Exploring the Incentive Effects of Food Aid on Crop Production in Zambia

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ABSTRACT

Understanding the effects of food aid on crop production is very valuable especially in Zambia where food aid distribution to rural households has become a common phenomenon in recent years. In many respects, food aid can be considered as an important enabler to food production while at the same time it can potentially act as an impediment to sustainable agricultural growth. Integrating the effects of food aid on small holder productivity in designing agricultural programs can be very helpful and could provide decision makers with the right choices for sustaining agricultural growth in Zambia.

This study analyzed the effects of food aid on the average quantities of maize produced by farmers in a community using two estimation procedures: OLS and quantile regressions. The OLS results show that there is a mean effect of food aid on average household maize production which is negative and significant (holding other observable factors constant). However, the results of the quantile regression show that food aid has distinct impacts at different points of the conditional maize production distribution. This shows for example that communities producing small quantities of maize are affected by food aid differently relative to communities that produce large quantities of maize. The quantile regression results actually show that communities at the lower end of the maize production conditional distribution (and in the region of the mean) tend to have stronger negative effects of food aid. The effect however reduces in magnitude in the extreme upper end of the distribution (at the 90^{th} quantile) even though this effect is not statistically significant.

Both the OLS and quantile regression results provide evidence that food aid distributed to communities does reduce household maize production significantly (at least at many points of the maize production distribution in the case of quantile regression results). These results suggest that it would be appropriate to carefully evaluate continuation of food aid programs in agricultural development as this approach results in an estimated average reduction in maize production of 2,000 Kgs for every 1,000 Kgs of food aid received by a community in the last season.

While the results suggest a negative effect of food aid at the community level, it should be recognized that the available data did not support panel estimation, which would have allowed us to correct for fixed or random productivity effects. We compensated for this data limitation by including province-level dummy variables and a lagged dependent variable. However, panel estimation would still be preferred. Future work could strengthen the implications of the results by using panel data at the household level.

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LIST OF ABBREVIATIONS

AVP	Average Value Product
CSA	Census Supervisory Area
CSO	Central Statistical Office
DMMU	Disaster Management and Mitigation Unit
FANRPAN	Food Agriculture and Natural Resource Policy Analysis Network
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
hh	Household
IFAD	International Fund for Agricultural Development
Kg	Kilogram
MACO	Ministry of Agriculture and Co-operatives
MFC	Marginal Value Factor
MVP	Marginal Value Productivity
OLS	Ordinary Least Squares
PHS	Post Harvest Survey
PPS	Probability Proportion to Size
PSU	Primary Sampling Unit
SADC	Southern African Development Community
SEA	Standard Enumeration Area
VIF	Variance Inflation Factor
WFP	World Food Program

CHAPTER I

INTRODUCTION AND BACKGROUND

1.0 General Problem

Agriculture is an important sector of the Zambian economy. Increased production of major crops such as maize, sorghum and wheat contributes positively to the Gross Domestic Product (GDP) of the country. The steady and sustained development of agriculture is crucial for the continued development of the Zambian economy.

Agricultural production in Zambia has been notoriously volatile over the years, hindering economic development of this sector. More often than not, years of surplus production have been followed by very difficult years of food deficits. In these deficit years, the Zambian government is faced with the problem of alleviating hunger in the affected agricultural areas by ensuring that there is food security at the household level (especially for rural households that are subsistence farmers). The government also has an imperative to ensure that there will be sufficient crop production in the years following a deficit year. Thus, the way government handles the deficit years has potential impacts on production in subsequent years. This double-edged problem of providing food security and sustaining agricultural production through deficit years has posed complex challenges for the Zambian government. Figure 1.1 provides a graphical summary of the pattern of output in the Zambian agricultural sector and reveals the persistent volatility of agricultural production in the country. Maize is used to illustrate the volatility of agricultural production because it is the major food crop grown in Zambia.

