DETERMINANTS OF MAIZE MARKETING DECISIONS FOR SMALLHOLDER HOUSEHOLDS IN TANZANIA

by

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Abstract

Smallholder farmers in Tanzania remain susceptible to food insecurity and poverty. To combat these challenges, the country and development organizations have turned to agriculture. In particular, value chains have been identified as a point of interest. Specifically, the maize value chain is of critical importance since maize is the staple crop of the country as well as the staple carbohydrate in the Tanzanian diet. Markets are beneficial because they enable households to specialize in agricultural production according to their comparative advantage. Specifically, markets have been shown to be one tool for increasing welfare, measured through the proxy income.

The objective of this thesis is to identify the determinants of a household's decision to participate in the maize market as well as identify the determinants of a household's decision regarding how much maize to sell in a given market. This research examines formal and informal market participation among 908 households during the 2008 long rainy season. Probit models were estimated to determine market participation for the formal, informal, and aggregate sale market levels. A Heckman OLS model was used to further analyze the value sold by the household in a given market.

Econometric results indicate that "quantity harvested" positively and significantly impacts market participation decisions as well as value sold decisions. The variable "male-headed households" was positive and significant in the formal market while the variable showed no significant impact in the informal market participation model. Both "radio ownership" and "mobile telephone ownership" proved to be positive and significant in the formal model while only the ownership of a radio was significant in the informal market. Additionally it was found that for the formal market participation decision, "bicycle ownership" was positive and significant. Overall, it appears that households participate in the informal market as a way to meet cash needs since farmers were not price-responsive. However, in the formal market farmers were found to be very price-responsive, following neo-classical economic theory.

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Chapter 1 - Introduction

Markets offer households, of all sizes, the opportunity to specialize in agricultural production according to their comparative advantage. Markets are beneficial because they enable households the ability to experience welfare gains from trade. Particularly, for subsistence farmers, markets can be a tool for increasing their welfare, measured through the proxy of income. In Kenya, subsistence farmers' average agricultural profits were 30 percent less than that of farmers who sold to the market (Omamo, 1998). Typically participation in markets helps spur further participation in markets. As a household's 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 (Boughton et al., 2007).

The Feed the Future Initiative

Markets, especially maize, are also at the forefront of focus for the United States Agency for International Development (USAID). USAID makes policy and investment decisions on behalf of the United States in the areas of economic, development, and humanitarian assistance. Feed the Future (FTF) is a USAID initiative to address global hunger and food security challenges. Through this initiative, USAID partners with agencies in developing countries to address and reduce hunger, poverty, and undernutrition. The main aim of the Feed the Future initiative is to "help communities feed themselves" where progress creates new markets and stability. The initiatives represent coordinated approaches to address food security issues. Tanzania was selected as a priority country for the Feed the Future initiative.

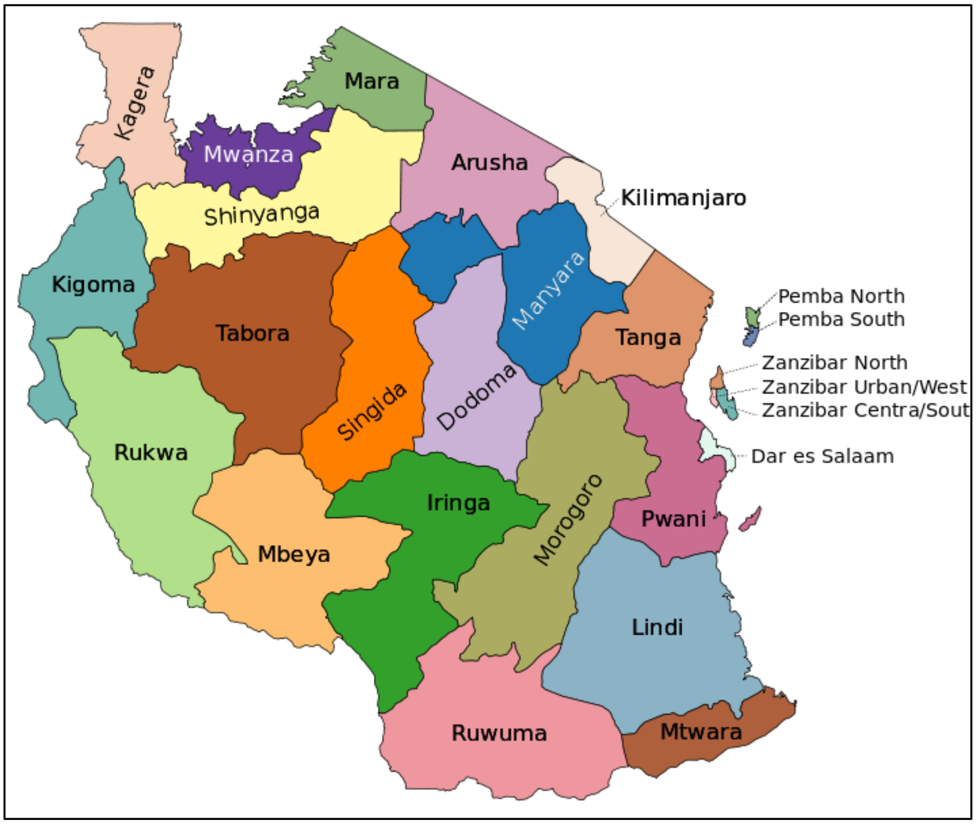
One method that is being addressed to maximize poverty reduction and growth in food security is through agricultural value chain development, specifically those value chains in which the poor participate. The value chains were selected based on analysis of potential to improve incomes and nutrition as well as prioritization by the country. Maize is one of the three value chains that was identified for the Feed the Future Tanzania Initiative. (United States Agency for International Development 2011).

Tanzanian Demographics

The United Republic of Tanzania, is located in East Africa, and is bordered by countries to the north, west, and south, the Indian Ocean is to its east. To the north the country is bordered by Kenya and Uganda, to the west Rwanda, Zambia, Malawi, and by Mozambique to the south. Outside of Africa, Tanzania is known as the home to Africa's highest mountain, Mount Kilimanjaro.

Originally a British colony, one region of the country, Tanganyika gained its independence in 1961 while independence came in 1963 for the Zanzibar region. In 1964 the two states merged to create what became the country of Tanzania (CIA: The World Factbook - Tanzania n.d.). The democratic republic's capital is located in the city of Dodoma while its largest city, Dar es Salaam, is situated on the coast (Figure 1-1). Dar es Salaam serves as the major port for Tanzania as well as for neighboring landlocked countries. Tanzania's official languages are Swahili and English. As of 2013, the country's estimated population is 49 million people (FAO Country Profiles - United Republic of Tanzania n.d.). Tanzania is divided into thirty different regions; five on the islands of Zanzibar and twenty-five on the mainland. The different regions can be seen in Figure 1-1.

Figure 1-1: A Map of the Regions of Tanzania



Source: Wikimedia Commons, Accessed on March 30, 2013
(https://commons.wikimedia.org/wiki/File:Tanzania_regions.svg)

Poverty and Food Security

Over the past decade, the country has averaged a 7 percent per year growth in the GDP. Despite this growth, the poverty rate has increased due to rapid population growth, especially in urban centers. Forty-three percent of the population is under the age of 15. Currently, 34 percent of the population lives below the international poverty rate ($1.25/day). Some regions of the country have as much as half of the population unable to meet their basic needs. As a result, Tanzania is unlikely to meet the 2015 Millennium Development Goals at its current status. Due to Tanzania's political stability, sound macroeconomic management, and considerable resources, the country has exceptional potential for sustained growth. The opportunities are also great for Tanzania to reduce poverty and hunger by increasing incomes through agricultural growth and improvement in nutrition. (United States Agency for International Development 2011).

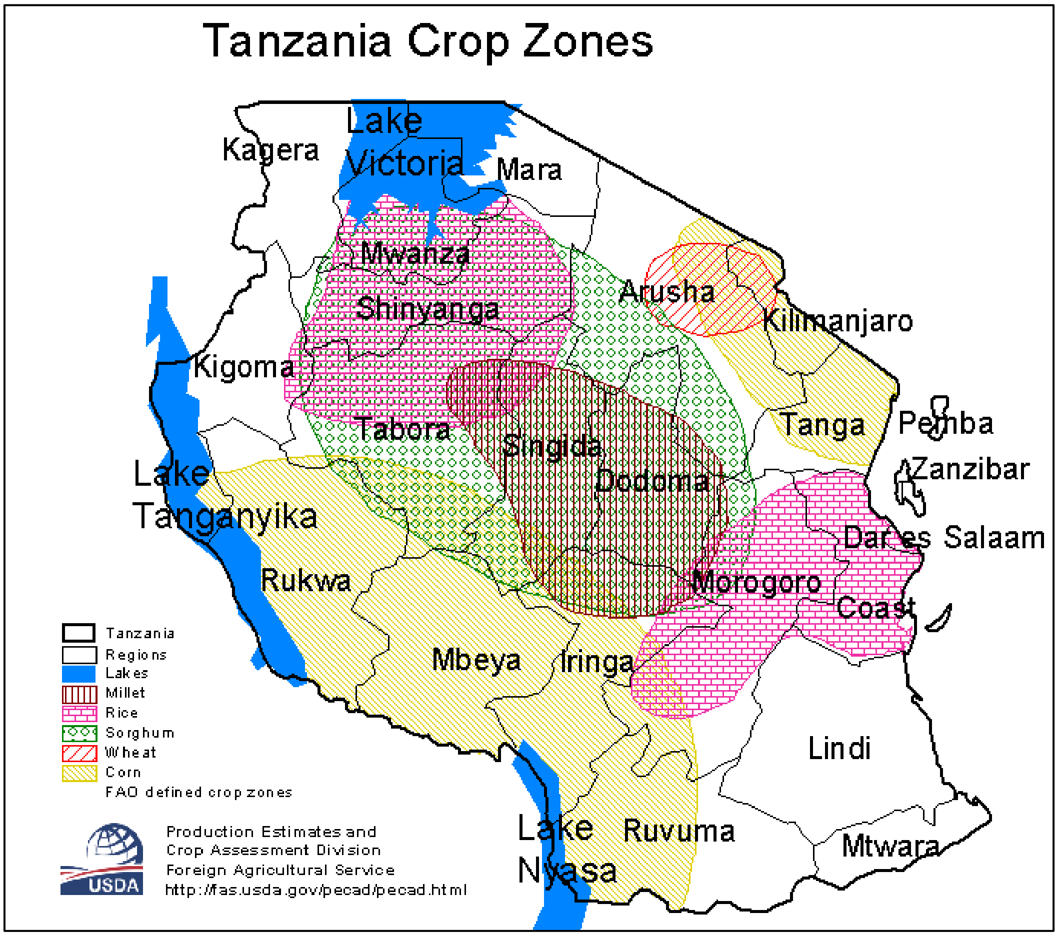
Undermining Tanzania's efforts to experience economic growth is chronic undernutrition. Currently, 40 percent of children under 5 years of age suffer from undernutirion throughout the country. This undernourishment impacts a child's ability to grow, learn, and contribute to the economy by earning income as an adult. The main factor contributing to undernourishment is inadequate access to a diverse and quality diet at the household level. The issue begins though even before a child is born with over half of pregnant women suffering from anemia in Tanzania. It is estimated that undernutrition costs Tanzania 2.65 percent of its GDP, due to lost revenues, mainly in the agricultural sector, which attributed to poor cognitive and physical development. (United States Agency for International Development 2011).

State of Agriculture

The agricultural industry ranks first in Tanzania, contributing approximately 26 percent of the GDP. Approximately 5 million hectares of crops are cultivated each year with 85 percent being food crops (Reynolds 2003). The industry employs 75 percent of the country's workforce with women contributing more than 75 percent of the agricultural labor (United States Agency for International Development 2011). Maize is the main subsistence crop cultivated in the country and is grown by more than 50 percent of the farmers (Reynolds 2003). Other crops that are important in the Tanzanian agricultural sector and diet include rice, sorghum, millet, wheat, pulses, cassava, potatoes, bananas, plantains, groundnuts, sesame, coconuts, and soybeans (Reynolds 2003).

Approximately 3.3 million metric tons of maize was produced in 2009 (FAO Food Balance Sheet – United Republic of Tanzania 2012). Seventy-seven percent of the maize produced in the country goes directly to human consumption (FAO Food Balance Sheet - United Republic of Tanzania 2012). As highlighted in Figure 1-2, the main production areas for maize include the regions of Arusha, Iringa, Mbeya, Rukwa, and Ruvuma. These 5 regions account for approximately 50 percent of all maize production in the country. The *vuli* season (October-December) brings about approximately 15 percent of total annual maize production in the regions of Mara, Arusha, Kilimanjaro, Tanga, Morogoro, Mbeya, Coast, Kagera, Kigoma, and Mwana. The outstanding maize production in Tanzania comes from the unimodal *musumi* and bimodal *masika* long rain seasons. (United States Agency for International Development 2011).

Figure 1-2: Regional Crop Production in Tanzania

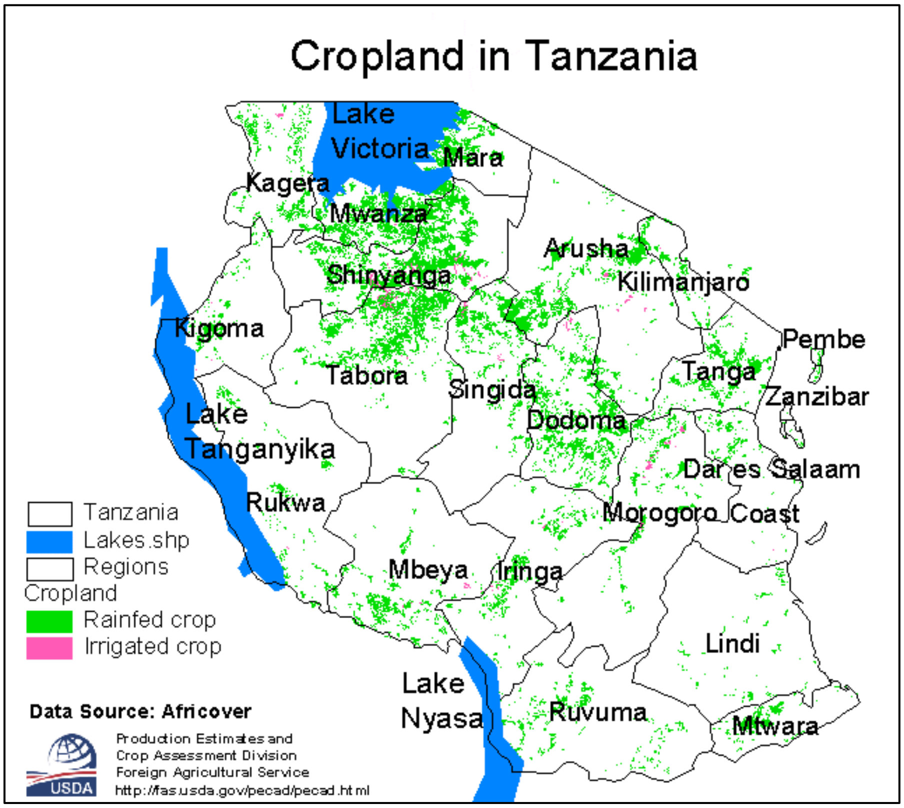


Source: USDA FAS, Accessed March 30, 2013
(http://www.fas.usda.gov/pecad2/highlights/2003/03/tanzania/images/cropland_tz.htm)

Overall, Tanzania is self-sufficient in production of maize, yet the country still faces shortages from time to time due to weather volatility such as prolonged drought and low yields. The country does face many challenges which do not provide incentives for the development of the agricultural sector. An example of one of the major country-wide challenges is the limitation of financial resources as only 9 percent of Tanzanians have access to formal financial services and only 4 percent have ever received a personal loan from a bank (United States Agency for International Development 2011).

Despite the many challenges faced, domestic advocates for an agriculture-based economic growth model in the country describe Tanzania as a "sleeping agricultural giant" with immense potential due to "the country having abundant land and water resources, motivated agricultural laborers and entrepreneurs, and access to international markets through a major port" (United States Agency for International Development 2011). Although very few agricultural crops are irrigated in Tanzania it is expected that with increased irrigation and improved seeds, productivity and yields are expected to rapidly increase (Figure 1-3).

Figure 1-3: Water Sources for the Regions of Tanzania



Source: USDA FAS, Accessed March 30, 2013
(http://www.fas.usda.gov/pecad2/highlights/2003/03/tanzania/images/cropland_tz.htm)

Within the maize value chain development, opportunities have been identified to engage and empower women specifically as the main beneficiaries. While women provide most of the agricultural labor force, they have limited participation in decision making and benefit little from the downstream portion of value chain activities such as warehouse receipt system, marketing, processing, and trade. Gender inequality also exists in access to resources, particularly, land and water resources as well as agricultural inputs such as improved seed and fertilizer. Tanzanian women also lack access to credit and technology training.

Thesis Outline

This thesis will first begin with a review of literature on the topic of market participation decision making. When possible, specific market participation studies dealing with subsistence farmers in Africa will be highlighted. The literature review chapter provides a basis to the thesis as it will give a background of previous studies and the corresponding findings. Following the literature review will be a chapter which gives an overview of the data. The data used in this thesis will be discussed in great detail allowing the reader to gain an understanding of the maize growing subsistence households analyzed in this study. Next is a chapter which provides the econometric methodology used to conduct the analyses. The chapter will also provide the specific models and variables used in this thesis. The results chapter reviews the econometric findings of each specific model. Finally, the conclusion will summarize the thesis as well as discuss policy implications from the findings and potential improvements for future research.

Thesis Objectives

The objectives of this thesis are to identify the determinants of a household's decision to participate in the maize market, as well as the determinants of a household's decision about how much maize to sell in a given market. An overarching question that is analyzed is whether it is important to distinguish between the formal and informal maize markets or if the same variables are significant in each model. A household is classified as participating in the formal market if the household sold any maize to a market, an open air market, a cooperative union, or a farmer's party. Households which sold to relatives or neighbors were classified as participating in the informal market. Households had to specify their primary market so the formal and informal markets are mutually exclusive in this thesis.

The first hypothesis is that the determinants of market participation and the value sold are different between the informal and formal markets. It is known that surplus production, fixed and variable transaction costs, as well as socio-demographic characteristics impact a household's marketing behavior.

Currently, there is a debate within market participation studies throughout developing countries whether transactions costs are the key limiting factor for a household to participate in the market or if market participation is limited because farmers simply do not have enough produce to sell. This debate is broken into two hypotheses in this thesis. It is hypothesized that market participation is affected by transactions costs. It is also hypothesized that marketing decisions are affected by how much maize is available.

One type of fixed transaction costs is information dissemination. Information is very important to farmers and how farmers obtain information has key policy implications. The fourth hypothesis deals with information dissemination via communication devices. It is hypothesized that both “ownership of a radio” and “ownership of a mobile telephone” positively affect a household’s decision to participate in the market and how much maize to sell.

The next set of hypotheses surrounds household characteristics. It is hypothesized that female-headed households are less likely to participate in the market than male-headed households and if they do participate, they sell less maize. It is also hypothesized that the older the head of the household is, the less likely the household is to participate in the market.

The final hypothesis deals with transportation. Transportation vehicles can be used as a method to gather information as well as a way to take goods to market. Therefore, it is hypothesized that “bicycle ownership” increases the likelihood that a household participates in the market and the amount of maize sold.

Chapter 2 - Review of Literature

The literature on agricultural development is vast. Rather than going through an exhaustive review of the entire literature, this thesis reviews literature specifically concerned with market participation and corresponding barriers in subsistence rural economies. The factors which cause some producers to buy, others to sell, and others to simply not participate in markets will be highlighted in this study.

Farm Household Model

The farm household model, developed by Branum and Squire (1979), made significant advances in the conceptual understanding of the issues that remained unexplained for subsistence farm households. The household model has been used to analyze and further understand policy issues relating to rural economies in developing countries, especially in explaining paradoxical microeconomic responses of farmers to changes in relative prices (de Janvry, Fafchamps, and Sadoulet, 1991). The model's distinguishing structure originates from the non-separability rather than the standard neo-classical assumption of separability in the household's consumption and production decision-making often seen in marketing decisions in the United States among other developed countries.

