highest yields, while others relied on hiring labor for payment in kind or reciprocal labor assistance. The lowest yielding groups were often unable to hire labor at all. Some farmers who were unable to weed on time, and could see that the yield potential of their crop was low, reported that they also cut back on the recommended number of pesticide applications to avoid ending the season further indebted to the cotton company. These

Figure 7: Log net sales value of different crops, by household land holdings



findings are very consistent with those reported elsewhere in the literature (e.g., Fafchamps 1993, Hanchate and Ramaswamy 1997). Another reason given by farmers for lower cotton yields was the presence of a hand hoe "pan," an impermeable layer resulting from repeated cultivation at shallow depth that encourages rainfall runoff and therefore poor rainfall infiltration to the soil. Access to animal traction allows land preparation at greater depth improving pre-planting weed control and better rainfall infiltration of the soil profile.

The finding of increasing returns to landholdings is remarkably consistent with Walker et al. (2004, forthcoming). Using the same data set to perform a regression analysis of the determinants of poverty, they predict that increasing the landholdings of households who currently exploit between 1.75 and 5.00 hectares to an amount greater than 5 hectares would have three times the poverty reduction impact as increasing the landholdings of the smallest farms (less than 0.75 hectares) to the modal range of 0.75 to 1.75 hectares. The explanation for their finding lies in the rapidly increasing expected returns to crop market participation for households with landholdings of four hectares or more, clearly visualized in figure 7. As figure 6 suggests, however, this effect is primarily due to

increased sales conditional on market participation, as the probability of market participation itself is only modestly increasing in area over most of the land distribution. So much of the effect comes through increased quantity and quality of output associated with greater farmer productive assets.

5 Conclusions

This paper set out a conceptual framework for analyzing smallholder asset requirements in relation to participation in different types of crop market. The motivation for the paper was the potential to raise farmer incomes and reduce poverty through smallholder participation in crop markets. Markets can only stimulate wealth creation among those who can afford to participate given production constraints and the costs of market participation. If poorer households are unable to participate effectively, then interventions to build up either their private stocks of productive assets, or the public goods that support agricultural production and marketing, or both, may be necessary.

Drawing conclusions from the empirical analysis undertaken in this paper requires caution because of the unavoidable challenges of endogeneity in a cross-section analysis of this sort and limitations in the availability of public good variables. Nevertheless, evidence from three crop markets in Mozambique, one food crop spot market and two cash crop contract markets, suggests the presence of household asset-related barriers to entry in each crop market. Among variables representing public goods, remoteness as measured by distance from the village to the nearest tarred road was negatively associated with cash crop sales. The consistent pattern of these results across crops indicates that, to achieve broad-based increases in crop market participation at this stage of Mozambique's smallholder agricultural development, private asset accumulation is necessary. Public investments in roads (and perhaps unobserved public goods and services, such as agricultural research) and increased private asset endowments may well be complements. This in turn raises important questions about the relative costs and benefits of public investments that are beyond the scope of this study.[10]

In the case of all three crop markets in Mozambique, both parametric and nonparametric regression analysis finds that land holdings are strongly positively correlated with the discrete decision to participate in crop markets as well as with the value of net sales. Animal traction is another significant factor affecting participation in tobacco contract farming, and is positively correlated with maize and cotton earnings for smallholders

who participate in those markets. Income sources other than crops are relevant to participation in both maize and tobacco markets. Education of the household head is important in tobacco contract farming.

Initiatives to increase farmer incomes through participation in specific crop markets need to take account of the asset portfolios necessary for smallholders to enter and expand net sales in those markets. Non-parametric (kernel) regression analysis suggests the presence of land thresholds, reflected in increasing marginal rates of earnings per hectare, in the upper quartile of the land distribution for all three crop markets. This helps explain the tremendous concentration of sales earnings among a relatively small share of the country's agricultural households.

In the specific case of Mozambique, more research is needed to understand the reasons for constrained land exploitation in an apparently land-abundant setting given the apparent increasing returns to additional land in cultivation. In the TIA 2001/2 survey, most households claimed that they could obtain additional land for cultivation (Walker et al. 2004). So why don't they? Clearly one factor is very limited access to animal traction because of a combination of historical and disease-related factors. Resolving the animal draught power constraint will require a concerted effort to provide rural finance for farm capitalization as well as public goods in the form of animal disease prevention and animal management extension. Since the costs of public and private asset provision to enable profitable crop market participation are likely to be high in relation to available government resources, it is unlikely that most smallholders will become commercially viable in the medium term, especially in more remunerative cash crops such as cotton and tobacco. The findings from the earlier work by Walker et al. (2004) are confirmed by the analysis in this paper: scarce resources are likely to have a higher payoff in poverty reduction if invested in helping better endowed (but still poor) smallholders increase their cultivated area to the point of increasing returns than if invested in helping the least well-endowed households, who may be better served through labor markets than through direct participation as sellers in crop markets.