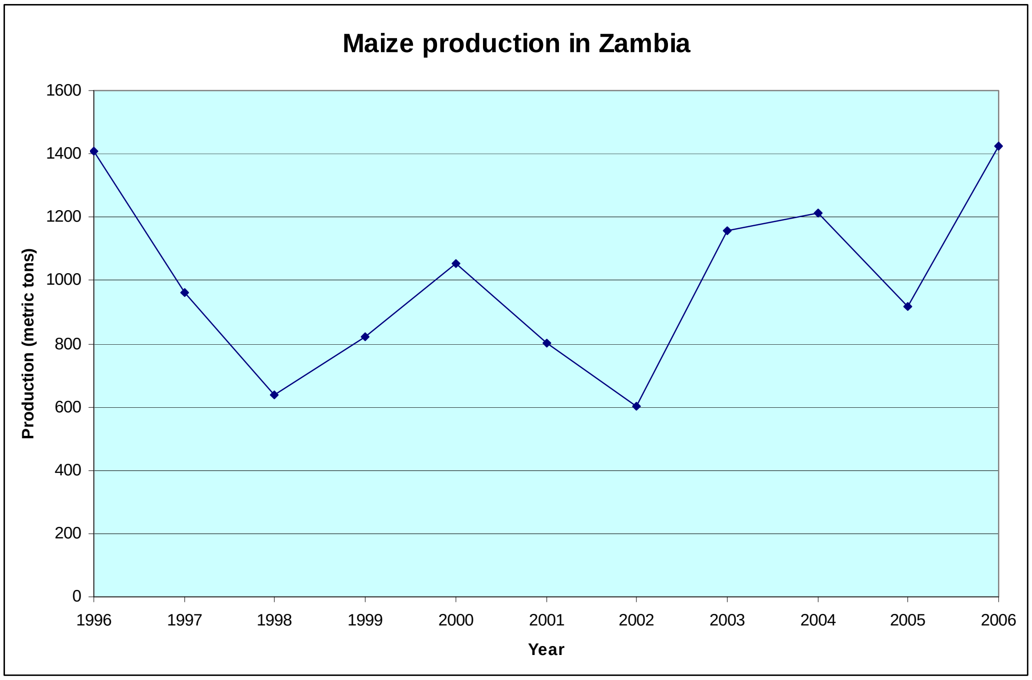

Figure 1.1: Maize production in Zambia, 1996-2006[1]

1.1 Specific Problem

During food deficit years when domestic/local agricultural production cannot meet the consumption needs of rural Zambian households, the government typically provides food aid to these affected rural households. In this case, the government of Zambia identifies and prioritizes "deserving rural households" as recipients of food relief. A government department, the Disaster Management and Mitigation Unit (DMMU), carries out a "food needs assessment" to identify rural households, most of which are farmers/farm families, to receive food aid. The Government believes that this will help alleviate the hunger problem in the affected areas and at the same time encourage these rural households to improve and sustain their agricultural production in the coming

[1] Source: National Early Warning Unit, Ministry of Agriculture and Co-operatives

cropping season. Further, the Government believes that if a community's normal means of accessing and acquiring food has been compromised by a disaster or calamity, a food aid response may be required to sustain life and protect or restore people's self reliance. This will reduce the need for the affected communities to adopt potentially damaging coping strategies such as sale of land, farming equipment, animals, and other productive assets. This line of thought emphasizes food aid's role in increasing poor households' access to and consumption of food in the face of exogenous climatic shocks, thereby improving the human nutritional status, health, labor productivity and income earning capacity relative to what would result in the absence of food aid (Abdulai, Barrett and Hazell, 2004).

However, there is a different school of thought that food aid provided by the government does not encourage rural farm families to improve agricultural production in the following year or even in the medium to long term. The critics of food aid argue that farmers actually reduce their crop production and productivity since they know that the government will provide them with food relief in the event of a deficit year. In the view of these critics, food aid reduces incentives for producers to give attention to their agricultural production enterprise. Farmers may not even attend important farming activities such as training offered by agricultural officers at the time when food aid is being distributed by other organizations. Moreover, even at the household level, one often hears informal claims that this distortion of incentives induces 'dependency' on food aid by reducing labor supply, discouraging investment in agricultural production and crowding out private transfers and other means of informal responses to shocks (Abdulai, Barrett and Hoddinott, 2004). Hence, in this view, food relief acts as a form of insurance for subsistence farmers, which eventually causes the moral hazard problem of reduced attention and effort in farming activities.