A drawback of the household model, as noted by Brooks, Dyer, and Taylor (2008), is its extreme sensitivity to the set of assumptions on which the model is based. One assumption is that the farm household decision-making process is recursive as consumption and labor supply decisions depend on production decisions but not the other way around. Production decisions are independent of all other decisions meaning that, as far as production is concerned, the household acts as a profit maximizer (Singh, Squire and Strauss, 1986a).

Take, for example a classic Singh, Squire, and Strauss (1986b) scenario of the on-farm production effects where there is an increase in the price of maize. For farm production if farmers are price-responsive, the price increase results in an increase in labor input as well as total production which earns the household more income. However, for the same household, as a consumer the household must pay more for the maize than they were previously. Increases in income are due to higher profits from farm production, leading to a positive income effect via agricultural production which competes with a negative substitution effect due to household consumption. Therefore, the net effect is quite ambiguous, depending on the slope of the household's utility function and the magnitude of the income effect. As a result of the recursive relationship between the household's production and consumption decisions, the supply response of marketed surplus, especially at the market level, may be of negative sign (Barnum and Squire, 1979).

Olson (1960) and Krishnan (1965) also found evidence that suggested an inverse relationship between the marketed volume of a subsistence crop and price. They argued that an increase in the price for the subsistence crop may increase the producer's real income sufficiently so that the income effect on his demand for crop consumption outweighs the price effect on production and consumption. Therefore, marketed surplus may vary inversely with market price.

As shown in the aforementioned examples, price policies impact net buyers and net sellers in the market differently (Azam et al., 2012; Jayne et al., 2010). Implications for governments attempting to aid the poor by setting a target price for commodities require extensive analysis to determine if the policy is truly helpful or not. The household model should be used as a basis to properly examine the decision making of the farm household. Recent studies have done just this and highlighted transaction costs and institutional factors which aid in determining a household's decision on market participation (Goetz, 1992; Sadoulet and de Janvry, 2000).

Transaction Costs

Barriers to market participation are often exemplified by transaction costs and are considered to be one of the factors liable for market failures in developing countries (de Janvry, Fafchamps and Sadoulet, 1995). A multitude of studies have shown that transactions costs determine households' decisions on market participation (Goetz, 1992; Sadoulet and de Janvry, 2000; Vikas, Sadoulet, and de Janvry, 2003; Vance and Goeghegan, 2004; and Carter and Olinto, 2003).

Transactions costs, as noted by Barrett (2008), have also been found to distort production. Transaction costs, as well as differential access to assets and services to mitigate transaction costs, help explain the heterogeneity of smallholder market participation. Transaction costs can be divided into two sub-categories: fixed transaction costs (FTC) and proportional transaction costs (PTC). The main differentiating factor between the two transaction costs is that FTCs are determined based upon information variables, while distance and transport variables are expected to determine PTCs (Alene et al., 2008). The following section will briefly explain FTCs and PTCs. Many of the market participation factors within the literature review are transaction costs variables and therefore will be specified as such.

Fixed Transaction Costs

Fixed transaction costs can include such activities as search, negotiation and bargaining, and screening. One type of search costs is the search for the existence of a market. Another type of search costs is the search for a buyer with the best price. The costs of negotiating and bargaining with a potential buyer are very important when there is imperfect information regarding prices. Finally, the costs of screening, enforcement, bribing, and supervision are important for those farmers who sell their product on credit (Azam et al., 2012; Alene et al., 2008). Farmers who sell their product on credit may have to screen buyers to ensure their reliability and trustworthiness in regards to debt repayment. Also, asymmetric information may require farmers to screen potential input sellers regarding the quality and price of the inputs. FTCs are invariant to the quantity traded and are usually considered a lumpy investment. For example, a farmer may incur the same search cost for a buyer to sell 5 kilograms or 50 kilograms of product. Once the information about the market has been acquired and contacts with the buyer have been made, the household can sell any quantity they desire without having to incur extra costs.

Proportional Transaction Costs

Variable, or proportional transaction costs are directly related to quantity and correspond to constant marginal transaction costs or the per-unit costs of accessing the market. PTCs include the costs of transferring the product or inputs being trading to the market, such as transportation costs, as well as the time invested in the delivering and/or receiving process. PTCs essentially raise the price paid for inputs while they lower the price received for output products, which creates a price band within which some households find it unprofitable to sell output or buy inputs (Azam et al., 2012; Alene et al., 2008).

The pure existence of a road as well as the quality of the road infrastructure impacts the transportation costs. An efficient transport system is critical for efficient agricultural marketing. In a study conducted by Hine and Ellis (2001) it was estimated that replacing a footpath by a vehicle track may be a hundred times more beneficial to the farmer than improving the same length of a poor quality earth track to a good quality gravel road. They also estimated that upgrading a 5 kilometer feeder road from earth to gravel may only increase farmgate prices by one-tenth of 1 percent while bringing new motor vehicle access 5 kilometers closer to a village (or farm) when the alternative was head-loading by hired labor could increase farmgate prices by over 100 times as much. If transport services are expensive, of poor quality, or infrequent, then farmers will be greatly disadvantaged when attempting to sell their crops. Seasonal issues also may arise in the form of impassable roads or infrequent transport services. While some researchers find market access infrastructure as a significant factor for market participation, Rios et al. (2008) analyzed cross-country market participation data from Vietnam, Tanzania, and Guatemala and found that investments in market access infrastructure only provided minimal improvements in agricultural productivity and market participation. Boughton et al. (2007) stated that 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 in Mozambique.

A new approach was taken when Goetz (1992) estimated a switching regression model of market participation and the amount traded in the Senegal grain market, treating the market participation decision as independent of the quantity traded decision. Fixed transaction costs greatly hindered, yet better information stimulated, smallholders' participation in the output market. Adding onto Goetz's model, Key, Sadoulet, and de Janvry (2000), estimated a market participation model using Mexican corn production data. Their results indicated that both types of transactions costs played a significant role in explaining household behavior, with proportional transactions costs being more important in selling decisions.

Transportation Costs

Remoteness

Further examining the transportation costs embedded within both fixed and proportional transaction costs yields additional constraints to market participation. Smale et al. (2011) noted that maize is the most widely-grown staple food of Sub-Saharan Africa and is often used as a wage good, yet market participation differs depending on population densities. The majority of maize producers live a substantial distance away from population centers. Farmers in sub-Saharan Africa face a greater challenge than the rest of the world as physical access to markets is much more limited in sub-Saharan Africa than any other region of the developing world. In sub-Saharan Africa, only 25 percent of all farmers are within 2 hours to the nearest market by motorized transport, compared with 50 percent in Asia and the Pacific, and 43 percent in the aggregated developing rural world (Smale et al., 2011). In looking at the challenge from another angle, it is estimated that approximately 75 percent of sub-Saharan African farmers are located more than 4 hours to the nearest market by motorized transport (Smale et al., 2011). It is essential to highlight that while the above numbers are accurate for travel time by motorized transport, the travel time for most farmers is much greater since the majority do not have access to motorized transport. Barrett (2008) found in a study conducted in eastern and southern Africa, that distance to market had a negative and significant impact on smallholder market participation. The same negative and significant impact of distance to market was found in rice market participation in Cambodia (Azam et al., 2012). In agreement with Barrett and Azam, Cadot et al. (2006), found that remoteness is a substantial barrier to market entry in Madagascar. Alene et al. (2008) found that remoteness impacts participation, even within input markets. In Kenya, remoteness of the fertilizer market reduced total marketed supply by over 40 percent.

Remoteness can also impact fixed transaction costs relating to market and information search, screening, enforcement, bargaining, transfer, and monitoring. The costs tend to be higher for farmers living in remote areas with poor communication and transportation infrastructure as general lack of information persists. The farmers lack information about prices of commodities at the local level as well as at the final consumer level, about quality requirements, about market locations and the best time periods to sell their products, about potential buyers, about production in other areas, as well as their rights and the overall legislative framework (Azam et al., 2012). Due to their remoteness, information about market demand is costly, difficult, and time consuming to obtain. Smallholders may obtain information through contacts with other members of the community but the accuracy of the information is not guaranteed as those information spreaders may have ‘opportunistic behavior’ that benefit their own welfare. Therefore, the distance to market in conjunction with poor infrastructure and poor access to information may be manifested in high transaction costs.

Storage and Perishability

Perishable products such as milk and fresh vegetables add additional challenges to the transportation process. Such products have specific storage needs and the requirement of a quick turn-around time, which affects proportional transaction costs. Other products, like fresh fruit, are extremely susceptible to rough road conditions and can be easily bruised. Bruising, of course, is unwanted as it decreases the value of the product received by the farmer when it reaches the market. Transport operating costs are usually always higher on rough roads than on good quality asphalt roads due to such reasons as perishability and storage needs (Hines and Ellis, 2001). A study conducted by Ellis (1998) found that markets and storage facilities were on average closer to villages in Asia than in Africa which allowed Asian farmers greater ability to sell their produce at a market. Due to a lack of storage facilities or transportation services with correct storage design, Africa farmers are more apt to sell their goods at lower prices rather than risk not being able to sell their produce at the market due to spoilage or bruising.

Productivity and Marketable Surplus

To participate in a market requires that the smallholder farmer has a production level beyond what his/her own family will consume. This quantity of product that could be sold at the market is referred to as 'marketable surplus'. Productivity, therefore, can play an important role in determining a household's decision to participate in the market. The main proxy measurement for productivity is mean yields. Olwande and Mathenge (2011) found in their market participation study in Kenya that productivity was positively correlated with increased market participation.

Mean Yield and Input Use

Mean maize yield affects market participation (Heltberg and Tarp, 2002). As output increases, farmers will retain a smaller portion for consumption and make a larger proportion available for off-farm consumption (Bardhan, 1970; Haessel, 1975). Therefore, factors that increase yield can positively impact market participation. Increased production can arise from several sources: access to inputs, improved knowledge, or farm machinery.

While economic theory assumes that farmers are price responsive and will market larger quantities as the price of the good increases, a sub-set of market participation literature suggests that some farmers are not necessarily driven by price. Mathur and Ezekiel (1961) as well as Enke (1963) suggest that farmers' planting and marketing decisions are governed by traditional behavior and practices, where price is of secondary importance in explaining variation in output. The authors believe that the marketed surplus of subsistence farmers may have fixed or relatively fixed monetary obligations. Therefore, subsistence farmers dispose of only as much produce as is necessary to obtain the desired cash income. It is thought that subsistence farmers are likely to be in debt due to a social obligation or an unforeseen weather occurrence which causes them to sell a portion of their produce to meet their commitments. The authors are of the opinion though that the result of a price increase of the product will be followed by a decrease in the quantity sold to the market, since a smaller quantity of produce marketed can meet their cash obligations. This conclusion was also found by Bellemare and Barrett (2006) with livestock sales in Kenya and Ethiopia.

Azam et al. (2012) identified that the state of technology use and the effect of other inputs is positive and significant for market participation of rice farmers in Cambodia. Alene et al. (2008) also came to the same conclusion in Kenya. However, with the need for inputs, this requires that the input market is well developed and that there exists agribusiness stores which sell improved seed and fertilizer and are located near the village. This also means that the owner of the agribusiness is an individual whom farmers can trust and know that what they purchase will be of good quality. The use of inputs also relies upon the existence of physical infrastructure to allow the timely availability and delivery of farm inputs so that marketable surplus can be increased. Increased investment in the public good of agricultural research may be very important to raise crop productivity and reduce minimum asset thresholds for market participation in Mozambique (Boughton et al., 2007).

Agro-ecological Zone

Productivity can greatly be enhanced or challenged depending upon the agro-ecological zone in which a farmer is located and what local resource endowments exist. Throughout the world, there are high-potential regions which have a better soil nutrient mix, greater irrigation potential, and therefore yield higher quantities of products with a less amount of investment per hectare than that required in low-potential regions. Barrett (2008) concluded that in eastern and southern Africa, those smallholders that were cultivating in higher potential agro-ecological zones appeared to be more likely to sell to market than others. Heltberg and Tarp (2002) proxied agro-ecological zone in their market participation model in Mozambique as climate risk and found that it was significant. Azam et al. (2012) also found their variable of a risky region negatively and significantly impacted market participation in Cambodia.

Extension

Extension can be very useful in order to inform and teach farmers about new technologies or agricultural practices. Extension efforts can increase a farmer's production knowledge to help them increase their marketable surplus. Extension agents can also serve as a channel of information about market locations, prices, and potential buyers/sellers. While a main effort of increasing production has been classically thought to be technology, Thirtle et al. (2003) said that "technology innovation may not be the main problem; instead it may lie with extension". Extension, measured usually through the number of extension visits or farmers per agent, has also been proven to have a significant and positive impact on maize supply (Alene et al., 2008). Gebremedhin and Hoekstra (2007) also found that household involvement in extension service is positively associated with the household's probability of growing market-oriented commodities.

Market Concentration

Market concentration is defined as the distribution of the total volume marketed across the sample households (Olwande and Mathenge, 2011). Olwande and Mathenge (2011) conducted a market participation study in Kenya and found that within the maize market, non-poor households had a higher participation rate than poor households. The authors also found that for maize, 70 percent of the marketed volume was sold by the top 20 percent of the households. However, the bottom 20 percent of the households sold less than 1.5 percent of maize. In support of these findings, Nyro (1999) also found in a study of Kenya's maize market that 10 percent of the farmers that were active in the market, accounted for 75 percent of the maize sold.

Asset Ownership

This section will be divided into two different types of ownership. These ownership categories are farm assets and transport vehicle. Ownership of any good, is a measure of an individual's wealth. Cadot et al. (2006) found that private wealth does indeed, positively and significantly, affect market participation. The role of productive assets, which improves a household's capacity to produce marketable surplus, was found to play a role in poverty reduction (Olwande and Mathenge, 2011).

Farm Assets

Farm assets include both livestock and machinery. Livestock can be valuable as a means of animal traction in place of farm machinery to aid in productivity, be used as an emergency cash fund, aid in transporting produce to the market, or used to travel to the market for the purpose of gathering information. Barrett (2008) stated that improving poorer households' access to productive assets is essential in stimulating smallholder market participation. Animal traction was a positive and significant variable for market participation (Heltberg and Tarp, 2002). Boughton et al. (2007) came to a similar conclusion in Mozambique in that private ownership of livestock and equipment are positively correlated with cash crop market participation. Households which owned agricultural implements were 139 percent more likely to participate in the market than households which did not own any agricultural implements in Cambodia and was significant at the one percent level (Azam et al., 2012).

Transport Vehicles

Heltberg and Tarp (2002) concluded that household ownership of a bicycle or a motorized vehicle increased market participation and sales volume. This variable is a measure of proportional transaction costs. Azam et al. (2012) too found transport equipment ownership to positively impact market participation; however, it was not significant in their study. Olwande and Mathenge (2011) as well as Alene et al. (2008) found in Kenya that ownership of transport equipment is positively correlated with market participation. In Alene et al.'s study it was found that transport vehicles served a greater role in accessing market information than facilitating product transport for the farmer.

Private asset accumulation (farm assets and transport vehicles) are a prerequisite for smallholders' escape from subsistence agricultural production. This view has been supported by findings in Mozambique (Boughton et al., 2007) and in Madagascar (Cadot et al., 2006).

Land Tenure

Land tenure, as defined by the Food and Agriculture Organization, is "the relationship whether legally or customarily defined, among people, as individuals or groups, with respect to the land and its natural resources" (Food and Agriculture Organization, 2012). Smale et al. (2011) concluded from their research that in sub-Saharan Africa, access to land has become so constrained that surplus maize production is unattainable for many smallholders, even with successful adoption of seed-fertilizer technologies. Land is one measure of wealth, and it was found that farm size per household worker has a positive and significant impact on market participation (Heltberg and Tarp, 2002).

An individual's ownership of the land is linked to their investment in the land and, therefore, the productivity of the land. If an individual has a title for the land they are currently cropping, or feel very secure that they will be allowed to continue farming that particular piece of land in the future, then they will be more apt to make long-term improvements in the land. Long-term improvements can include such activities as enhancing soil fertility or building an irrigation system. Both of the previously stated projects have high upfront costs and its benefits are only realized after operating on the land several years.

Land Ownership

Through his research in eastern and southern Africa, Barrett (2008) found that there were strong associations between households' asset holdings, land in particular, and their participation in the market. The author also found that wealthier households are more likely to participate in the market than households with less wealth. A similar conclusion was reached by Boughton et al. (2007) in that private asset holdings, especially land, is positively and significantly correlated with cash crop market participation. Azam et al. (2012) found that land per worker was a positive and significant variable for market participation. While land ownership does have a strong positive impact, simply having access to land has a positive impact as well. Olwande and Mathenge (2011) found that land size, through simply having access to land, was correlated with increased market participation in Kenya. Supporting this is the research conducted in Kenya by Alene et al. (2008) which found that a 1 percent increase in access to land per capita increased the probability of market participation by 11 percent.

Credit

Stephens and Barrett (2011) found that households with access to credit are more likely to transact in the foodgrains market. This finding is also supported with research conducted by Cadot et al. (2006). Alene et al. (2008) concluded that in Kenya, credit worthy farmers had a 19 percent greater likelihood of market participation. Boughton et al. (2007) highlighted that the policy implications for credit's role in market participation are that more attention needs to be given to policies and programs that address missing rural financial markets.

Credit can be useful when farmers are attempting to start a new project or simply expand their operation where there are many upfront costs. An example of where credit could make a considerable impact is highlighted in Kenya. In land-scarce Kenya, farmers who have sufficient assets to invest in tea as a cash crop are able to finance fertilizer to maintain soil fertility on their maize fields. However, since tea is a perennial crop that takes several growing seasons to reach full maturity, farmers often find it difficult to pursue that venture as they cannot afford to forego income from the land the tea occupies until the tea bushes become productive (Barrett et al., 2006). In this case, access to credit would allow farmers to set aside a portion of their land for the tea crop while still having enough income to eat. Another example of when credit would be very beneficial is found in Madagascar. There is a high proportion of the poor rural households that have to sell their rice at low prices due to lack of access to secure storage facilities and to immediately repay debt (Barrett, 1996; Barrett et al, 2006; Moser et al., 2006). Access to credit would allow farmers or communities to invest in building storage facilities or repay their debts not immediately after harvest.

Information Dissemination

To actively participate in the market, knowledge about prices, market location, and potential buyers is necessary. This knowledge is a type of proportional transaction costs. A market works most efficiently when perfect knowledge exists. As is known, perfect knowledge does not exist in reality so the following sections are ways in which knowledge can be gained to be better informed when making decisions.

Communication Device Ownership

Olwande and Mathenge (2011) have evidence through their three-year panel data survey in Kenya that ownership of communication equipment is a positive and significant variable which impacts market participation. Azam et al. (2012) also found that variables capturing information processing: ownership of a radio, television, or telephone has a positive impact on market participation. The authors found that for households which owned one or more of the previously stated communication devices were 46 percent more likely to participate in the market than households which did not own a communication device. Contrasting the previous findings, Alene et al. (2008) found that access to communication had positive but insignificant impacts on market participation. Specifically, Aker and Mbiti (2010) find that mobile phone ownership has a positive impact on agricultural market efficiency.

Organization Membership

Membership in farmer organizations, associations, or groups has been shown to have a positive and significant impact on market participation (Olwande and Mathenge, 2011). Alene et al. (2008) found that farmers that participated in the Maize Marketing Movement (a group marketing association in Kenya) supplied 56 percent more maize to the market than did participants who did not belong to the group. Membership in these organizations brings about the ability for collective action. The collective action that transpires from organizations facilitates access to information as well as credit which enhance market access. Barrett (2008) suggests that facilitating smallholder involvement in farmer organizations is essential to stimulating smallholder market participation.