These findings, if confirmed through further analysis—ideally, in a multi-country study with panel data to control for some of the econometric identification problems associated with cross-sectional analysis of this sort—are potentially relevant for agricultural development policy in Sub-Saharan Africa more broadly. Jayne et al. (2003), in a cross-country study involving Mozambique and three other African countries, found that land access was statistically significantly and positively associated

with smallholder household incomes. An important complementary finding from our analysis is that increased access to land, and the set of assets necessary to cultivate it, appears necessary to enable farmers to benefit from emerging market opportunities. The key development policy message thus relates to the first-order importance of private productive asset holdings and their potential complementarity with public goods investments necessary to unlock the poverty reduction potential of the commercial agricultural sector. When new market opportunities open up, smallholders must either already be endowed with the necessary set of assets to cultivate enough area to surmount the relevant—if often latent—land thresholds or must be provided those assets as part of a deliberate agricultural market development strategy.

If the complementarity between different kinds of private and public investments in achieving broad-based poverty reduction is valid, then two key implications follow. First, ensuring coordination between the public and private sectors to identify and facilitate access to the correct asset mix could be a valuable public good in its own right. Second, because of the high multiplier effects from increased smallholder market-generated incomes, public investments that help leverage smallholders' private investment to attain the necessary land thresholds (e.g., through appropriate financial market interventions) may be justified. An important set of empirical research questions concerns the targeting of, and social returns to, smallholder investment subsidies for different types of market opportunities. Recent evidence that smallholder farm size is declining in several Sub-Saharan African countries (Jayne et al. 2006) lends greater urgency to this research agenda. Additional research similar to that undertaken here is clearly needed to ascertain the extent to which these findings are specific to the case of Mozambique versus being of more general application to other countries in the region and/or countries at different stages of structural transformation.

Endnotes

1 Even in those parts of Mozambique where expanded access to land is feasible, the limited availability of animal traction often prevents its exploitation. Increasing the availability of animal traction to smallholders is a difficult challenge because of the high investment cost, the need for access to veterinary inputs to treat for trypanosomiasis, and the lack of tradition of maintaining animals in many areas.

2 The inability to signal, or the distortion of signals about the ability of contract growers to use inputs effectively (e.g., as a result of gender bias or rent seeking behavior by company extension agents), raises unit costs and, in the presence of monopsony power, can adversely affect grower returns.

3 Households will not both buy and sell the staple in this simple, one-period model because of the price wedge created by transactions costs, so there exists a complementary slackness condition, $M^{sb}M^{ss}=0$ at any optimum. Because the household does not consume the cash crops, it can only participate in those markets as a seller.

4 While assets are represented by continuous variables in the simple theoretical model used to illustrate our analytical framework, in practice the data often contain dichotomous values (e.g., ownership of animal traction, access to market information). The model is sufficiently general to be valid for binary as well as continuous metrics of asset holdings.

5 Because the characteristics of maize production and marketing are so different in the three southern provinces of Mozambique compared to rest of the country we only include households from the seven provinces in the central and northern regions of the country for the empirical analysis of maize market participation that follows. In the case of cotton and tobacco, we only include households in districts where contract farming schemes are in operation.

6 We chose not to employ the Tobit model due to its restriction that participation and the extent of participation are determined by the same variables, and that a variable that increases the probability of participation also increases the extent of participation.

7 In Mozambique, all land is owned by the state under the constitution. The 1994 Land Law recognizes traditional land use rights that are allocated or adjudicated by traditional authorities, usually village chiefs. The land area variable is the sum of the area of annual crops, permanent crops, and fallow that the household reports having access to. A correction factor is applied to reported area based on a sub-sample of measured fields.

8 Pitoro et al. (2001) discuss the weakness of cotton extension services provided by three companies based on a survey of cotton farmers in Nampula province.

9 In an interview with the authors in April 2007, the Managing Director of the sole cotton company operating in Cabo Delgado province reported that the poor condition of rural roads was a major constraint to the company's effectiveness.

10 A recent draft public agricultural research investment plan to improve livestock and crop production technology to increase the productivity of household assets and/or reduce the risk of crop production projects an internal rate of return of 22 percent assuming only 10 percent of rural households benefit through adoption (Ministry of Agriculture 2006). The returns on such programs would obviously expand with greater adoption and/or market participation rates, thus the benefit/cost profile of public investments may well be endogenous to the private asset holdings of the target subpopulations.

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