This latter argument has stimulated vigorous debate as to whether the government should continue to provide subsistence farmers with food relief during times of low agricultural production. As explained above, many people in Zambia hold the view that food relief or food aid is counterproductive in many respects. However, there is no study in Zambia that has rigorously examined this problem and, therefore, the research reported in this thesis contributes to the literature in this regard. Insights from this research will provide important agricultural and economic policy guidance for the government of Zambia.

1.2 Main Objective

This study examines whether or not government-provided food aid given to subsistence farmers in food deficit years has an impact on crop production in the following year.

1.3 Specific Objectives

More specifically, this study investigates the incentive effects of food aid on the quantity of maize produced by Zambian farmers by:

1) Estimating the mean impact of food aid on household maize production in a community.

2) Examining the effect of food aid for producers with differing levels of production in a community.

1.4 Food Aid Distribution Mechanism

To understand the food aid mechanisms in Zambia, it is useful to provide a description of the agricultural season in the country. The agricultural season in Zambia spans from the beginning of October of one year to the end of September the following year. Land preparation and planting activities for crop production usually take place from September through January. Harvesting of major crops such as maize, sorghum and millet normally takes place from the end of March through May.

When sufficient evidence is established about the need for a community to receive food aid, the food is then distributed according to established eligibility criteria. The need for food aid is judged to arise from occurrence of a verified event (such as a drought or flood) that is expected to outstrip the coping capacity of the local community.

Compared to the agricultural season, food aid activities and distribution in Zambia can be summarized as illustrated in Figure 1.2 below.