Demographics

Individual characteristics also can have a significant role in household market participation decisions. These characteristics include such examples as age of the household head, sex of the household head, education level of the household head, and the family size.

Gender and Age

Gender was not statistically significant for market participation in Kenya (Olwande and Mathenge, 2011). Alternatively, it was found that 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 (Boughton et al., 2007). However, conversely Alene et al. (2008) found in Kenya that female-headed households had a greater likelihood of participation in maize markets than male-headed households, with males being ten percent less likely to participate than females.

Age of the household head significantly affects market participation (Heltberg and Tarp, 2002). In Kenya, Alene et al. (2008) found that market participation declines with age, which supports the characterizations that older farmers are risk averse and slow to adopt new technology. Therefore, they have a lower ability to produce for the market and lower trust that prevents them from trading at lower costs. Gebremedhin and Hoekstra (2007) found a U-shaped relationship between age of the household head and market orientation of the household in cereal crops, which indicates the need for a time period of learning prior to the household embarking to participate in the market.

Education

The variable for education revealed a positive and significant relationship with market participation for farmers in Nigeria (Gani and Adeoti, 2011). This conclusion was also found in the rice market of Cambodia (Azam et al., 2012). Thirtle et al. (2003) summed up the impact of education in the statement that "literate farmers are better able to assimilate information and make use of new technologies as they have a less steep learning curve". Education has long been a focus of development efforts in general improvement of human welfare, and now appears to even be crucial to farming activities as well.

Family Size

The size of the family in a household has a significant effect on the amount of marketed surplus. Families that are larger sell less to the market than smaller families. This difference is due to a greater quantity consumed by the household in the larger families (Sharma and Gupta, 1970). Particularly in regards to the type of crop grown, Gebremedhin and Hoekstra (2007) found that larger households are more likely to grow cheaper but more productive subsistence crops since they have greater consumption needs. The authors also stated that the number of dependents appears to induce market participation as the cash needed to cover expenses is related to the number of dependents. Gaini and Adeoti (2011) found that in Nigeria, family size had a negative impact on participation and was significant at the 1 percent level. Specifically, the study found that an increase in the family size can lead to a decrease in the market participation by three percent.

Price Risk

Price risk is a new variable that has recently been examined for its impact on market participation. Cadot et al. (2006) concluded that price risk is a large impediment to market entry. This conclusion was also found by Heltberg and Tarp (2002). Landlocked countries in southern Africa that are dependent upon maize are most exposed to domestic sources of market shocks due to highly variable food production. The national capacity to participate in world markets to smooth supply variability is limited by high transport costs and foreign exchange constraints (Smale et al., 2011). It is important for agricultural systems to shift to market-based food systems and build capacity in private markets. Specifically, investment in transport, storage, information systems, and market regulations will reduce the volatility of maize prices in sub-Saharan Africa (Smale et al., 2011). To improve efficiency within regional markets, countries need to agree to eliminate export restrictions. Price risks can arise because of the impact of food production in surrounding countries as well as due to domestic concerns. Fafchamps (2004) concluded that weak marketing infrastructure, both institutional and physical, leads to considerable spot market price risk. Specifically, the infrastructure that the author cited was contract law, police protection, uniform grades and standards, roads, and electricity.

Streamlining the regulatory process for trade can greatly reduce downside price risks that are often a disincentive to participate in the market (Jayne et al., 2012). Local production shocks can be mitigated by regional trade (Koester, 1986) when different regions experience different levels of supply and demand. For example, if Tanzania experiences extreme drought but Kenya does not, it is in the best interest for both countries to trade since there is a shortage of grain in Tanzania but a surplus in Kenya. Tanzania will benefit by having access to major staple crops and avoid immense food security stress while Kenya will benefit from selling their larger supply quantities at a higher price.

Summary

This chapter has reviewed a portion of the current literature in the agricultural economics discipline dealing with market participation and volume sales. Specific household characteristics, endowments, and information were highlighted as well as their impact on a household's decision to participate in the market. The previous findings outlined in this chapter served as the basis in selecting the variables used and tested in this thesis. The next chapter outlines the specific variables selected and gives an overview of the data used to perform the market participation and value sold analyses.

Chapter 3 - Data Overview

This chapter's aim is to provide a more extensive examination of the variables and data used in this thesis. The first section of the chapter focuses on the source of the data used to conduct the analysis. The following sections provide a picture of the household characteristics for the households surveyed. Information regarding asset ownership, production practices, and resource endowments, as well as other variables describing the household will be examined.

Data Source

The data used in this thesis was collected by the World Bank through their Living Standards Measurement Study: Integrated Surveys on Agriculture (LSMS-ISA) project (LSMS: ISA Country Program Tanzania). The LSMS-ISA project is being implemented in seven different African countries, one of which is Tanzania. Recognizing that the existing agricultural data in the Sub-Saharan African region is weak or nonexistent, the aim of the LSMS-ISA projects are to expand the statistical data and research dealing with the linkage between agriculture and poverty reduction in the region. LSMS-ISA projects collaborate with the national statistics office of each country to implement multi-topic, national level household surveys.

The household surveys that are used in this research were conducted from October 2010 to December 2011. There were 3,924 households that participated in this study, providing key socioeconomic variables of all regions of Tanzania. Three questionnaires were administered: a household survey, an agricultural survey, and a community level survey. The surveys were conducted in Swahili and then translated into English and the questionnaires were administered via a single visit to the households. For the purposes of validation of information received, 25 percent of the sampled households' agricultural plots were measured using GPS technology.

Being that this thesis is interested in maize production, considerable data management was conducted in eliminating the households that specified that their primary crop was something other than maize. In keeping with the mindset of the household model where the household makes production and consumption decisions, only 1 entry per household was wanted. Therefore, households which had more than 1 plot of maize was aggregated together with corresponding information either being summed or given a weighted average, depending on the needs of the specific questions. Specifically, the information on market participation for each plot was aggregated so that there is 1 entry per household. In total, 908 households comprise the dataset that was used to produce the maize research and results found in subsequent chapters.

The objectives of this thesis on market participation and descriptive analyses were divided up among the formal market, informal market, and those that did not participate in any market. Further information regarding the difference between the formal and informal markets will be described in subsequent chapters.

Main Crops Grown in Tanzania

Before focusing solely on maize, the top 10 crops grown in Tanzania are identified from the agricultural surveys administered. Maize was the most grown crop followed by beans and paddy (rice). Production of groundnuts and sorghum round out the top five most frequently produced crops in the nation. Crops 6 through 10 are sweet potatoes, cassava, sunflowers, cowpeas, and pigeon peas, respectively. In table 3-1, the breakdown of households which sold each crop to the formal and the informal market are displayed.

Table 3-1: Top 10 Crops Grown in Tanzania and the Percentage Sold to the Formal Market, Informal Market, and No Market

		Sold Crop			Did Not Sell
Crop Name	***Frequency Grown***	***Formal Market***	***Informal Market***	***Aggregate Market***	
Maize	908	10.7%	22.9%	33.6%	66.4%
Beans	457	14.7%	20.6%	35.2%	64.8%
Paddy	428	16.4%	20.3%	36.7%	63.3%
Groundnut	315	19.7%	27.3%	47.0%	53.0%
Sorghum	257	4.3%	8.9%	13.2%	86.8%
Sweet Potatoes	202	11.4%	14.4%	25.7%	74.3%
Cassava	198	3.0%	8.1%	11.1%	88.9%
Sunflower	149	26.2%	32.2%	58.4%	41.6%
Cowpeas	122	11.5%	13.1%	24.6%	75.4%
Pigeon Pea	112	16.1%	27.7%	43.8%	56.3%

Household Market Orientation

Of the 908 households that were surveyed, slightly over a third sold maize. Of those that sold maize, 10.7 percent (97 households) sold maize to the formal market, while 22.9 percent (208 households) sold maize to the informal market (Table 3-2).

In inspecting the market participation of the households that sold maize, it is found that those that participated in the formal market sold a greater quantity than those in the informal market. The households participating in the formal market also received a higher price for their maize than those in the informal market which corresponds to a higher value reaped. One interesting aspect to note is that the households that did not sell to any market had the highest expected price for their maize which may or may not have influenced their decision to not participate.

Table 3-2: Household Market Participation and Sale Values

	Sold Maize						Did Not Sell	
	Formal Market		Informal Market		Aggregated			
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Participation in… (%)	10.7		22.9		33.6		66.4	
Transported Crop for Sale (%)	33.1		24.1		27.4		----	
Quantity Sold (kg)	634.39	825.55	488.81	627.52	542	708.68	----	----
Value Sold (USD)	118.97[b]	185.81	69.82[a]	98.23	87.87	138.84	----	----
Expected Price (USD/100kg)	13.18	5.71	12.75	14.79	12.91	12.27	17.17	32.82
Realized Price (USD/100kg)	17.68	10.90	15.56	8.70	16.33	9.60	----	----

[1]

[a] and [b] indicate significant statistical difference between households which participated in the formal and informal respectively at the 0.05 level using Tukey's HSD test.

As shown in Table 3-2, approximately 33.1% transported their crop to the sell location in the formal market while 24.1% did so in the informal market. To give further detail about this subject, Figure 3-1 and Figure 3-2 show the number of trips taken to transport maize to the sell

[1] All monetary units are converted from Tanzanian Shillings to US dollars (USD) at the average exchange rate of TZS 1571.50 per US dollar. This value is the average exchange rate between October 1, 2010 and December 1, 2011 which corresponds to the time period in which the surveys were administered (Oanda.com).

location by households. As already stated, the majority of households did not transport their crop for sell in the formal or informal markets. However, for those that did transport their crop for sell, most made only 1 trip. Approximately 26 percent of the households that sold maize to the formal market made 1 trip to the market. In the informal market, the percentage of households which made 1 trip to the market was 12 percent.

Figure 3-1: Percent of the Population Making Marketing Trips to the Formal Market

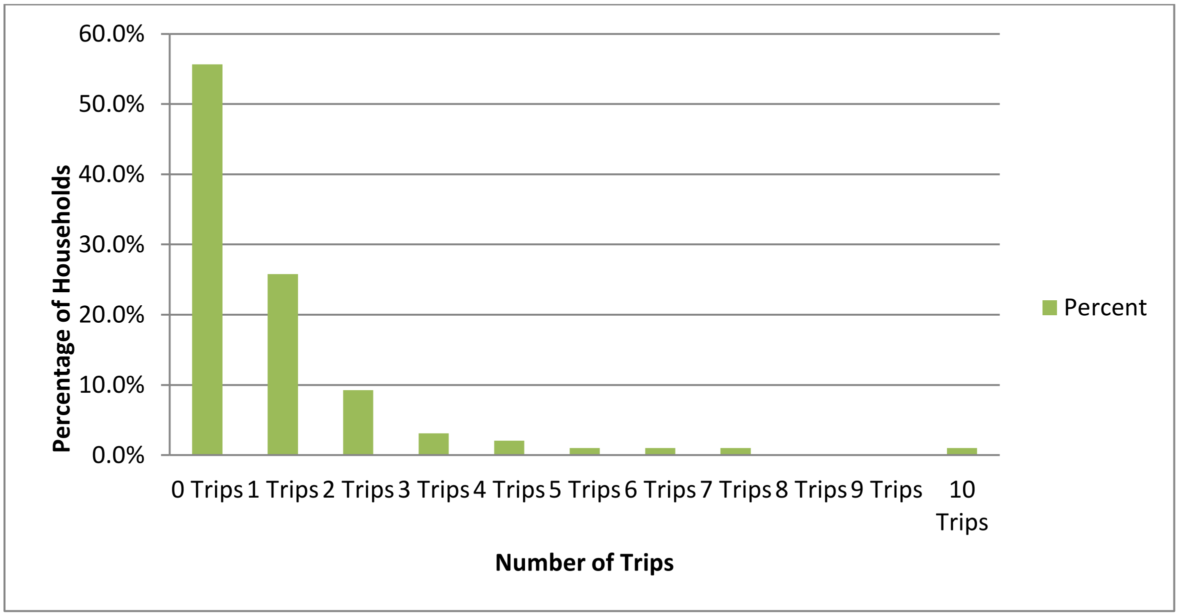
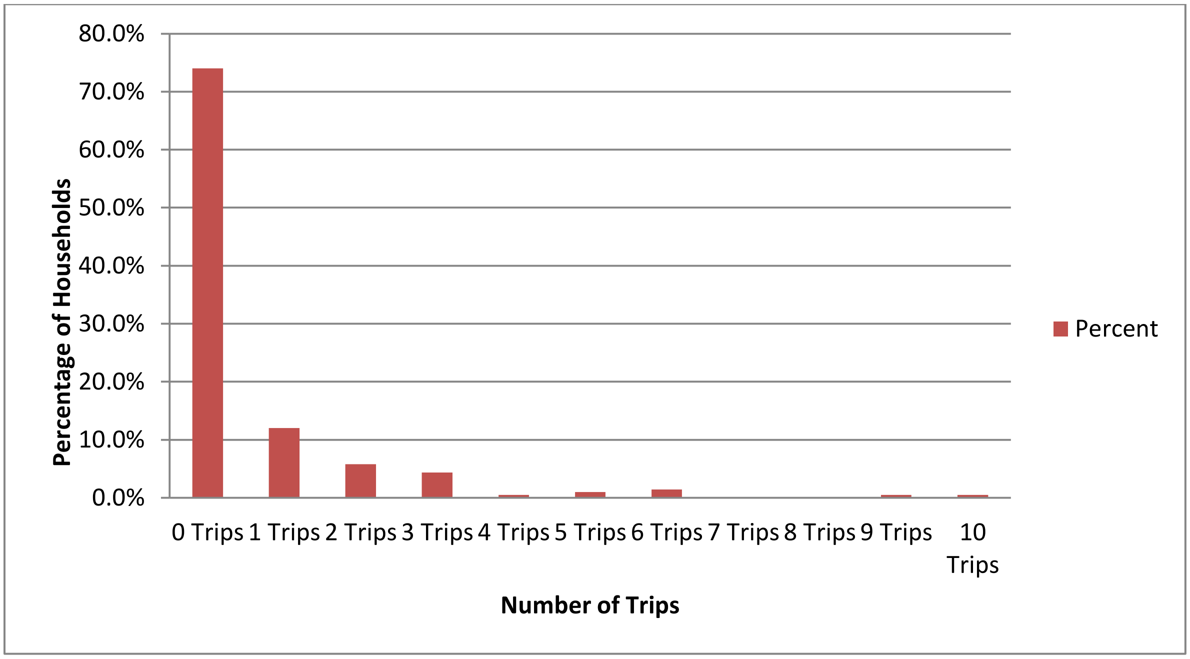


Figure 3-2: Percent of Population Making Marketing Trips to the Informal Market



Household Characteristics and Social Capital

Demographics and Education

As a subsistence level household makes decisions on consumption and production needs, the number in the household directly influences the consumption needs of the family, making less produce surplus available for the market, holding land constant. Of all the households, those that participated in the formal market the average age of the household head was 43 while in the informal market participation level and no participation level, it was 46 and 50 years of age, respectively (Table 3-3). The percentage of male-headed households was much higher for the households which sold maize, especially in the formal market and was statistically different, than the households which did not participate in the market.

While there is a relatively high amount of household heads that attended school, there was a difference in attendance percentages when broken down by market level. Between the households which sold to the informal market and the households which sold to no market at all, school attendance by the household head was only different by one percent and was not statistically different. Contrast that though to the formal market where the percentage of household heads that attended school was 16 or 17 percent higher than those who sold in the informal market or did not sell their maize crop at all, and was significant at the 5 percent level (Figure 3-3). While school attendance is relatively high, it seems that most of the education received by the majority of the household heads, no matter what market level they interact in, does not go beyond primary school. For all levels of market orientation, the percentage of household heads that achieved an education level above primary school was very low. A slight difference is seen when comparing the 10 percent of household heads in the formal market (statistically different) who received an education that was above primary school versus the 4 percent for those in the informal market and 5 percent for those that did not sell their product.

Table 3-3: Household Characteristics – Age, Sex, and Education

	Sold Maize			Did Not Sell
	Formal Market	*Informal Market*	*Aggregated*	
People per household	5.36	5.23	5.28	5.46
Average age of head of household	43[c]	46[c]	44.68	50[a,b]
% of Households (1=yes)				
Household Head is male	87.7[c]	78.6	81.9	72.4[a]
Head of household attended school	88[b,c]	72[a]	77.4	71[a]
Head of household's education level was beyond primary school	10[b]	4[a]	6.2	5

[a], [b], and [c] indicates significant statistical difference between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Wealth and Land Assets

When analyzing the descriptive data, it is unknown what form of land tenure system exists in each village – whether land is formally purchased or sold, if it is assigned by the village chief without ever being taken back, or if the village chief assigns/reassigns plots of land at his leisure. In terms of maize plot ownership status, several different types of ownership exist. The majority of households own their maize plots, followed next by renting, as well as using the plot free of charge. As seen in Table 3-4, the highest level of plot ownership is found with the households which sold to the informal market (94.2 percent), followed by the households which did not participate in any market (85.9 percent), and finally followed by those that participated in the formal market (73.8 percent).

Less than 8 percent of the households that own their maize plot actually have any type of a title for their land. Of those that have a title for their land, it is either in the form of a letter of allocation from the local village government or in the form of a village-government witnessed purchase agreement. Other types of titles that were held by households included a certificate of customary right of occupancy, a granted right of occupancy letter, an inheritance letter, and a local court certified purchase agreement. Collateral, usually via land, is often needed to obtain loans, credit, and also yield bargaining power. Of the households that own their plot, the percentage that can use the land as collateral range from approximately 75 to 83 percent. One interesting aspect is that although the households which interacted primarily in the formal market had the lowest percentage of land ownership, it is these households which possess the highest percentages of collateral via land.

Table 3-4: Land Ownership, Title, and Collateral

	Sold Maize			Did Not Sell
	Formal Market	*Informal Market*	*Aggregated*	
% of Households (1=yes)				
Owned Plot	73.8[b,c]	94.2[a,c]	86.7	85.9[a,b]
Have a plot title	6.9	4	5.1	7.6
Can use land as collateral	82.5	74.9	77.3	78.6

[a], [b], and [c] indicates significantly different plot ownership between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Production Characteristics

Size of Operations and Quantity Harvested

The data used to run descriptive analysis only looks at maize production. Agriculture production occurs on a small scale for the majority of the households. The aggregated mean of area harvested for all 908 households surveyed is approximately 2 hectares of land. Those that marketed their maize harvested over 2 hectares of maize with those participating in the formal market, growing the most. It appears that most households have more than 1 maize plot. Those that did not participate in the market farm an average of 1.32 maize plots while the aggregate total for the households which participated in the market farm 1.57 maize plots. As one would expect, the households (formal and informal market oriented) that had higher land area of maize also produced greater quantities of maize. The households that sold to the formal market produced approximately three times more maize than the households which did not participate in any market during the survey year (Table 3-5).

Table 3-5: Production Characteristics: Quantity, Number of Plots, and Area Harvested

	Sold Maize						**Did not Sell**	
	Formal Market		***Informal Market***		***Aggregated***			
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Number of Maize Plots	1.64[c]	1.08	1.53[c]	0.86	1.57	0.94	1.32[a,b]	0.57
Area Harvested (ha)	2.62[c]	2.35	2.41[c]	2.93	2.49	2.73	1.75[a,b]	1.98
Quantity Harvested (kg)	1472.6[c]	2003.5	1189.9[c]	1741.3	1293.7	1844.2	501.0[a,b]	1596.7

[a],[b], and [c] indicates significant statistical difference between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Inputs: Seed, Water, Fertilizer, and Labor

As is true with any type of agricultural production, yield is a function of the area harvested as well as a function of the inputs used (intensification) prior to and during the growing season. The agricultural inputs commonly used will be examined among the households. As described in Table 3-6, credit was not commonly used to aid in the purchase of inputs. It is thought that the credit percentages are so low because credit is not widely available and accessible for those in the rural areas or it may be due to other unknown reasons. Those that interacted in the formal market did though have the highest percentage of credit use for purchasing inputs compared to the other two levels of market orientation.

Seed Inputs

Overall, the majority of the maize seed that was used by households was "traditional" seed. Approximately 16 percent of all households surveyed used improved seed. The highest rates of use were by the households which participated in the formal market at 26.9 percent followed by those that did not sell maize in any market (16.3 percent), with the lowest rates of use occurring in households which sold maize to the informal market (9.4 percent). In terms of purchasing maize seed, approximately 32 percent of the 908 households surveyed purchased seed. Of those that purchased seed, 57 percent was traditional seed while 43 percent was improved seed. There were many locations where seed was purchased. Relatives and neighbors ranked the highest in seed sales (84.3 percent), most likely providing traditional seed, followed by markets and cooperative unions (15.7 percent) which may have provided improved seed.

Irrigation

Households that irrigated their maize crop were a rarity. Approximately 3.1 percent of the households which did not sell to the market as well as the households which sold maize to the formal market irrigated their maize crop(s). The households which interacted in the informal market had an irrigation percentage of 1.8 percent. Of the few households that used irrigation, the type of irrigation or water that was used came from flooding during the rainy season and was applied via gravity.

Fertilizer Inputs

Fertilizers, like irrigation, were used by only a small portion of the households surveyed. Organic fertilizer, which is comprised of compost or manure, is available typically without having to be purchased from market suppliers. The highest rates of usage of both organic and inorganic fertilizer was by the households which interacted in the formal market, followed by the households which did not interact in any maize market, and then by the households which participated in the informal maize market (Table 3-6). Overall the percentages of households which use organic and inorganic fertilizer are about the same except for those households which sold to the formal market where the percentage of households which used inorganic fertilizer was double the percentage of households which used organic fertilizer. Of those that purchased inorganic fertilizer, Calcium Ammonium Nitrate (CAM) was the most popular, followed by Di-ammonium Phosphate (DAP) and Sulphate of Ammonium (SA). Approximately two-thirds of the households which purchased inorganic fertilizer noted that they selected the specific type of fertilizer due to their own experience. The next reasoning that influenced their selection was due to advice given by an agricultural officer.

Labor Inputs

Labor time investments were aggregated for land preparation, planting, weeding, and harvesting. Approximately one-third to slightly over half of all households hired labor. The percentage of households which participated in the maize markets hired more labor than the households which did not participate in the market. The households which had higher percentages of hiring labor were those which participated in either the informal or formal markets. In combining both the number of days worked by family labor and hired labor, the households which did not interact in any maize markets had a mean value of 109 days of labor contributed to their maize crop. This number is lower than the households which sold maize when analyzing the days of labor invested in maize production. The greatest number of days of labor invested in the crop per household was held by those that were informal market oriented.

Table 3-6: Inputs - Credit, Seed, Water, Fertilizer, and Labor

	Sold Maize			**Did Not Sell**
	Formal Market	***Informal Market***	***Aggregated***	
% of Households (1=yes)				
Used credit to purchase inputs	2.3	0.4	1.1	1.3
Purchased Improved Seed	26.9[b,c]	9.4[a,c]	15.8	16.3[a,b]
Irrigated Crop	3.1	1.8	2.3	3.1
Used organic fertilizer	16.2	12.1	13.6	15.1
Used inorganic fertilizer	33.8[b,c]	13.4[a]	20.9	15.3[a]
Hired labor	56.2[b,c]	40.2[a]	46	34.6[a]
Days of Labor: Family & Hired (average)	119.56	132.93[c]	128.02	109.22[b]

[a], [b], and [c] indicates significant statistical difference between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Extension Services

Information on farming practices, prices, and production knowledge can be obtained from interaction with extension services. In this survey, questions were asked about the topic in which households received extension as well as the organization that provided it: the government, a nonprofit, or a farmer's association. Unfortunately, due to extremely low response rates for those questions, it is unclear what information was shared, by whom, if it was via a phone conversation or an on-farm visit, and if the information was useful or not. Overall, of the households surveyed, approximately 20 percent to 35 percent received some type of extension service (Table 3-7). The frequency of extension interactions or visits was also measured. The median and mode for number of extension interactions is 0 for all levels of market orientation.

The average number of extension visits was lowest for those which interacted in the informal maize market at 0.34 visits during the growing season. Second in line for extension visits are the households which did not interact in the market at 0.46 visits. The households which interacted in the formal market had a mean value of 1.62 extension interactions during the growing season, much more than the other levels.

Table 3-7: Household Visits from Extension Services

	Sold Maize						Did not Sell	
	Formal Market		*Informal Market*		*Aggregated*			
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Extension Frequency	1.62[b,c]	9.72	0.34[a]	1.29	0.81	5.99	0.46[a]	3.85
% of Households (1=yes)								
Received Extension	34.6[b,c]		18.8[a]		24.6		23.6[a]	

[a], [b], and [c] indicates significant statistical difference between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Wealth, Animal Assets, and Farm Assets

Animal ownership is often used as one measure of a household's wealth. Large livestock, comprised of cattle, oxen, donkeys, and horses, are owned by slightly less than a third of all households. Of all the households, those that participated in the formal market had the highest percentage of large livestock ownership (Table 3-8). Households which participated in the informal market and the lowest percentage of ownership was held by those that did not interact in any market. Ownership percentages are similar for small livestock ownership, which is comprised of sheep, goats, and hogs.

Aside from animal assets on the farm there were hardly any farm assets in the way of mechanical equipment or storage bins. Out of the 908 households that were surveyed, not a single household owned or shared ownership in a tractor or any tractor planting or harvesting equipment. The percentage of households that have storage available is small for all levels of market participation, with the households which sold to the informal level having the highest level of storage.

Table 3-8: Agricultural Assets: Animals, Farm Implements, and Storage Availability

	Sold Maize			Did Not Sell
	Formal Market	*Informal Market*	*Aggregated*	
% of Households (1=yes)				
Own Large Livestock	30	26.3[c]	27.7	23.6[b]
Own Small Livestock	50	44.3	46.5	45.7
Own Poultry & Rabbits	88.8	91.8	90.6	85
Own Oxen and Oxen Equipment	14.6	18.3	16.9	10.3
Tractor and Tractor Equipment	0	0	0	0
Storage Available	7.7	10.3	9.3	6.6

[a],[b], and [c] indicates significant statistical difference between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Transaction and Transportation

Plot Distances

A proxy for capturing transportation costs to market goods is the distance from the plot to a tarmac road. Since most households have more than one maize plot, a single household's distance was calculated for each category based upon a quantity harvested weighted average. The mean distance from the plot to the tarmac road ranges between 1.76 kilometers and 2.27 kilometers, with the households interacting in the formal market having the least distance (Table 3-9). The distance from the plot to the home seems to be similar for the households which did not sell any maize and those which sold maize to the informal level averaging around 2.8 kilometers. However, the distance from plot to home increases to 4.7 kilometers for the households which sold to the formal market.

Transportation Ownership

The main method of transportation besides foot appears to be by way of bicycle. An aggregated total of those surveyed indicates that slightly less than half of the households own or have access to a bicycle. Households which do not interact in any maize market have the lowest percentage of bicycle ownership. For the households interacting in the informal maize market, 44.6 owned a bicycle while approximately 60.8 percent of the households which participated in the formal market owned a bicycle.

Virtually no household had access to a car; the same case holds true for motorcycle ownership (Table 3-9). Therefore, since these two methods of transportation makeup the descriptive category of motorized transport vehicles, it is not surprising that the mean value of the number of transport vehicles is small for each level of market orientation. Out of all 908 households, only 30 have any access to a motorized transport vehicle. For those that own or have access to a transport vehicle, it is unclear what is the primary purpose of the transport vehicle.

In efforts to gain more information about the role of transport vehicles in market participation, the households which interacted in the market are further examined. Approximately 27 percent of all households that sold to the market, formal or informal, transported their crop. For those that transported maize for sell, the average distance traveled was considerably higher for the formal market at 456.77 kilometers compared to 215.14 kilometers for the informal market. The majority of those who transported their crop for sell, made 1 trip; however, 2.3 is the mean number of trips made. By far, for those that transported their crop, approximately 40 percent of the households' method of transportation is via bicycle. The next highest method of transportation used is by car (25 percent), followed by on foot (20 percent).

Table 3-9: Transportation and Transactions Cost

	Sold Maize						Did not Sell	
	Formal Market		*Informal Market*		*Aggregated*			
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Distance from Plot to Tarmac Road (km)	1.76	2.16	2.27	2.97	2.09	2.71	1.83	2.68
Average Distance Traveled to Sell Location (km)	456.77[b]	1387.5	215.14[a]	632.96	303.87	985	----	----
Number of motorized transport vehicles owned	0.03	0.17	0.02	0.13	0.02	0.15	0.04	0.21
% of Households								
Owns a bicycle	60.8[b,c]		44.6[a]		50.6		43.4[a]	
Owns a car	1.5		0		0.6		1.6	
Owns a motorcycle	1.5		1.8		1.7		2.1	

[a], [b], and [c] indicates significant statistical difference between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Information Dissemination

Communication Devices

Information can be shared via many different devices and depending on the device, the information conversation can be only one-sided or two-sided. Radios seem to be the most prevalent communication device available and are owned by 63 percent of the households. As seen in Table 3-10, formal market participants have the highest ownership percentage of radios (75 percent) followed by informal market participants and finally the non-market participants (60 percent). The second most prevalent method of communication are mobile telephones. Households that participate in the formal market lead the way in the highest percentage of cell phone ownership at 41 percent and the households which participate in the informal market actually have the lowest percentage of cell phone ownership. The other communication devices that were owned by the households included landline telephones and computers. However, both of these communication devices were scarce.

In terms of aggregating the different types of communication devices, it appears that approximately 67 percent of all households own at least one of the following: radio, mobile phone, computer, or landline telephone. The highest percentage (80 percent) of ownership of a communication device occurs within the households that sold maize to the formal market. When a count was conducted, adding up the number of communication devices (radio, mobile phone, computer, and landline telephone) that each household had, the average value for formal market participants was 1.19 while it was 0.89 for informal market participants and 0.92 for non-market participants. In an effort to tease out the importance of certain communication devices, a variable was created that measured the number of households which owned both a radio and a mobile telephone since these two devices seem to be the most prevalent. Overall, about 25 percent of the households owned both communication devices.

Farmer Association Meetings

Another method of obtaining agricultural information can be through village or farmer association meetings. Attendance at farmer association meetings for all levels of market participation is under 20 percent. The highest level of attendance occurred in the households which sold maize in the formal market while the lowest attendance rates occurred in the households which sold maize in the informal level. However, one reason that the attendance percentages may be so low is due to the fact that between 35 to 50 percent of the households surveyed had no village-based or local farmer's association meetings.

Table 3-10: Ownership of Communication Devices and Farm Association Meetings

	Sold Maize						Did Not Sell	
	Formal Market		***Informal Market***		***Aggregated***			
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
# of communication devices	1.19	0.76	0.89	0.71	1	0.74	0.92	0.83
% of Households (1=yes)								
Owns a radio	75.4[c]		64.7		68.6		59.9[a]	
Owns a landline telephone	0.8		0.4		0.6		1.6	
Owns a mobile phone	40.8[b,c]		22.8[a]		29.4		29.0[a]	
Owns a computer	2.3		1.3		1.7		2.3	
Owns a communication device	80[c]		70.1		73.7		63.9[a]	
Attended Farmer Association Meetings	19.2		16.1		17.2		18.6	
No Farmer Association Meetings Occurred in Informal Village	36.2		45.5		48.8		41	

[a], [b], and [c] indicates significant statistical difference between households which participated in the formal, informal, and no-sell market, respectively at the 0.05 level using Tukey's HSD test.

Summary

The results obtained from the data overview reveal both differences and similarities between the households which participate in different levels of the market. While no conclusions can be made without empirical analysis, this chapter has made known more knowledge about the characteristics, resource endowments, location, and production practices of the Tanzanian households surveyed. This information is very useful in testing the hypotheses that production quantities, household characteristics, and communication devices impact market participation and value sold decisions. The following chapter discusses the variables and methodology used to test these hypotheses.

Chapter 4 - Methodology

The objective of Chapter 4 is to examine the econometric models and corresponding theories that were used to perform the analyses in this thesis. The main issues addressed are to identify the determinants of a household in selling their crop and identify the determinants of a household's decision on what volume they sell. Are the constraints the same for both decisions or do they vary? Another question addressed is whether there are different variables which influence participation in the formal market versus the informal market.

With the main focus of this thesis being to determine market participation constraints, a two-stage Heckman model was selected. The first stage of the Heckman model uses the binary selection probit model while the second stage using an Ordinary Least Squares model with a correction of the Inverse Mills Ratio to eliminate the biasedness of self-selection. In an effort to determine if it is important to distinguish between the level of market orientation: formal versus informal markets, three forms of the Heckman model were run. The first model is for the formal market, the second is for the informal market, and the third is an aggregate model based on the fact that the household sold maize, the level does not matter. In the second stage of the Heckman model, the OLS regression, four different types of models with differing variables were run for the formal, informal, and aggregate market models. These models will be explained in greater detail later in this chapter but differ due to the exclusion and/or inclusion of the variables "differences in prices", "attend farmer group meetings", and "education level".

In addition to the Heckman model, a quadratic production function model was also developed to better analyze the drivers for the quantity harvested variable used in the Heckman models. First, the Heckman model will be analyzed encompassing the probit and OLS models, followed by the production function model. The variables will first be discussed in detail that will be used for the probit and Heckman models.

Variables

The variables included in the probit and OLS models are explained below (Table 4-1). While some variables are expected to have the same sign effect for the market participation probit model and the volume sold OLS model, it is expected that other variables will have different impacts. Unless otherwise stated, the expected sign is to be the same for all three market participation levels.

Table 4-1: Description of Variables Used in Probit and Heckman OLS Models

Variable Name	Description
Quantity Harvested	The quantity, in kilograms, of the maize harvested by the household
Expected Price	The maize price expected (USD/kg) at the time of harvest by the household
Differences in Prices	The price (USD/kg) received at the time of the sell minus the expected price
Household Head Sex (1=Male)	The dummy takes a value of one if the household head sex is male and zero if female
Household Head Age	The age of household head
Education Level of Household Head	The dummy takes a value of one if the household head has an education level above primary school and zero otherwise
Number in Household	The number of people living in the household
Own Radio	The dummy takes a value of one if the household owns one or more radios and zero otherwise
Own Mobile Telephone	The dummy takes a value of one if the household owns one or more cell phones and zero otherwise
Distance from Plot to Road	The aggregated weighted average distance from the household's maize plot(s) to the nearest tarmac road
Average Distance Traveled to Sale Location	The aggregated volume sold weighted average distance traveled by the household to the location where maize was sold
Own Bicycle	The dummy takes a value of one if the household owns a bicycle and zero if none are owned
Extension Frequency	The number of interactions with extension services
Land Collateral	The dummy takes a value of one if the household can use land as a collateral and zero if they cannot
Attend Farmer Group Meetings	The dummy takes a value of one if the household head attended some or all of the informal farmer association/group meetings and zero if the household head attended no meetings

Regional Dummy	The dummy takes a value of one if the household is located in a region which produces more than five percent of Tanzania's maize output and zero if not

The "quantity harvested" variable is expected to be positive in sign for all models. Maize yield significantly affects market participation (Heltberg and Tarp, 2002) due to farmers retaining a smaller portion for consumption purposes as output increases, making a larger proportion available for off-farm consumption (Haessal, 1975). "Expected price" should be positive as well because as price increases, a household is more likely to want to sell; this though is dependent upon whether the household is interacting in the market for profit or simply to satisfy cash needs. For those households which interact in the market to satisfy cash needs, the household does not participate in the market to obtain a profit; rather they sell only the amount of maize needed to obtain a certain amount of cash to cover such things as school fees. The coefficient for the variable "differences in price" which only appears in the OLS value sold model, should have a positive impact. This is thought to be positive since a household may be enticed to sell more volume of maize if the realized price is greater than the expected price. However, as the household model outlines in Chapter 2, an increased expected price may help or hinder the household overall depending on whether the household is a net seller or net buyer of maize. Therefore, many of these issues become empirical because it is unclear which price platform is dominating a household's decision.

The expected sign of the "household head sex" variable is ambiguous. Depending on regions of the world and crop, research has concluded that women are at risk from exclusion for crop sales (Boughton et al., 2007) while at the same time female-headed households participated in the market at a greater amount than male-headed households in Kenya (Alene et al., 2008). Since the USAID Feed the Future initiative, discussed in detail in the introduction, identified that Tanzanian women are disadvantaged in agricultural decision making, it is expected that the coefficient for "household head sex" be positive. "Household head age" is expected to have a negative impact on market participation and maize volume sales due to older people being more risk averse, slow to adopt technology, and less physically able to transport goods, which is consistent with the findings of Heltberg and Tarp (2002) as well as Alene et al. (2008). "Education level" should have a positive impact on both market participation and volume sold

(Gani and Adeoti, 2011; Azam et al., 2012; Thirtle et al., 2003). As the number of individuals in the household increase, it is expected that there will be a negative impact on both the market participation decision as well as the volume sold decision. More members in the family translate to more mouths to feed and higher consumption needs making less maize available to sell.

The sign of “radio ownership”, as well as “mobile phone ownership” are expected to positively impact the probit model as well as the Heckman OLS model since communication device ownership has been shown to be positive and significant in previous market participation studies (Olwande and Mathenge, 2011; Azam et al., 2012; Alene et al., 2008). The “ownership of a bicycle” variable is thought to positively impact both market participation and volume sold decisions to aid in accessing market information as well as being used to transport maize to the market. This hypothesis is due to findings of transport equipment, including bicycles and motorized vehicles, positively and significantly affecting market participation (Heltberg and Tarp, 2002; Olwande and Mathenge, 2011).

The coefficient and marginal effect of the variable “distance from plot to market” used in the probit model is expected to be negative. As the distance needed to travel increases so does the transport costs which can serve as a disincentive for market participation. Similarly, in the Heckman model, the variable “average distance traveled to sell location” is expected to have a negative impact on the maize volume sold. Both of the previously stated distance variables are used as proxies to measure the transport costs involved in marketing decisions and is supported by findings in eastern and southern Africa (Barrett, 2008), in Cambodia (Azam et al., 2012), and in Madagascar (Cadot et al., 2006).

“Extension frequency” is expected to have a positive impact on the probit model market participation decision. It was found by Alene et al. (2008) that extension, usually measured through the number of extension visits, has a positive and significant impact on maize supply. Since the household decision to participate in the market or not depends largely on if marketable surplus exists, as “extension frequency”, by way of production, increases a positive impact on the market participation decision can occur.

The only proxy variable available that measures access to credit is “land collateral”. While it is not an exact measure, it is the best that is available from the survey. It is expected that the sign of “land collateral” in both the probit model and the Heckman model will have positive signs. It was found by Stephens and Barrett (2011) that households with access to credit are more likely to transact in the foodgrains market. Specifically for land, it was found that in eastern and southern Africa, there were strong associations between household's land holdings and their participation in the market (Barrett, 2008).

The sign for the variable "attend farmer group meetings" is expected to be different depending on which market level is being examined. It is expected for the formal market that the variable will yield a positive impact since information about price and markets can be given at the meetings as well as demonstrations of different production practices. For the informal market, the sign is expected to be negative; it is expected that farmers that do attend meetings, will instead be participating in the formal market and not the informal market. Barrett (2008) suggests that facilitating smallholder involvement in farmer organizations is essential to stimulating smallholder market participation. It has been shown that membership in farmer organizations have a positive and significant impact on market participation (Olwande and Mathenge, 2011).

It is expected that the variable, "regional dummy", will have a positive impact on maize market participation decisions as well as the value sold decisions in both the formal, informal, and aggregate market levels. Since the dummy represents the regions in Tanzania which have maize yield greater than 5 percent of the nation's production level, it is used as a proxy to capture agro-ecological information as well as input market access, both which yield greater production quantities. A household which has higher levels of maize production also has higher levels of marketable surplus. Barrett (2008) concluded that those smallholders that were cultivating in higher potential agro-ecological zones appeared to be more likely to sell to the market than others. This conclusion was also found by Heltberg and Tarp (2002).

Econometric Models

Probit Model

The question of market participation is modeled through the discrete choice probit model since a household can either participate or not participate in the maize market. The dependent variable is binary, meaning it can take on the values of zero or one; one if the household participates in the maize market in question, and zero otherwise. A probit model is a nonlinear, in parameters, statistical model that relates the explanatory variables in such a way that the probability of the dependent variable remains in the zero to one interval. The nonlinearity of the probit model is transformed by a cumulative distribution function which follows a standard normal distribution (Griffiths, Hill, and Judge, 1993). In total, three different probit models were run: one for the formal market, one for the informal market, and one for the aggregate market. For the probit econometric analysis, one model, with the same specific variables, was used for all three market levels. The following probit model was estimated:

$$(4.1)\quad \begin{aligned} P_{ij} = F[&\beta_{0,j} + \beta_{1,j}(Quantity\ Harvested)_{ij} + \beta_{2,j}(Expected\ Price)_{ij} \\ &+ \beta_{3,j}(Household\ Head\ Sex)_{ij} + \beta_{4,j}(Household\ Head\ Age)_{ij} \\ &+ \beta_{5,j}(Education\ Level)_{ij} + \beta_{6,j}(Number\ in\ Household)_{ij} + \beta_{7,j}(Radio)_{ij} \\ &+ \beta_{8,j}(Mobile\ Telephone)_{ij} + \beta_{9,j}(Distance\ from\ Plot\ to\ Road)_{ij} \\ &+ \beta_{10,j}(Bicycle)_{ij} + \beta_{11,j}(Extension\ Frequency)_{ij} \\ &+ \beta_{12,j}(Land\ Collateral)_{ij} + \beta_{13,j}(Attend\ Farmer\ Group\ Meetings)_{ij} \\ &+ \beta_{14,j}(Regional\ Dummy)_{ij} + \varepsilon_{ij}] \end{aligned}$$

In the above model, F[·] represents the cumulative distribution function. The subscript “i” represents the individual household observation and the subscript “j” represents the three different maize market levels. The dependent variable P_{it} is the probability that the “i” household participates in the “j” maize market.

Due to the probit model being nonlinear, its parameters, β’s, cannot be directly interpreted. Therefore, to interpret the marginal effects of each explanatory variable on the dependent variable, the derivative of the cumulative distribution function must be taken with respect to the independent variable being observed. The equation to find the marginal effects is below:

$$(4.2)\quad \frac{\partial P_i}{\partial X_{ij}} = \frac{\partial F[X'\beta]}{\partial X_{ij}} = f({X_{ij}}'\beta)\beta_i$$

Heckman Model

The use of the sample selection Heckman model follows the basis that households make two separate decisions about market participation, the first of whether or not to participate, and the second about the specific level of participation (Boughton et al., 2007; Olwande and Mathenge, 2011; Azam et al., 2012;). The sample selection model is very useful in dealing with non-random samples that come as a result of survey design or non-response. Often, in the case of market participation, the first step of the Heckman model uses a probit estimation for the decision to participate in the market and is the case with this research analysis as detailed above. The second step of the Heckman model, which is conditional on the household participating in the market, is an OLS regression of the log of crop sales value on the regressors plus the Inverse Mills Ratio. The Inverse Mills Ratio is derived from the first stage probit regression and controls for biasedness from self-selection into the second step of the Heckman model selection bias due to endogenity to the dependent variable (Griffiths, Hill, and Judge, 1993). Correcting for biasedness then allows the remaining regressors to explain sale volumes conditional on a given probability of market participation (Boughton et al., 2007). The Inverse Mills Ratio which is the probability density function over the cumulative distribution function is as follows:

$$(4.3) \quad \lambda_j = \frac{\emptyset(\frac{\beta' X_j}{\sigma})}{\Phi(\frac{\beta' X_j}{\sigma})}$$

In the equation above, λ_j represents the Inverse Mills Ratio for the maize market "j". β represents the vector of parameters and X is the vector of variables. When the Inverse Mills Ratio is incorporated into the OLS in the second step of the Heckman model, the resulting model is below:

$$(4.4) \quad Y_j = \beta' X + \sigma\rho\lambda_j + \varepsilon_j$$

In the above model, Y_j represents the log value of maize sales for each "j" maize market level. In this model, β also represents the vector of parameters and X is the vector of variables. The Inverse Mills Ratio is represented by λ_j and $\sigma\rho$ measures the significance for the Inverse Mills

Ratio. The model's error term is represented by ε_j. As opposed to the probit model, the parameters of the OLS model can be directly interpreted based on the coefficient values.

There are four different OLS models that are used in this thesis. Four models, instead of one, are tested to better determine which explanatory variables impact the value sold dependent variables. The same four models are used for all three levels of the market. The models will be described in greater detail below.

OLS Model A:

$$
\begin{aligned}
(4.5)\quad & (Log\ Value\ of\ Sales)_{ij} \\
& = \beta_{0,j} + \beta_{1,j}(Quantity\ Harvested)_{ij} + \beta_{2,j}(Households\ Head\ Sex)_{ij} \\
& + \beta_{3,j}(Household\ Head\ Age)_{ij} + \beta_{4,j}(Number\ in\ Household)_{ij} \\
& + \beta_{5,j}(Radio)_{ij} + \beta_{6,j}(Mobile\ Telephone)_{ij} \\
& + \beta_{7,j}(Average\ Distance\ Traveled\ to\ Sale\ Location)_{ij} + \beta_{8,j}(Bicycle)_{ij} \\
& + \beta_{9,j}(Land\ Collateral)_{ij} + \beta_{10,j}(Regional\ Dummy)_{ij} + \sigma\rho\lambda_j + \varepsilon_{ij}
\end{aligned}
$$

The model above is the base model for the maize market value of sales. Representing each individual household is "i" while "j" represents the different maize market levels.

OLS Model B:

$$
\begin{aligned}
(4.6)\quad & (Log\ Value\ of\ Sales)_{ij} \\
& = \beta_{0,j} + \beta_{1,j}(Quantity\ Harvested)_{ij} + \boldsymbol{\beta_{2,j}(Differences\ in\ Prices)_{ij}} \\
& + \beta_{3,j}(Households\ Head\ Sex)_{ij} + \beta_{4,j}(Household\ Head\ Age)_{ij} \\
& + \beta_{5,j}(Number\ in\ Household)_{ij} + \beta_{6,j}(Radio)_{ij} + \beta_{7,j}(Mobile\ Telephone)_{ij} \\
& + \beta_{8,j}(Average\ Distance\ Traveled\ to\ Sale\ Location)_{ij} + \beta_{9,j}(Bicycle)_{ij} \\
& + \beta_{10,j}(Land\ Collateral)_{ij} + \beta_{11,j}(Regional\ Dummy)_{ij} + \sigma\rho\lambda_j + \varepsilon_{ij}
\end{aligned}
$$

The model above is similar to base model A with the addition of the variable "differences in prices".

OLS Model C:

(4.7) $(Log\ Value\ of\ Sales)_{ij}$

$$= \beta_{0,j} + \beta_{1,j}(Quantity\ Harvested)_{ij} + \boldsymbol{\beta_{2,j}(Differences\ in\ Prices)_{ij}} + \beta_{3,j}(Households\ Head\ Sex)_{ij} + \beta_{4,j}(Household\ Head\ Age)_{ij} + \beta_{5,j}(Number\ in\ Household)_{ij} + \beta_{6,j}(Radio)_{ij} + \beta_{7,j}(Mobile\ Telephone)_{ij} + \beta_{8,j}(Average\ Distance\ Traveled\ to\ Sale\ Location)_{ij} + \beta_{9,j}(Bicycle)_{ij} + \beta_{10,j}(Land\ Collateral)_{ij} + \boldsymbol{\beta_{11,j}(Attend\ Farmer\ Group\ Meetings)_{ij}} + \beta_{12,j}(Regional\ Dummy)_{ij} + \sigma\rho\lambda_j + \varepsilon_{ij}$$

The model above differs from base Model A due to the inclusion of the variables “differences in prices” and “attend farmer group meetings”.

OLS Model D:

(4.8) $(Log\ Value\ of\ Sales)_{ij}$

$$= \beta_{0,j} + \beta_{1,j}(Quantity\ Harvested)_{ij} + \boldsymbol{\beta_{2,j}(Differences\ in\ Prices)_{ij}} + \beta_{3,j}(Households\ Head\ Sex)_{ij} + \beta_{4,j}(Household\ Head\ Age)_{ij} + \boldsymbol{\beta_{5,j}(Education\ Level)_{ij}} + \beta_{6,j}(Number\ in\ Household)_{ij} + \beta_{7,j}(Radio)_{ij} + \beta_{8,j}(Mobile\ Telephone)_{ij} + \beta_{9,j}(Average\ Distance\ Traveled\ to\ Sale\ Location)_{ij} + \beta_{10,j}(Bicycle)_{ij} + \beta_{11,j}(Land\ Collateral)_{ij} + \beta_{12,j}(Regional\ Dummy)_{ij} + \sigma\rho\lambda_j + \varepsilon_{ij}$$

The model above differs from base Model A due to the inclusion of the variables “differences in prices” and “education level”.

Production OLS Model

To further analyze the importance and impact of the quantity harvested variable, an OLS production function was modeled. Since it is expected that the quantity harvested has a very large impact on a household’s decision to participate in the market and magnitude to sell, it is valuable to know what the drivers of production are for specificity purposes. The linear, quadratic, and Cobb-Douglas functional forms were analyzed to determine which form was the most robust. The estimates for each functional form are included in Table 4-3.

A Breusch-Pagen test was conducted and heteroskedasticity was present in the linear and quadratic models. Due to heteroskedasticity, the least squares estimators are inefficient and biased and the variance estimates are biased as well, invalidating the reliability of its significance. To correct for heteroskedasticity, the White robust standard errors were calculated and are included in the in Table 4-3. Calculating White robust standard errors allows for the regression errors to be reliable even when heteroskedasticity is present.

Production Function Variables and Model

The variables included in the production function, excluding the interaction terms used in the quadratic function are described in the table below.

Table 4-2: Description of Variables Used in the OLS Production Model

Variable Name	Description
Area Harvested	The area of maize harvested measured in hectares
Improved Seed	The dummy takes a value of one if the household used improved seed and zero otherwise
Inorganic Fertilizer	The dummy takes a value of one if the household used inorganic fertilizer and zero otherwise
Received Extension	The dummy takes a value of one if the household had any extension interactions and zero otherwise
Own Large Livestock	The dummy takes a value of one if the household owns any cattle, donkeys, or horses and a zero otherwise
Labor	The aggregate number of days worked by hired and non-hired (family) during land preparation, planting, weeding, and harvesting
Own Oxen and Equipment	The dummy takes the value of one if the household owns any oxen, ox plough, ox seed planter, or an ox cart and zero otherwise
Regional Dummy	The dummy takes a value of one if the household is located in a region which produces more than five percent of Tanzania's maize output and zero if not

The base production function modeled is the same for the linear functional form and the Cobb-Douglas functional form. The model for the quadratic functional form is the same with the addition of interaction terms.

$$(4.9)\quad Quantity\ Harvested \\ = \beta_0 + \beta_1(Area\ Harvested) + \beta_2(Improved\ Seed) \\ + \beta_3(Inorganic\ Fertilizer) + \beta_4(Recieved\ Extension) \\ + \beta_5(Own\ Large\ Livestock) + \beta_7(Labor) + \beta_8(Own\ Oxen\ and\ Equipment) \\ + \beta_9(Regional\ Dummy) + \varepsilon$$

It is expected that the “area harvested” variable will be positive since extensification increases household production. The second method of increased production yield comes through an increased use of inputs: use of improved seed, fertilizer, and irrigation. Yield growth, through the use of modern varieties, or improved seed, accounted for 86 percent of all the increases in food production in developing countries during the 1980s to 2000 (Evenson and Gollin, 2003). The “use of improved seed” is also expected to positively impact the quantity harvested due to improved seeds being bred to have greater viability in drought conditions, produce greater yield, and can be pest/disease resistant. Since modern or improved seed varieties respond best to the fertilizer (Evenson and Gollin, 2003), the “use of inorganic fertilizer” is also expected to have a positive impact on the quantity harvested.

Households that are involved in extension services are positively associated with the household’s probability of growing market-oriented commodities (Gebremedhin and Hoekstra, 2007). Extension has also been proven to have a significant and positive impact on maize supply in Kenya (Alene et al., 2008). Therefore, the variable “received extension dummy” is expected to have a positive marginal effect on maize quantity harvested. It is expected that the variable “own large livestock dummy” will have a negative sign. This is due to the reasoning that if a household owns large livestock, they are more likely to be invested in livestock production than crop production.

The “labor” variable is expected to have a positive impact on the quantity harvested unless it has reached a level in the production function where the marginal product of one more unit of labor becomes negative. The “ownership of oxen and oxen equipment” is expected to be positive due to the reasoning that oxen are used for animal traction in crop production. The regional dummy is expected to be positive accounting for locations that are in more favorable agro-ecological zones. The variable, “attended farmer association meetings”, is expected to be positive since the transfer of knowledge and information can occur during the meetings.

Summary

This chapter has outlined the methodology and econometric models that are used in this thesis. Other models that were run are included in the Appendix of this thesis. However, those models were not selected because the model performance results revealed that they were mis-specified. Variables that were described in this chapter were selected for each specific model based on past market participation and production research. In the following chapter, the results of the probit and Heckman OLS models are described for each level of market participation.

Chapter 5 - Results

This chapter will discuss in detail the results obtained from the econometric models outlined in the previous chapter. The chapter will first examine the results of the market participation probit models followed by the results of the value sold Heckman OLS models. The three market participation levels are separated within each section. Following the probit and Heckman models are the results for the production function, used to better analyze the "quantity harvested" explanatory variable.

Probit Model Results

The results of the market participation probit model are contained in Table 5-1. The market participation models for the formal maize market, the informal maize market, and the aggregate sale market are listed side-by-side for comparison purposes. The models show the effect that the explanatory variables have on the household's decision of whether or not to participate in the maize market. Specifically, the marginal effects, the partial derivative of the function with respect to the variable of interest evaluated at the mean value, are given in the tables.

Table 5-1: Econometric Results for the Formal, Informal, and Aggregate Market Participation Probit Models

	Probit Formal Market Participation *(1= HH Sold Maize)* **Marginals**		Probit Informal Market Participation *(1= HH Sold Maize)* **Marginals**		Probit Aggregate Market Participation *(1= HH Sold Maize)* **Marginals**	
Intercept	----		----		----	
Quantity Harvested (100 kg)	0.0010	***	0.0023	***	0.0044	***
Expected Price (TZS/100 kg)	-0.0114		-0.0075		-0.0157	*
Difference in Prices (Realized - Expected)	----		----		----	
Household Head Sex (1=Male)	0.0377	*	0.0268		0.0596	
Household Head Age (10 years)	-0.0133	**	-0.0205	**	-0.0382	***
Education Level of Household Head	0.004		0.001		0.0053	
Number in Household	-0.006	*	-0.0031		-0.0109	*
Own a Radio	0.0339	*	0.0436		0.0757	**
Own a Mobile Phone	0.0243		-0.0755	**	0.0757	
Distance from Plot to Road (km)	-0.001		0.0127	**	0.0141	**
Average Distance Traveled to Sell Location (10 km)	----		----		----	
Own a Bicycle	0.0479	**	-0.0106		0.047	
Number of Extension Visits	0.0027	*	-0.004		0.0032	
Land Collateral	0.0113		-0.057		-0.0445	
At Farmer Group Meetings	-0.0011		-0.0455		-0.0419	
Region Dummy	0.0408	**	0.0756	***	0.1274	***
Model Performance						
Number of Observations	908		908		908	
Uncensored Observations	----		----		----	
Correctly Classified Predictions (%)	89.32		77.42		70.59	
Log Likelihood	-280.512		-464.443		-533.4776	
LR Chi2	56.11	***	48.41	***	94.87	***
Pseduo R2	0.0909		0.0495		0.0817	
McFadden's R2	0.091		0.050		0.082	
McKelvey and Zavoina's R2	0.228		0.106		0.186	
Cragg & Uhler's R2	0.122		0.079		0.137	
Efron's R2	0.075		0.059		0.120	

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Formal Market

Eight variables proved to be statistically significant for the formal market probit model as shown in Table 5-1. The variables which are significant include: "quantity harvested", "household head sex", "household head age", "number in household", "own a radio", "own a bicycle", "number of extension visits", and "region dummy". First, production and consumption proxy variables will be examined. Quantity harvested was the variable which had the most statistical significance at the 1 percent level and had a positive coefficient. This result is not surprising as marketable surplus is needed to interact in the market, the more maize production a household has, the more likely they will participate in the formal maize market. Similarly, consumption needs, measured through the variable "number in household", is significant at the 10 percent level. The coefficient of number in household is negative indicating that as the number of people living in a household increases, more mouths to feed, the less likely a household is to sell maize to the formal market. "Expected price" of maize had a negative coefficient which is perplexing but was not a significant variable in the household's decision to sell maize to the formal market.

In evaluating household characteristics, the "household head sex", was significant at the 10 percent level and was positive. This means that if the household head is male, then the household is 3.7 percent more likely to interact in the formal market compared to female-headed households. The variable, "household head age", is negative and significant at the 5 percent level indicating that for every 10 year increase in age of the household head, the household is 1.3 percent less likely to sell maize to the formal market. The "education level" had a positive coefficient but was not significant variable in the household's decision to sell maize in the formal market.

"Ownership of a radio" was significant at the 10 percent level and positive. This value indicates that a household which owns one or more radios is 3.4 percent more likely to market maize in the formal market than those households which do not own a radio. "Ownership of a mobile telephone" was positive in sign but not significant in the decision to sell maize to the formal market. "Ownership of a bicycle" was significant at the 10 percent level and was positive indicating that if a household owns a bicycle they are 4.8 percent more likely to participate in the formal market than those households which did not own a bicycle. This finding is in line with previous studies conducted by Heltberg and Tarp (2002) and Alene et al. (2008) which found that transport vehicles were important for the farmer to access market information.

Distance from the household's plot to the nearest tarmac road was negative in sign, which was expected, but was not significant. The "number of extension visits" was positive and significant meaning that if the number of interactions the household has with extension agents increases by one, the household is 0.27 percent more likely to sell to the formal maize market. "Land collateral", a proxy for credit access, was positive in sign but not significant. The variable, "at farmer group meetings", was also insignificant. The variable was negative in sign which was unexpected; however, it is unclear what was discussed at the meetings and if they were useful or a waste of time. The variable, "region dummy", which is used as a proxy to measure agro-ecological zones, was significant at the 5 percent confidence and was positive. This value indicates that if a household is located in a region that grows 5 percent or more of the overall Tanzanian maize production, then the household is 4 percent more likely to sell maize in the formal market than those households which are not located in those regions.

To determine if certain groups of variables mattered in a household's market participation decision, Chi-square tests were run to determine their significance. In testing the hypothesis that household characteristics matter, it was found that they do impact a household's decision to participate in the market. The Chi-square test for the variables, "household head sex", "household head age", "education level of the household head", and "number in household" was significant at the 5 percent level. Information dissemination was measured through the grouping of the variables "own a radio" and "own a mobile telephone". The Chi-square value was significant at the 10 percent level for the information dissemination variables. Continuing education, by way of "extension frequency" and "attendance of farmer group meetings" have a Chi-Square value that was insignificant.

Informal Market

Five variables were statistically significant in the informal market participation probit model. The variables which were significant included: "quantity harvested", "household head age", "own a mobile telephone", "distance from plot to road", and "region dummy". In examining production's importance, it was found that "quantity harvested" was significant at the 1 percent level and was positive in sign. This means that for every 100 kilograms more of maize harvested, the household is 0.23 percent more likely to sell maize in the informal market. The variable, “number in household”, which measures consumption needs, was negative in sign but not significant. Similar to the formal market participation probit model, the “expected price” of maize was negative in sign and insignificant.

Unlike the formal market model, “household head sex” was not significant in the decision a household makes to sell maize to the informal market as seen in Table 5-1. “Household head age” was significant at the 5 percent significance level and was negative, as it was in the formal market model. Again, the “household head’s education level” was positive but insignificant.

“Ownership of a radio” was positive in sign but was insignificant, a contrast from the formal market probit model. In this model, “ownership of a mobile telephone” was negative and significant at the 5 percent level. This finding means that if a household owns at least one mobile telephone, then they are 7.5 percent less likely to participate in the informal market than a household which owns no mobile telephone. This result indicates the possible importance of mobile telephones in the formal market. The “ownership of a bicycle” was negative and insignificant, different than the findings in the formal market model. However, again this value could indicate the importance of bicycle ownership in the formal market.

The “distance from plot to road” variable was positive and significant at the 5 percent level. While this finding is somewhat perplexing, it also makes some sense. The greater the “distance from the plot to road”, the more likely the household is to sell their maize to a family member or friend, not having to be transported via the road. The “number of extension visits” variable was negative and insignificant, again indicating the possibility of the variable’s importance in the formal market. “Land collateral” was also negative and insignificant, along with the variable “at farmer group meetings”, which was also negative in the formal market. Similarly to the formal market participation model, the “region dummy” variable is positive and significant at the 1 percent level.

Unlike the formal market, the household characteristic variables of sex, age, education level, and number in household, have an insignificant Chi-square value. The information dissemination communication variables had a Chi-square probability that was significant at the 5 percent level. Continuing education did not have a significant Chi-square probability.

Aggregate Sale Market

The aggregate sale market, measures simply those households which sold maize and does not distinguish between the formal and informal markets. Since there were more households that transacted in the informal market than the formal market, the results of the aggregate sale market resemble more closely to the results found in the informal market probit model. In total, there were seven variables which were significant in the aggregate sale market participation model. These variables were: “quantity harvested”, “expected price”, “household head age”, “number in household”, “ownership of a radio”, “distance from plot to the road”, and the “region dummy”.

“Quantity harvested” was a positive and significant variable, similar to the findings in both the formal and informal market participation models. The variable, “number in household” was negative in sign and significant at the 10 percent level. “Expected price” was negative in sign, similar to the findings in the formal and informal models, but is significant in the aggregate sale market model. This sign is unexpected yet could be caused by farmers not being price-responsive. Possibly, price information was not known by the households, especially those that did not sell in the market and therefore the expected prices were pure guesses that were not reflective of current market conditions.

The “household head sex” was positive but was insignificant while the “household head age” variable was negative and significant at the 1 percent level. This means that if the age of the household head increases by 10 years, the household is 3.8 percent less likely to sell their maize. The “education level of the household head” was positive but was not significant in the model.

“Ownership of a radio” was positive and significant at the 5 percent level. This variable was positive in both the formal and informal markets as well. “Ownership of a mobile telephone” on the other hand, was positive in sign but insignificant. “Ownership of a bicycle” had a positive coefficient but was insignificant in the decision to sell maize.

The “distance from plot to road” variable had a positive sign and was significant at the 5 percent level. This result is confusing as one would think that a variable serving as a proxy for transportation cost would be a disincentive for market participation. However, this is an example when the informal market’s values overtake the formal market’s values indicating that market participation analyses should be split between the formal and informal market sectors. Similarly to the formal market model, the “number of extension visits” variable was positive in sign. However, the variable was insignificant in the aggregate market. “Land collateral” was negative in sign and insignificant. This is another example when the importance of separating the formal versus the informal market becomes important. Similarly to the findings in both the formal and informal market, the variable “at farmer group meetings” was negative in sign and insignificant. The variable was expected to be positive in sign due to the transfer or knowledge and information; however, it is unknown if the meetings are actually useful. Finally, the “region dummy” was positive and significant at the 1 percent level.

In examining model performance information, the probit model correctly predicted 89.32 percent of the 908 households surveyed in the formal market, 77.42 percent in the informal market, and 70.59 percent in the aggregate market. The formal model had the best correctly predicted value and no model had values greater than 5.55 in the VIF test, indicating that multicollinearity was not present. The likelihood ratio chi-square test values were 56.11, 48.41, and 94.87 and were all significant at the 1 percent level as seen in Table 5-1.

In the aggregate model the Chi-square value for household characteristics was significant at the 1 percent level. Unlike the findings in the informal model results, the variables representing information dissemination were found only to be significant at the 10 percent level. The continuing education variables of “extension frequency” and “attend farm group meetings” had a Chi-square value that was insignificant.

Probit Model Comparisons

As Table 5-1 indicates, there are some similar determinants for market participation across the market levels as well as differences. Across all three market levels, “quantity harvested” was significant at the 1 and 5 percent levels. “Household head education level” was also negative and significant for all three market levels. The “region dummy” was significant for all three market levels as well. These consistencies convey the variables’ importance in households’ marketing decisions.

Heckman Model Results

The following models estimate the dollar amount of maize sales for a household in a given market level. The dependent variable is the natural log of the value of maize sold which is based on the market participation probit models. These models include the Inverse Mills Ratio calculated from the probit models to correct for self-selection biasness. As outlined in the previous chapter, there are four different types of Heckman OLS models that were examined.

This was done to provide a more robust analysis and pinpoint the specific variables which impact the value sold dependent variable. The results from the four different models are in Tables 5-2, 5-3, and 5-4. All models were found to have significant, at the 1 percent level, Wald Chi-Square values. An overview of the significant variables will be given.

Formal Market

The results for the four Heckman OLS models can be seen in Table 5-2. Of the four models, Model A had six statistically significant variables while the other three models (B, C, and D) had seven. However, the focus will be on Models B, C, and D which had seven statistically significant variables. These models have the additional variable, “differences in prices”, which proved to be significant, therefore, making them more robust models than Model A. Aside from the intercept, the most statistically significant variable at the 1 percent level was “differences in prices”. “Quantity harvested” in the formal market Heckman OLS model was positive and significant at the 5 percent level. As the quantity harvested by a household increases by 100 kilograms, the value of maize sold is expected to increase between 1.57 to 1.71 percent. This significance level is different than in the formal market probit model. The “number in household” variable was negative in sign but insignificant.

The variable “household head sex” was significant at the 5 percent level and is positive. This means that if the household head is male, the household is expected to have a value sold amount that is 96 to 100 percent higher than female-headed households. “Household head age” was negative in sign and was significant at the 10 percent level. As the household head ages by 10 years, it is expected that the maize value sold by the household will decrease by 17.5 to 19.3 percent. Education was included only in Model D and was found to be negative and insignificant.

Communication devices prove to be important in the formal market Heckman OLS model. In Model B, “own a radio” was significant at the 5 percent level while in Models C and D, the variable was significant at the 10 percent level. If the household owns one or more radios, they are expected to have a sell value between 74 to 80 percent more than those households which sold maize to the formal market and do not own a radio. “Ownership of a mobile telephone” was significant at the 5 percent level in all models, indicating that it has a greater significance than radio ownership in determining the value amount of maize sales for households in the formal market. This significance means that for households which own a mobile telephone, they are likely to have a sell value of 70.5 to 72 percent more than households which do not own a mobile telephone. The variable “own a bicycle” was positive but insignificant in this model.

The “average distance traveled to sell location” variable was negative in sign and insignificant. “Land collateral” was found to be positive in sign but insignificant. Model B included the variable, “at farmer group meetings”; however, the variable was insignificant in determining the value amount of maize sales in the formal market. The “region dummy” has a positive coefficient but is insignificant. The IMR (lambda) was found to be statistically insignificant in the model indicating that there was no selection bias present in the sample. While this insignificance was unexpected, it is likely due to there being such a small number of households, 97 out of 908, which participated in the formal market.

In evaluating the Chi-square tests for groups of variables, household characteristics were significant at the 5 percent level. The information dissemination variables, “own a radio” and “own a mobile telephone”, were significant between the 5 and 1 percent levels indicating that communication devices heavily impact the value amount of maize sold. Continuing education variables were found to be insignificant.

Informal Market

The result of the informal market Heckman OLS models A, B, C, and D can be viewed in Table 5-3. Three of the four models have four statistical variables while Model D, which includes the variable “education level of the household head”, has five statistically significant variables. Three variables proved to be significant at the 1 percent level: “quantity harvested”, “education level of the household head”, and “own a radio”. It was found that if a household increases the quantity harvested by 100 kilograms, the household will increase the value of maize sold by 2 to 2.5 percent. The “differences in prices” variable was positive in the models but was insignificant, an indicator that is very different than the findings of the formal market. The “number in household” variable is positive in sign, which is somewhat perplexing, and is significant at the 5 percent level. However, the sign of this variable could indicate that the informal market is only used to satisfy cash needs; therefore, if a household has more children and hence more school fees to pay, they are likely to sell more in the informal market and obtain a higher supply of cash from the transaction.

"Household head sex" was positive in sign but insignificant. The variable "household head age" had a negative coefficient but was statistically insignificant. As stated earlier, the "education level of the household head" variable was statistically significant at the 1 percent level and positive. If the household head has an education level that is above primary school, they are expected to have a value sold amount in the informal market that is 108 percent higher than the household heads which have only a primary or no education.

The variable, "own a radio" was significant at the 1 percent level and was positive in sign indicating that for a household which owns a radio, they are expected to have a value sold amount which is 49 to 55 percent higher than the households which do not own a radio. The coefficients of "own mobile telephone" were mixed in sign and the variable was insignificant. The variable "own a bicycle" had positive coefficients but was found to be statistically insignificant.

The "average distance traveled to sell location" was positive in three of the four models and was insignificant. "Land collateral" was found to positively impact the maize value sold in the informal market but was statistically insignificant. Model C included the "at farmer group meetings" variable which was negative in sign and was insignificant. The "region dummy" variable was significant at the 5 percent level and was positive in determining the value of maize sold in the informal model. Similar to the formal market, the lambda representing the IMR was insignificant indicating that selection bias was not present in the sample. While this insignificance is unexpected, it is likely due to there being such a small number households, 208 out of 908, which participated in the informal maize market.

In three of the four models, the Chi-square value was significant at the 5 percent level while it was significant at the 1 percent level in one of the models for household characteristics. In all four models, the Chi-square value was significant at the 1 percent level for information dissemination via communication devices while the continuing education variables were insignificant.

Aggregate Sale Market

Analogous to the findings of the market participation probit model, the aggregate value sold Heckman OLS models overall represent the informal market model more than the formal market and can be viewed in Table 5-4. This indicates the need for separation of the informal and formal markets when evaluating market participation and value sold information. The "quantity harvested" variable was positive and significant at the 1 percent level, most similar to the informal market. Also positive and significant was the variable "differences in prices". The "number in household" variable was positive and significant at the 5 percent level. This statistical significance is most similar to the findings in the informal market.

"Household head sex" proved to be significant at the 10 percent level in Models C and D and was insignificant in Models A and B; its sign was positive. The variable "household head age" was negative and was insignificant. "Education level of the household head" was included in one model but insignificant.

The variable representing "ownership of a radio" was positive and significant at the 1 percent level in all models. This means that for a household which owns a radio, they will reap a sale value 53 to 65 percent higher than a household which does not own a radio. In the aggregate sale market models the "ownership of a radio" proved to be more important than "ownership of a mobile phone" as the variable "own a mobile phone" was significant at the 10 percent level and only in two models. The variable "own a bicycle" was positive and insignificant in all four Heckman OLS models.

While the coefficient for the "average distance traveled to sell location" was positive, it was insignificant. The variable "land collateral" was positive in sign yet statistically insignificant. The variable "at farmer group meetings" was included in Model B and was insignificant. "Region dummy" was significant in three of the four models and ranged in significance from the 5 to 10 percent level. The IMR (lambda) was insignificant in all four models indicating that selection bias was not present in the sample or not well specified. While this insignificance was unexpected, it is likely due to there being such a small number with approximately one-third of the households surveyed selling any maize.

The Chi-square value for the household characteristics variables was significant at the 1 percent level. Similar to the informal market model, the variables representing information dissemination via communication devices had a Chi-square value that was significant at the 1 percent level. Parallel to the findings in the formal and informal models, the continuing education variables had a Chi-square value that was insignificant.

Table 5-2: Results for the Formal Market Value Sold Heckman OLS Models

	OLS Model A Value Sold *ln(Value of Maize Sold)* **Coeff.**		OLS Model B Value Sold *ln(Value of Maize Sold)* **Coeff.**		OLS Model C Value Sold *ln(Value of Maize Sold)* **Coeff.**		OLS Model D Value Sold *ln(Value of Maize Sold)* **Coeff.**	
Intercept	7.1845	***	6.5482	***	6.4798	***	7.0812	***
Quantity Harvested (100 kg)	0.0165	**	0.0171	**	0.0169	**	0.0157	**
Difference in Prices (Realized - Expected)	----		0.2522	***	0.2646	***	0.2448	***
Household Head Sex (1=Male)	0.7923	*	0.9619	**	1.0065	**	0.973	**
Household Head Age (10 years)	-0.1943	*	-0.1752		-0.1929	*	-0.1878	*
Education Level of Household Head	----		----		----		-0.5071	
Number in Household	0.0039		0.0158		0.0121		0.0193	
Own a Radio	1.0032	**	0.8029	**	0.7972	*	0.738	*
Own a Mobile Phone	0.6727	**	0.7048	**	0.7173	**	0.7226	**
Average Distance Traveled to Sell Location (10 km)	0.001		-0.00005		-0.00002		-0.00004	
Own a Bicycle	0.5966		0.573		0.63		0.5832	
Land Collateral	0.2256		0.5083		0.4962		0.4724	
At Farmer Group Meetings	----		0.2875		----		----	
Region Dummy	0.5487		0.4648		0.5191		0.4284	
Model Performance								
Number of Observations	908		908		908		908	
Uncensored Observations	97		97		97		97	
Inverse Mills Ratio: Lambda	1.2142		1.2948		1.3683		1.1069	
Rho	0.7851		0.8342		0.8524		0.7732	
Sigma	1.5465		1.5522		1.6051		1.4302	
Wald chi2	18.92	**	31.6	***	29.94	***	33.37	***

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Table 5-3: Results for the Informal Market Value Sold Heckman OLS Models

	OLS Model A Value Sold *ln(Value of Maize Sold)* **Coeff.**		OLS Model B Value Sold *ln(Value of Maize Sold)* **Coeff.**		OLS Model C Value Sold *ln(Value of Maize Sold)* **Coeff.**		OLS Model D Value Sold *ln(Value of Maize Sold)* **Coeff.**	
Intercept	9.6471	***	8.8304	***	9.2701	***	9.1193	***
Quantity Harvested (100 kg)	0.0203	***	0.0247	***	0.0218	***	0.0226	***
Difference in Prices (Realized - Expected)	----		0.0443		0.0389		0.04	
Household Head Sex (1=Male)	0.2778		0.3849		0.3288		0.3113	
Household Head Age (10 years)	-0.062		-0.0985		-0.0799		-0.0886	
Education Level of Household Head	----		----		----		1.0887	***
Number in Household	0.0704	**	0.0687	**	0.0686	**	0.0625	**
Own a Radio	0.4933	**	0.5549	***	0.5376	***	0.5454	***
Own a Mobile Telephone	0.1453		-0.0149		0.0862		-0.0212	
Average Distance Traveled to Sell Location (10km)	0.0004		0.0004		0.0003		-0.0001	
Own a Bicycle	0.1997		0.1633		0.1854		0.1985	
Land Collateral	0.2406		----		0.1799		0.2017	
At Farmer Group Meetings	----		-0.2364		----		----	
Region Dummy	0.3829	*	0.496	**	0.434	**	0.4978	**
Model Performance								
Number of Observations	908		908		908		908	
Uncensored Observations	208		208		208		208	
Inverse Mills Ratio: Lambda	-0.1681		0.5424		0.1509		0.269	
Rho	-0.1491		0.4496		0.1346		0.2407	
Sigma	1.1271		1.2065		1.1213		1.1176	
Wald chi2	66.33	***	65.58	***	68.37	***	77.96	***

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Table 5-4: Results for the Aggregate Market Value Sold Heckman OLS Models

	OLS Model A		OLS Model B		OLS Model C		OLS Model D	
	Value Sold *ln(Value of Maize Sold)*		Value Sold *ln(Value of Maize Sold)*		Value Sold *ln(Value of Maize Sold)*		Value Sold *ln(Value of Maize Sold)*	
	Coeff.		**Coeff.**		**Coeff.**		**Coeff.**	
Intercept	9.9251	***	9.4173	***	9.2055	***	9.0879	***
Quantity Harvested (100 kg)	0.0145	***	0.017	***	0.0187	***	0.0194	***
Difference in Prices (Realized - Expected)	-----		0.0624	*	0.0683	**	0.0717	**
Household Head Sex (1=Male)	0.2567		0.3455		0.388	*	0.3998	*
Household Head Age (10 years)	-0.0337		-0.0667		-0.0848		-0.0906	
Education Level of Household Head	----		----		----		0.2819	
Number in Household	0.0737	***	0.066	**	0.0629	**	0.0601	**
Own a Radio	0.5322	***	0.6196	***	0.6405	***	0.6552	***
Own a Mobile Telephone	0.3091	*	0.2761	*	0.2482		0.2141	
Average Distance Traveled to Sell Location (10 km)	0.001		0.0008		0.0008		0.0008	
Own Bicycle	0.1245		0.1539		0.174		0.1818	
Land Collateral	0.2614		0.2146		0.203		0.2027	
At Farmer Group Meetings	----		0.1545		----		----	
Region Dummy	0.2883		0.3807	*	0.4401	**	0.4772	**
Model Performance								
Number of Observations	908		908		908		908	
Uncensored Observations	307		307		307		307	
Inverse Mills Ratio (Lambda)	-0.5335		-0.0708		0.1633		0.2641	
Rho	-0.4398		-0.0631		0.1445		0.2314	
Sigma	1.213		1.1224		1.1301		1.1414	
Wald chi2	62.56	***	72.6	***	71.45	***	71.89	***

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

As seen in Tables 5-2, 5-3, and 5-4, there are similar determinants of the value a household sells while there are also different determinants for the three market levels. Overall, “quantity harvested” was very significant in all three market levels. “Radio ownership” was significant in all three market levels as well. Price variables were significant in the formal and aggregate sale markets but not the informal market. “Household head sex” was positive and significant in the formal market and part of the aggregate market. “Mobile telephone ownership” was significant in the formal market but not in the other two markets. The “number in household” variable was significant in the informal and aggregate markets but not in the formal market. “Education level” was also significant in the informal market but not the other two levels. “Region dummy” was also significant in both the informal and aggregate models.

Production Model Results

As stated in the previous chapter, the objective for defining a production function was to better understand the “quantity harvested” variable that is used in both the probit market participation model as well as the Heckman OLS value sold model. When analyzing the three different OLS functional forms, the quadratic and Cobb-Douglas functional forms seem to fit the data best with a R-square value of 0.4247 and 0.4727, respectively (Table 5-5). The interaction terms of the quadratic production function were significant at the 1 percent level through the F-test statistic indicating that the nonlinear functional form best fits the data. Based upon the interactions terms being significant, the production model that will be further examined in the greatest detail is the quadratic production function. In some cases, it will be compared to the results found in the linear production function. There are some differences between the linear and quadratic models with the linear model finding more variables that are significant as seen in Table 5-7. The quadratic marginal effects which take into account the squared and interaction terms are described below. All results are shown in Table 5-5, 5-6, and 5-7 on the following pages.

“Area harvested” proved to be the most statistically significant variable with a marginal effect value of 308.86. This value means that if the area harvested of maize increases by one hectare, the quantity harvested would increase by 308 kilograms. The use of improved seed was significant at the 5 percent level. If a household uses improved seed, they are expected to produce 155 kilograms of maize more than households which do not “use improved seed”. In both the linear and quadratic functions, the “use of inorganic fertilizer” variable was positive. In the linear function the variable was significant at the 1 percent level yet it was insignificant in the quadratic functional form. The same conclusion was found for the “received extension dummy” variable. “Owning large livestock” had a negative impact on maize quantity harvested but was not statistically significant.

“Labor” was found to be significant in both the linear and the quadratic production functions. However, in the linear model, the coefficient was positive whereas it is negative in the quadratic function. This means that households are overusing labor and have entered into the third stage of the production function curve where the marginal product of one more unit of labor is negative. The variable “own ox and equipment dummy” was significant and positive. This sign was expected as animal traction and implements can greatly increase the quantity harvested. The “regional dummy” had a positive impact on quantity harvested and was significant at the 10 percent level in the quadratic function. The variable, “attended farmer association meetings dummy” was positive in sign for both functional forms but was not statistically significant in impacting quantity harvested.

Table 5-5: OLS Regression Results for All Functional Forms for Maize Production

	Linear			Cobb-Douglas			Quadratic		
	Coeff		Robust Std. Error	Coeff		Std. Error	Coeff		Robust Std. Error
INTERCEPT	-252.87	***	89.97	4.75	***	0.19	244.93	***	83.56
Area Harvested (hectares)	231.55	***	38.92	0.69	***	0.04	121.87	***	35.3
Used Improved Seed Dummy	206.6	*	133.61	-0.05		0.09	249.52	*	155.83
Used Inorganic Fertilizer Dummy	383.1	***	138	0.48	***	0.09	199.67		180.5
Received Extension Dummy	218.04	**	107.03	0.07		0.07	-57.43		138.88
Own Large Livestock Dummy	-114.83		79.62	-0.06		0.08	-145.6		113.43
Labor: Non-hired & Hired (days)	1.49	**	0.68	0.14	***	0.04	-1.31	*	0.69
Own Ox and Equipment Dummy	592.16	***	188.64	0.54	***	0.11	546.15	**	248.61
Regional Dummy	283.45	***	71.65	0.31	***	0.07	-178.07	*	96.78
Attended Farmer Association Meetings Dummy	51.92		107.93	0.02		0.08	-158.37		122.26
Model Performance									
N	883			883			883		
R^2	0.3364			0.4727			0.4247		
Adjusted R^2	0.3296			0.4672			0.4072		
F Statistic	13.95	***		86.95	***		25.23	***	
F Statistic for Interaction & Squared Terms *(on following page)*	----			----			5.71	***	
Heteroskedasticity, BP Test 2 (iid)	24.16			0.3			21.55		

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Table 5-6: Interaction Term Results for OLS Quadratic Maize Production Function

Variable	Coeff		Robust Std. Error
Area			
* Area (kg²)	-2.06		4.49
* Used Improved Seed Dummy	-40.58		100.44
* Used Inorganic Fertilizer Dummy	286.2	*	167.99
* Received Extension Dummy	203.79	**	88.18
* Own Large Livestock Dummy	-31.18		78.23
* Labor: Non-hired & Hired	0.12		0.14
* Own Ox and Equipment Dummy	-13.58		108.87
* Regional Dummy	146.57	**	64.8
* Attended Farmer Association Meetings Dummy	85.76		71.4
Labor			
* Labor	0.01	*	0
* Used Improved Seed Dummy	-0.06		1.52
* Used Inorganic Fertilizer Dummy	-2.76	**	1.27
* Received Extension Dummy	-1.73		1.15
* Own Large Livestock Dummy	1.67	*	0.92
* Own Ox and Equipment Dummy	0.25		1.49
* Regional Dummy	1.1		0.78
* Attended Farmer Association Meetings Dummy	-0.18		1.47

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Table 5-7: Comparisons of the Marginal Effects of the Quadratic Functional Form and Coefficients of the Linear Functional Form

	Quadratic			Linear		
	Marginal Effects		Robust Std. Error	Coeff		Robust Std. Error
INTERCEPT	----	----	----	-252.87	***	89.97
Area Harvested (hectares)	308.8612	***	35.3	231.55	***	38.92
Used Improved Seed Dummy	155.0765	*	155.83	206.6	*	133.61
Used Inorganic Fertilizer Dummy	479.0267		180.5	383.1	***	138
Received Extension Dummy	170.17		138.88	218.04	**	107.03
Own Large Livestock Dummy	-10.2718		113.43	-114.83		79.62
Labor: Non-hired & Hired (days)	-0.63317	*	0.69	1.49	**	0.68
Own Ox and Equipment Dummy	547.8167	**	248.61	592.16	***	188.64
Regional Dummy	269.2815	*	96.78	283.45	***	71.65
Attended Farmer Association Meetings Dummy	3.910736		122.26	51.92		107.93

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Summary

This chapter gave a detailed view of the results obtained from the market participation probit models and the value sold Heckman OLS models. The results of the production function were also examined to shed greater light on the "quantity harvested" variable. As the models in this chapter highlight, there is no one single variable that determines a household's marketing decisions. Rather several areas must be targeted in order to enhance market participation and the value sold. It is important to acknowledge and identify these differences as the policy impacts, as shared in the final chapter, will be different.

Chapter 6 - Conclusion

The objective of this thesis was to identify the determinants of participation in formal and informal markets and specifically the value sold. The aggregate sale market was analyzed and also divided into the formal market and the informal market to analyze the specific determinants of each market level. As described in the introduction, households that participate in markets often increase their welfare, their income, and have better access to foods which meet their dietary needs.

To analyze the determinants for a household's decision to participate in a respective maize market, three probit models were estimated. The Inverse Mills Ratio was calculated from the probit models and was then used to estimate four different Heckman selection models for each of the three market levels: formal, informal, and aggregate. The Heckman OLS selection model estimated the log of the value sold that a household had in a particular market. In addition, a production function was estimated to better determine what impacts the variable "quantity harvested".

This chapter will first examine the results of the hypotheses that were tested in this thesis and will then be followed by the empirical evidence supporting the results. Next the main policy implications are identified and are ranked in an ordinal manner. Finally, areas of future research are suggested.

Hypotheses Tested

Seven hypotheses were tested in this thesis. The first hypothesis tested was that the determinants of market participation in the formal and informal markets differ. The second hypothesis was that transaction costs affect market participation. It was also hypothesized that marketing decisions are affected by how much maize is available. The fourth hypothesis deals with information dissemination via communication devices. It was hypothesized that both "ownership of a radio" and "ownership of a mobile telephone" affect a household's decision to participate in the market and how much to sell. Next, household characteristics were examined. It was hypothesized that female-headed households are less likely to participate in the market than male-headed households and if they do participate, they are likely to sell less maize. The final hypothesis, which dealt with transportation, was that “bicycle ownership” increases the likelihood that a household participates in the market as well as the amount of maize sold.

Empirical Evidence

Separating the formal versus informal markets does make a difference as the two market levels have different determinants of participation. When combined, as in the aggregate sale model, the results of each particular market level are muted and the results are not as effectively interpreted or reliable in application. “Quantity harvested” proved to be significant at the 1 percent level in all three market participation probit models. The variable was also significant at the 1 percent level in the Heckman value sold informal market model but was less significant, at the 5 percent level, in the Heckman value sold formal market model. The findings of this thesis support the initial hypothesis. Price was not significant for market participation in any market level or in the Heckman value sold informal market model. However, conversely, price was significant at the 1 percent level in the Heckman value sold formal market model. The “number in household” variable, a proxy for household consumption, was significant and negative in the formal market participation model but not in the informal market participation model. The variable was not significant in the formal market value sold model. However, the variable was significant and positive in the informal market value sold model.

A male-headed household was a significant determinant of both market participation and value sold decisions in the formal market. However, the variable showed no significance in the informal market participation decision or the informal market value sold decision. The hypothesis held for the formal market but did not hold for the informal market. Communication devices did appear to positively affect household decision-making which supports the previously stated hypotheses. “Ownership of a radio” was significant and positive for the formal level market participation while “ownership of a mobile phone” was significant and negative for the informal level market participation model. Both radio and mobile telephone ownership were significant in the formal market value sold model with mobile telephone being more important. In the informal market value sold model though, “ownership of a radio” was found to be significant and positive while “mobile telephone ownership” was insignificant. “Ownership of bicycle” was found only to be significant and positive in the household decision to participate in the formal maize market. This finding was different than the proposed hypothesis.

It appears that households participate in the informal market as a way to meet cash needs and not for profit as the households were not price-responsive. This is converse to the neo-classical economic theory that farmers respond to prices by selling more quantity of a good in the market as the price received for the good increases. However, in the formal market it appears that profit is actually the main reason for participation as the price variable is the most significant variable in the determinant.

Policy Implications

Many conclusions may be drawn from the findings of this thesis; a few suggestions are listed below. The policy implications are listed in an ordinal manner according to their significance levels and magnitudes of the marginal effects in the probit models and the magnitudes of the coefficients in the Heckman models. It appears that "quantity harvested" is a significant driver, if not the main driver, for market participation and value sold decisions. Therefore, efforts to increase production capabilities are important. Specifically, the development of the input supply market is recommended making improved seed and inorganic fertilizer more accessible to household farmers as shown in the production function model results.

Secondly, efforts to empower women should be designed. This policy suggestion is in line with current work being done by USAID and the World Bank which works within cultural norms of the country. Making sure that women know of and are educated to take hold of agricultural marketing opportunities is important but it is unsure in what format it should be done. Since, female-headed households are at a disadvantage in making marketing decisions; group marketing maybe an option that will bring about greater bargaining power and greater access to agricultural inputs. Or possibly, individual extension service interaction should occur which provides informational and teaching sessions on markets designed specifically for women to reach, encourage, and empower them.

Information dissemination via communication devices is an area which brings great potential for increased market participation and value sold decisions. Therefore, market locations and price information can be broadcast over the radio or made available via mobile phones. An example of success in this area is TradeNet, a Ghana-based trading platform which is being set-up throughout West Africa. TradeNet allows farmers to sign-up for SMS (short message service) alerts for commodity market information of their choice as well as recommendations of when to buy or sell. The users can also receive real-time price information for over 80 commodities in over 400 different markets located in the region (World Bank, 2007).

Information dissemination continues to be an area of focus as "bicycle ownership" was found to serve as a method of gathering information. This combined with the significance of the previous information dissemination method via communication devices conveys that households seek to gather information through whatever method possible. The significance of bicycle ownership shows that farmers want market information but must gather it themselves. Another example of increasing access to market information comes from India. Rural internet kiosks called "e-Choupals" were set-up in nine Indian states. Each e-Choupal is run by a informal farmer who has been trained to manage the kiosks. Farmers can freely come and gather information on informal and global market prices, weather, and different farming practices. The e-Choupals also have the ability to allow farmers to buy consumer goods as well as agricultural inputs and services which are sourced from other companies (World Bank, 2007).

Future Research

Market participation research is limited in Tanzania and there are many implications that are not examined in this research. One area that should be examined in the future is the use of a "predicted quantity harvested" value which reflects the expectations at the time the household plants their maize crop. This method is more reflective of the farm household model (Branum and Squire, 1979) where production and consumption decisions are non-separable. Testing the impact of motorized transport vehicles on market participation would be extremely valuable as a method in which a household gathers information as well as a method of transporting their crop to market. Unfortunately, since there were such few households which owned a motorized transport vehicle: motorcycle or car, the variable was unable to be included in this thesis as the model became mis-specified. Therefore, it is unclear how the inclusion of this variable would impact the "own a bicycle" variable. Information on "ownership of motorized transport" would convey information about transport costs to market centers and asset thresholds. Another area of future research includes analyzing the importance of "membership in farmer organizations". While the findings in this thesis concluded that the variable "at farmer group meetings" was negative and insignificant, this is counter to all previous literature. Therefore, it is expected that the variable in this thesis does not properly capture the information.

Chapter 7 - References

Aker, Jenny C., and Isaac M. Mbiti. "Mobile Phones and Economic Development in Africa." *Journal of Economic Perspectives, in press.*, n.d.

Alene, A.D., V.M. Manyong, G. Omanya, H.D. Mignouna, M. Bokanga, and G. Odhiambo. "Smallholder Market Participation Under Transactions Costs: Maize Supply and Fertilizer Demand in Kenya." *Food Policy* 33 (2008): 318-328.

Azam, M.S., K.S. Imai, and R. Gaiha. "Agricultural Supply Response and Smallholders Market Participation - the Case of Cambodia." Discussion Paper, Research Institute for Economics and Business Administration, Kobe University, 2012.

Bardhan, K. "Price and Output Response of Marketed Surplus of Foodgrains: A Cross-Sectional Study of Some North Indian Villages." *American Journal of Agricultural Economics* 52 (1970): 51-61.

Barnum, H., and L. Squire. "An Econometric Application of the Theory of the Farm Household." *Journal of Development Economics* 6 (1979): 79-102.

Barrett, C.B. "Smallholder Market Participation: Concepts and Evidence from Eastern and Southern Africa." *Food Policy* 33 (2008): 299-317.

Barrett, C.B. "Urban Bias in Price Risk: The Geography of Food Price Distributions in Low-Income Economies." *Journal of Development Studies* 32, no. 6 (1996): 830-849.

Barrett, C.B., P.P. Marenya, J.G. McPeak, B. Minten, F.M. Murithi, W. Oluoch-Kosura, F. Place, J.C. Randrianarisoa, J. Rasambainarivo, and J. Wangila. "Welfare Dynamics in Rural Kenya and Madagascar." *Journal of Development Studies* 42 (2006): 248-277.

Bellemare, Marc F., and Christopher B. Barrett. "An Ordered Tobit Model of Market Participation: Evidence from Kenya and Ethiopia." *American Journal of Agricultural Economics* 88, no. 2 (May 2006): 324-337.

Boughton, D., D. Mather, C.B. Barrett, R. Benfica, D. Abdula, D. Tschirley, and B. Cunguara. "Market Participation by Rural Households in a Low-Income Country: An Asset-Based Approach Applied to Mozambique." *Faith and Economics* 50 (2007): 64-101.

Brooks, Jonathan, George Dyer, and Ed Taylor. *Modeling Agricultural Trade and Policy Impacts in Less Developed Countries.* OECD Food, Agriculture and Fisheries Working Paper No. 11, 2008.

Cadot, O., L. Dutoit, and M. Olarreaga. "How Costly Is It for Poor Farmers to Lift Themselves Out of Subsistence?" Working Paper 3881, World Bank Policy Research , 2006.

Carter, Michael R., and Pedro Olinto. "Getting Institutions "Right" for Whom? Credit Constraints and the Impact of Property Rights on the Quantity and Composition of Investment." *American Journal of Agricultural Economics* 85, no. 1 (2003): 173-186.

CIA: The World Factbook - Tanzania. n.d. https://www.cia.gov/library/publications/the-world-factbook/geos/tz.html (accessed April 20, 2013).

de Janvry, A., M. Fafchamps, and E. Sadoulet. "Peasant Household Behavior with Missing Markets: Some Paradoxes Explained." *Economic Journal* 101, no. 409 (1991): 1400-1417.

Ellis, S., and J. Hine. "The Provision of Rural Transport Services." Sub-Saharan Africa Transport Policy Program Working Paper No. 37, Washingtpm D.C.: World Bank, 1998.

Enke, S. *Economics for Development.* Englewood Cliffs: Prentice Hall, 1963.

Evenson, R. E., and D. Gollin. "Assessing the Impact of the Green Revolution, 1960 to 2000." *Science* 300, no. 5620 (May 2003): 758-762.

Fafchamps, M. *Market Institutions in Sub-Saharan Africa.* Cambridge, MA: MIT Press, 2004.

FAO Country Profiles - United Republic of Tanzania. n.d. http://www.fao.org/countryprofiles/index/en/?iso3=TZA (accessed April 19, 2013).

FAO Food Balance Sheet - United Republic of Tanzania. 2012. http://faostat3.fao.org/home/index.html#DOWNLOAD (accessed April 19, 2013).

Gani, B.S., A.I. Adeoti. "Analysis of Market Participation and Rural Poverty among Farmers in Northern Part of Taraba State, Nigeria." *Journal of Economics* 2, no. 1 (2011): 23-36.

Gebremedhin, B., and D. Hoekstra. "Cereal Marketing and Household Market Participation in Ethiopia: The Case of Teff, Wheat, and Rice." *AAAEA Conference Proceedings.* 2007. 243-252.

Goetz, S.J. "A Selectivity Model of Household Food Marketing Behavior in Sub-Saharan Africa." *American Journal of Agricultural Economics* 74, no. 2 (1992): 444-452.

Griffiths, William E., R. Carter Hill, and George G. Judge. *Learning and Practicing Econometrics.* New Jersey: John Wiley & Sons, Inc., 1993.

Haessel, W. "The Price and Income Elasticites of Home Consumption and Marketed Surplus of Food Grains." *American Journal of Agricultural Economics* 57 (1975): 111-115.

Heltberg, R. and F. Tarp. "Agricultural Supply Response and Poverty in Mozambique." *Food Policy* 27 (2002): 103-124.

Hine, J.L., S.D. Ellis, and TRL Limited. "Agricultural Marketing and Access to Transport Services." World Bank Rural Travel and Transport Program, 2001.

Jayne, T.S., D. Mather, and E. Mghenyi. "Principal Challenges Confronting Smallholder Agriculture in Sub-Saharan Africa." *World Development* 38, no. 10 (2010): 1384-1398.

Key, N., E. Sadoulet, and A. de Janvry. "Transaction Costs and Agricultural Household Supply Responses." *American Journal of Agricultural Economics* 82 (2000): 245-259.

Koester, Ulrich. *Regional Cooperation to Improve Food Security in Southern and Eastern African Countries.* Washington, D.C.: International Food Policy Research Institute, 1986.

Krishnan, T.N. "The Marketed Surplus of Foodgrains: Is it Inversely Related to Price?" *Economic Weekly, Annual No. 17*, 1965.

"Living Standards Measurement Study: Integrated Surveys on Agriculture." *World Bank.* n.d. www.worldbank.org/lsms/ (accessed March 2013).

Mathur, P. N., and H. Ezekiel. "Marketable Surplus of Food and Price Fluctuations in a Developing Economy." *Kyklos, 14,* 1961: 396-408.

Moser, C., C.B. Barrett, and B. Minten. "Spatial Integration at Multiple Scales: Rice Markets in Madagascar." Working Paper, Cornell University, 2006.

Nyoro, J.K., M. W. Kiiru, and T. S. Jayne. "Evolution of Kenya's Maize Marketing Systems in the Post-Liberalization Era." *4th Agricultural Transformation Workshop.* Nairobi, Kenya: Tegemeo Institute of Agricultural Policy and Development, 1999.

Olson, R. O. "Impact and Implications of Foreign Surplus Disposal on Underdeveloped Countries." *Journal of Farm Economics* 42 (1960): 1042-1051.

Olwande, J., and M. Mathenge. "Market Participation Among Poor Rural Households in Kenya." Working Paper, Tegemeo Institute of Agricultural Policy and Development, 2011.

Omamo, S.W. "Transport Costs and Smallholder Cropping Choices: An Application to Siaya District, Kenya." *American Journal of Agricultural Economics* 80, no. 1 (1998): 116-123.

Reynolds, Curt. *Production Estimates and Crop Assessment Division - Tanzania.* March 24, 2003. http://www.fas.usda.gov/pecad2/highlights/2003/03/tanzania/images/cropland_tz.htm (accessed March 30, 2013).

Rios, A.R., W.A. Masters, and G.E. Shively. "Linkages Between Market Participation and Productivity: Results from a Multi-Country Farm Household Sample." Paper Presented at AAEA Annual Meeting, Orlando, FL, 27-29 July 2008., n.d.

Sadoulet, Elizabeth, and Alain de Janvry. *Quantitative Development Policy Analysis.* Baltimore and London: The Johns Hopkins University Press, 1995.

Sharma, K.L., and M.P. Gupta. "Study of Farm Factors Dtermining Marketed Surplus of Bajra in Jaipur District." *Indian Journal of Agricultural Economics* 25 (1970): 64-68.

Singh, I., L. Squire, and John Strauss. *Agricultural Household Models.* Baltimore, MD: The Johns Hopkins Press, 1986.

Smale, M., D. Byerlee, and T.S. Jayne. "Maize Revolutions in Sub-Saharan Africa." Working Paper, Tegemeo Institute of Agricultural Policy and Development, 2011.

Stephens, E.C., and C.B. Barrett. "Incomplete Credit Markets and Commodity Marketing Behaviour." *Journal of Agricultural Economics* 62, no. 1 (2011): 1-24.

The World Bank. *2008 World Development Report: Agriculture for Development.* Quebecor World, 2007.

Thirtle, C., L. Lin, and J. Piesse. "The Impact of Research-Led Agricultural Productivity Growth on Poverty Reduction in Africa, Asia and Latin America." *World Development* 31, no. 12 (2003): 1959-1975.

United States Agency for International Development. ""Feed the Future: Tanzania FY 2011-2015 Multi-Year Strategy"." 2011. http://www.feedthefuture.gov/sites/default/files/country/strategies/files/TanzaniaFTFMulti-YearStrategy.pdf (accessed February 13, 2013).

Vance, C., and J. Geoghehan. "Modeling the Determinants of Semi-Subsistent and Commercial Land Uses in and Agricultural Frontier of Southern Mexico: A Switching Regression Approach." *International Regional Science Review* 27 (2004): 326-347.

Appendix A - Additional Model Tables

Table A-1: Results for the Formal, Informal, and Aggregate Market Participation Probit Models including Quantity Predicted and Motorized Transport Vehicles

	Probit		Probit		Probit	
	Formal Market Participation *(1= HH Sold Maize)*		Informal Market Participation *(1= HH Sold Maize)*		Aggregate Market Participation *(1= HH Sold Maize)*	
	Marginals		**Marginals**		**Marginals**	
Quantity Harvested Predicted (from Quadratic Prod Fxn) (in 100kg)	0.0033	***	0.0065	***	0.015	***
Expected Price (per 100 kg)	-0.0124		-0.00953		-0.0193	**
Household Head Sex (1=Male)	0.0415	*	0.0405		0.0721	*
Household Head Age	-0.0013	**	-0.0019	**	-0.0037	***
Education Level of Household Head	0.0037		-0.0066		-0.0108	
Number in Household	-0.0081	**	-0.0077		-0.0193	***
Number of Communication Devices	0.026	**	-0.0074		0.019	
Distance from Plot to Road	-0.0019		0.0112	**	0.0117	*
Own Bicycle	0.0405	**	-0.0228		0.0253	
Number of Motorized Transport Vehicles Owned	-0.0185		-0.141		-0.1502	
Number of Extension Visits	0.0025	*	-0.0044		0.0021	
Collateral	0.0104		-0.0619	*	-0.0552	
At Farmer Group Meetings	-0.0055		-0.0513		-0.0561	
Region Dummy	0.0315	*	0.0574	**	0.0886	***
Model Performance						
Number of Observations	908		908		908	
Uncensored Observations	----		----		----	
Correctly Classified Predictions (%)	89.22		77.45		70.19	
Log Liklihood	-279.459		-465.323		-529.787	
McFadden's R2	0.095		0.048		0.089	
McKelvey and Zavoina's R2	0.24		0.113		0.225	
Cragg & Uhler's R2	0.126		0.077		0.149	
Efron's R2	0.078		0.058		0.114	
LR Chi2	58.44	***	47.17	***	103.08	***
Pseduo R2	0.0947		0.0482		0.0887	

Table A-2: Results for the Formal Market Heckman Models including Quantity Predicted and Transport Vehicle Variables

	OLS Model A		OLS Model B		OLS Model C		OLS Model D	
	ValueSold *ln(Value of Maize Sold)*		ValueSold *ln(Value of Maize Sold)*		ValueSold *ln(Value of Maize Sold)*		ValueSold *ln(Value of Maize Sold)*	
	Coeff		**Coeff**		**Coeff**		**Coeff**	
Intercept	6.4275	***	5.66	**	5.8017	***	6.2265	***
Quantity Harvested Predicted (from Quadratic Prod Fxn) (in 100kg)	0.0569	**	0.0619	***	0.0602	***	0.0588	***
Difference in Prices (Realized - Expected)	----		0.283	***	0.2736	***	0.2636	***
Household Head Sex (1=Male)	0.9364	*	1.167	**	1.1183	**	1.1316	**
Household Head Age (10 years)	-0.0235	**	-0.0223	*	-0.0214	*	-0.0225	**
Education Level of Household Head	----		----		----		-0.4789	
Number in Household	-0.0307		-0.0254		-0.02		-0.0166	
Number of Communication Devices	0.8561	***	0.7967	***	0.7916	***	0.7753	***
Average Distance Traveled to Sell Location (10 km)	0.001		0.00008		-0.0001		-0.00008	
Own Bicycle	0.6839	*	0.608		0.5694		0.5534	
Number of Motorized Transport Vehicles Owned	-1.1025		-1.115		-1.1703	*	-1.033	
Collateral	0.2658		0.531		0.5403		0.5028	
At Farmer Group Meetings	----		----		0.2194		----	
Region Dummy	0.5378		0.4938		0.4508		0.4171	***
Model Performance								
Number of Observations	908		908		908		908	
Uncensored Observations	97		97		97		97	
Inverse Mills Ratio: Lambda	0.156		0.126		0.143		0.167	
Rho	0.889		0.939		0.922		0.893	
Sigma	1.77		1.835		1.759		1.651	
Wald chi2	21.21	***	34.47	***	36.3	***	37.91	***

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Table A-3: Results for Informal Market Heckman Models including Quantity Predicted and Transport Vehicle Variables

	OLS Model A ValueSold *ln(Value of Maize Sold)*		OLS Model B ValueSold *ln(Value of Maize Sold)*		OLS Model C ValueSold *ln(Value of Maize Sold)*		OLS Model D ValueSold *ln(Value of Maize Sold)*	
	Coeff		**Coeff**		**Coeff**		**Coeff**	
Intercept	9.2683	***	8.6814	***	7.7902	***	8.5978	***
Quantity Harvested Predicted (from production function) (in 100kg)	0.0209	***	0.0406	***	0.0549	***	0.0417	***
Difference in Prices (Realized - Expected)	----		0.0521		0.0672		0.0529	
Household Head Sex (1=Male)	0.4549		0.555	**	0.7037	**	0.5436	**
Household Head Age (10 years)	-0.0086		-0.0113	*	-0.015	*	-0.0118	*
Education Level of Household Head	----		----		----		1.0624	***
Number in Household	0.048		0.0387		0.0274		0.0315	
Number of Communication Devices	0.3278	***	0.3216	**	0.2776	*	0.2976	**
Average Distance Traveled to Sell Location (10 km)	0.0008		0.0007		0.0009		0.0004	
Own Bicycle	0.1258		0.0822		-0.0066		0.0769	
Number of Motorized Transport Vehicles Owned	0.1004		-0.1233		-0.5532		-0.4307	
Collateral	0.138		0.0389		-0.0569		0.068	
At Farmer Group Meetings	----		----		-0.4129		----	
Region Dummy	0.4367	**	0.501	**	0.5937	**	0.5487	**
Model Performance								
Number of Observations	908		908		908		908	
Uncensored Observations	207		207		207		207	
Inverse Mills Ratio: Lambda	0.72		0.334		0.158		0.291	
Rho	0.2068		0.5764		0.886		0.6203	
Sigma	1.1647		1.3144		1.7632		1.328	
Wald chi2	54.2	***	52.06	***	41.28	***	59.03	***

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Table A-4: Results for Aggregate Market Heckman Models including Quantity Predicted and Transport Vehicle Variables

	OLS Model A *ln(Value of Maize Sold)*		OLS Model B *ln(Value of Maize Sold)*		OLS Model C *ln(Value of Maize Sold)*		OLS Model D *ln(Value of Maize Sold)*	
	Coeff		**Coeff**		**Coeff**		**Coeff**	
Intercept	9.3685	***	8.4643	***	8.3967	***	8.3783	***
Quantity Harvested Predicted (from production function) (in 100kg)	0.0335	***	0.0521	***	0.0539	***	0.0534	***
Difference in Prices (Realized - Expected)	----		0.0953	***	0.0976	***	0.0985	***
Household Head Sex (1=Male)	0.4451	**	0.6535	***	0.6703	***	0.6641	***
Household Head Age (10 years)	-0.0098	*	-0.0159	**	-0.0164	**	-0.0162	**
Education Level of Household Head	----		----		----		0.3019	
Number in Household	0.0438		0.0143		0.0119		0.0106	
Number of Communication Devices	0.441	***	0.4701	***	0.4699	***	0.463	***
Average Distance Traveled to Sell Location (10 km)	0.001	**	0.0009		0.0009		0.0009	
Own Bicycle	0.15		0.1686		0.1704		0.1717	
Number of Motorized Transport Vehicles Owned	-0.3545		-0.6062		-0.6221		-0.6885	
Collateral	0.1934		0.1135		0.1088		0.1169	
At Farmer Group Meetings	----		----		-0.0499		----	
Region Dummy	0.4191	**	0.5589	***	0.583	***	0.5854	***
Model Performance								
Number of Observations	908		908		908		908	
Uncensored Observations	307		307		307		307	
Inverse Mills Ratio: Lambda	0.785		0.112		0.134		0.095	*
Rho	0.1222		0.733		0.766		0.7643	
Sigma	1.1511		1.412		1.4501		1.4458	
Wald chi2	68.7	***	66.82	***	65.32	***	66.41	***

***, **, * indicates significance at the 1%, 5%, and 10% significance levels respectively.

Appendix B - Correlation Matrices

Figure B-1: Correlation Matrix for the Formal Market Participation Probit Model

	Sold to Formal Market	Quantity Harvested	Expected Price	Household Head Sex	Household Head Age	Education Level Above Primary School	Number in Household	Owns a Radio	Owns a Mobile Phone	Distance from Plot to Road	Owns a Bicycle	Number of Extension Visits	Land Collateral	Attend Farmer Group Meetings	Region Dummy
Sold to the Formal Market	1.000														
Quantity Harvested	0.1363	1.000													
Expected Price	-0.0367	-0.0676	1.000												
Household Head Sex	0.1026	0.1067	-0.0453	1.000											
Household Head Age	-0.1045	0.0291	0.0932	-0.1928	1.000										
Education Level Above Primary School	0.0404	0.0049	-0.0011	0.0768	-0.036	1.000									
Number in Household	-0.0147	0.1049	0.022	0.2054	0.0237	0.0685	1.000								
Owns a Radio	0.1145	0.0539	-0.0084	0.2211	-0.1533	0.1047	0.1435	1.000							
Owns a Mobile Phone	0.0831	0.0609	0.1009	0.0854	-0.0622	0.1884	0.1969	0.318	1.000						
Distance from Plot to Road	-0.0079	0.0402	-0.0252	0.0742	-0.0035	0.0485	0.107	0.034	-0.0042	1.000					
Owns a Bicycle	0.1249	0.0958	-0.0079	0.2645	-0.0932	0.0755	0.2163	0.328	0.2212	-0.0468	1.000				
Number of Extension Visits	0.0975	0.0138	0.0087	0.0388	-0.0014	0.2059	0.0604	0.064	0.059	0.0004	0.0511	1.000			
Land Collateral	0.0367	0.0171	0.049	0.1073	0.0053	-0.0198	-0.033	0.046	0.0512	0.0347	0.0395	-0.0047	1.000		
Attend Farmer Group Meetings	0.0097	0.0348	0.0105	0.0487	0.0115	-0.0128	0.0305	0.014	-0.0132	-0.0007	0.0105	0.0062	0.0879	1.000	
Region Dummy	0.0805	0.0655	0.0126	-0.0027	-0.0131	-0.0373	-0.0618	-0	0.0294	-0.089	-0.086	-0.0227	0.0689	0.049	1.000

Figure B-2: Correlation Matrix for the Informal Market Participation Probit Model

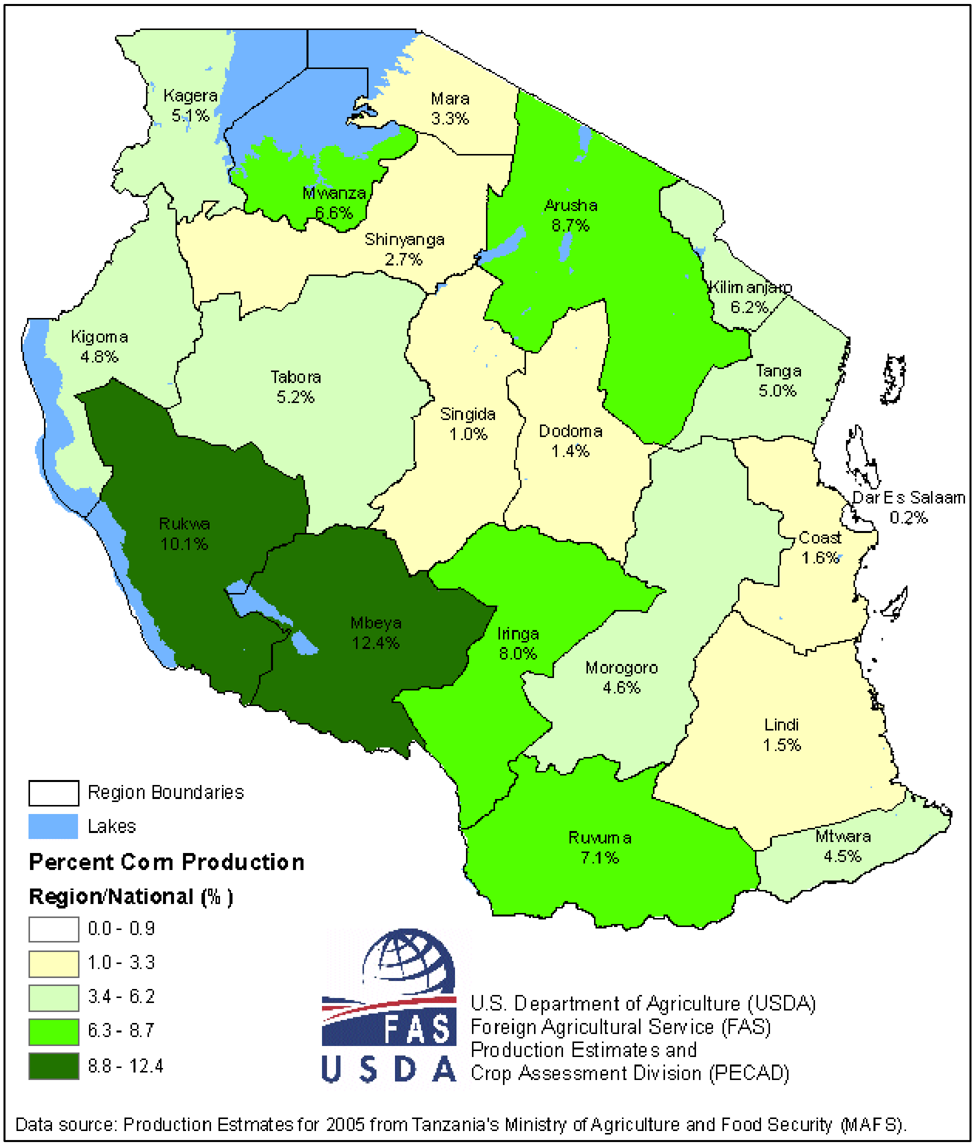
	Sold to Informal Market	Quantity Harvested	Expected Price	Household Head Sex	Household Head Age	Education Level Above Primary School	Number in Household	Owns a Radio	Owns a Mobile Phone	Distance from Plot to Road	Owns a Bicycle	Number of Extension Visits	Land Collateral	Attend Farmer Group Meetings	Region Dummy
Sold to the Informal Market	1														
Quantity Harvested	0.1309	1													
Expected Price	-0.0516	-0.0676	1												
Household Head Sex	0.0487	0.1067	-0.0453	1											
Household Head Age	-0.0821	0.0291	0.0932	-0.1928	1										
Education Level Above Primary School	-0.0105	0.0049	-0.0011	0.0768	-0.036	1									
Number in Household	-0.0175	0.1049	0.022	0.2054	0.0237	0.0685	1								
Owns a Radio	0.0384	0.0539	-0.0084	0.2211	-0.1533	0.1047	0.1435	1							
Owns a Mobile Phone	-0.0649	0.0609	0.1009	0.0854	-0.0622	0.1884	0.1969	0.318	1						
Distance from Plot to Road	0.0853	0.0402	-0.0252	0.0742	-0.0035	0.0485	0.107	0.034	-0.0042	1					
Owns a Bicycle	-0.0133	0.0958	-0.0079	0.2645	-0.0932	0.0755	0.2163	0.328	0.2212	-0.0468	1				
Number of Extension Visits	-0.0274	0.0138	0.0087	0.0388	-0.0014	0.2059	0.0604	0.064	0.059	0.0004	0.0511	1			
Land Collateral	-0.047	0.0171	0.049	0.1073	0.0053	-0.0198	-0.033	0.046	0.0512	0.0347	0.0395	-0.0047	1		
Attend Farmer Group Meetings	-0.0438	0.0348	0.0105	0.0487	0.0115	-0.0128	0.0305	0.014	-0.0132	-0.0007	0.0105	0.0062	0.0879	1	
Region Dummy	0.0867	0.0655	0.0126	-0.0027	-0.0131	-0.0373	-0.0618	-0.001	0.0294	-0.089	-0.0858	-0.0227	0.0689	0.049	1

Figure B-3: Correlation Matrix for the Aggregate Sale Market Participation Probit Model

	Sold to the Market	Quantity Harvested	Expected Price	Household Head Sex	Household Head Age	Education Level Above Primary School	Number in Household	Owns a Radio	Owns a Mobile Phone	Distance from Plot to Road	Owns a Bicycle	Number of Extension Visits	Land Collateral	Attend Farmer Group Meetings	Region Dummy
Sold to the Market	1														
Quantity Harvested	0.205	1													
Expected Price	-0.0706	-0.0676	1												
Household Head Sex	0.1074	0.1067	-0.0453	1											
Household Head Age	-0.1418	0.0291	0.0932	-0.1928	1										
Education Level Above Primary School	0.016	0.0049	-0.0011	0.0768	-0.036	1									
Number in Household	-0.0274	0.1049	0.022	0.2054	0.0237	0.0685	1								
Owns a Radio	0.1027	0.0539	-0.0084	0.2211	-0.1533	0.1047	0.1435	1							
Owns a Mobile Phone	-0.0062	0.0609	0.1009	0.0854	-0.0622	0.1884	0.1969	0.318	1						
Distance from Plot to Road	0.068	0.0402	-0.0252	0.0742	-0.0035	0.0485	0.107	0.034	-0.0042	1					
Owns a Bicycle	0.0701	0.0958	-0.0079	0.2645	-0.0932	0.0755	0.2163	0.328	0.2212	-0.0468	1				
Number of Extension Visits	0.0387	0.0138	0.0087	0.0388	-0.0014	0.2059	0.0604	0.064	0.059	0.0004	0.0511	1			
Land Collateral	-0.0153	0.0171	0.049	0.1073	0.0053	-0.0198	-0.033	0.046	0.0512	0.0347	0.0395	-0.0047	1		
Attend Farmer Group Meetings	-0.0288	0.0348	0.0105	0.0487	0.0115	-0.0128	0.0305	0.014	-0.0132	-0.0007	0.0105	0.0062	0.0879	1	
Region Dummy	0.1296	0.0655	0.0126	-0.0027	-0.0131	-0.0373	-0.0618	-0.001	0.0294	-0.089	-0.0858	-0.0227	0.0689	0.049	1

Appendix C - Maize Production in Tanzania

Figure C-1: Percent Maize Production per Region for the 2004/2005 Tanzanian Crop Year which Determined "Dummy Region" Variable



Source: USDA FAS, accessed on March 30, 2013 (http://www.fas.usda.gov/pecad/highlights/2005/09/tanzania_2005/images/TZ_region_corn_prod_area_yld.htm)