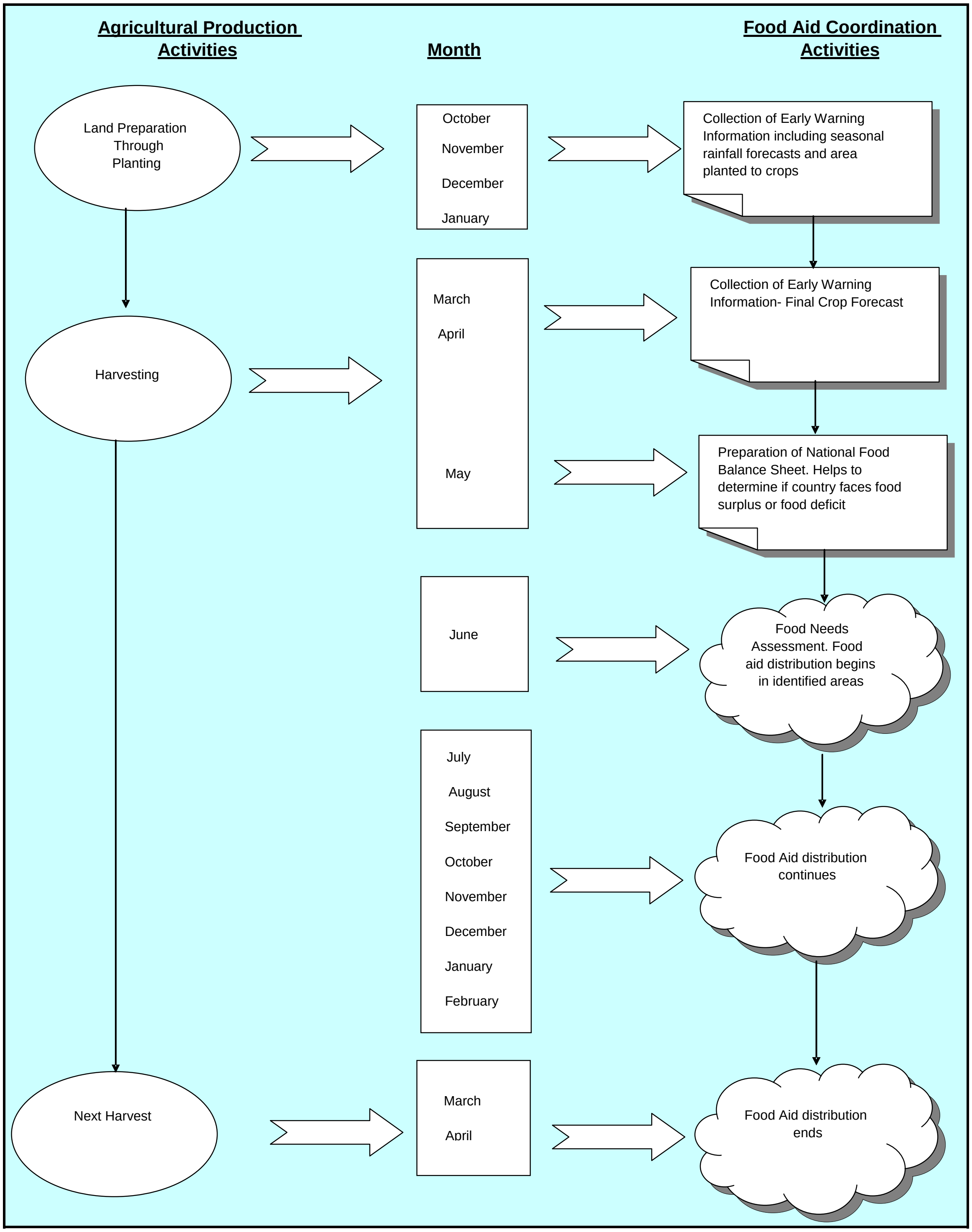

Figure 1.2 Food aid activities in Zambia.

Depending largely on information arising from crop production estimates and the comprehensive needs assessment (which is carried out by the DDMM in conjunction with other stakeholders including the non-Governmental Organizations, the United Nations organizations and other Government departments), the Government will initiate a number of response activities including the distribution of food aid. The decision to distribute food aid is made by DMMU in close consultation with the collaborating partners. The Food aid distribution may carry through until the next harvest depending on the extent of the estimated crop loss. Compared to the growing season, distribution of food aid begins around June of the same season after the expected production for the season is judged to be insufficient to sustain the recipient household's food needs and continues until the next harvest. Food aid is typically timed to arrive just before the household has exhausted the food supply from its own production. In this case, the distribution of food aid begins when the majority of the households in the community are considered to be near the point of exhausting food available from their own production. This may be immediately after harvest or anytime thereafter up to the next harvest depending on the extent of the production deficit.

1.5 Frequency of Food Aid Distribution

Food aid distributions to communities are becoming common phenomena in Zambia. The southern part of Zambia, for instance, has experienced severe weather conditions (e.g. floods and droughts) since 2002 and most households in these areas have received food aid each year since then. For such areas, there is essentially an expectation of food aid built in the frequency of distribution (which is annually) and as a result ex-ante effects of food aid may begin to set in.

1.6 The Lag Effect of Food Aid.

Because food aid is distributed within the same season after a low harvest of a food crop (as illustrated in figure 1. 2 above), there is obviously some potential for a lagged effect of food aid on crop production in Zambia. This means that the impact of food aid on variables such as fertilizer application, area planted and quantity harvested will begin to take effect the following season.

CHAPTER II

LITERATURE REVIEW

2.0 Background

Widespread hunger in any country is an impediment to overall growth and poverty alleviation efforts. Mobilizing and carefully deploying resources where the impact can be greatest is fundamental to the effort of reducing poverty, hunger and food insecurity. A successful strategy for alleviating poverty and hunger in developing countries must begin by recognizing that these are mainly rural phenomena and that agriculture is at the heart of the livelihoods of rural people (IFAD/FAO/WFP, 2002).

When food availability from local production and commercial imports is insufficient – as most commonly occurs in acute emergencies – food aid fills a crucial gap, thereby contributing to economic development and the protection of basic human rights. But if used inappropriately or managed poorly, food aid can undermine agricultural production, market development and international trade, thus impeding economic development (Barrett and Maxwell, 2004). Often, however, rural development policies and programs are a hasty response to crisis and political exigency. For instance, when drought occurs, the distribution of food aid is a rapid and routine policy reaction (Adams, Cekan and Sauerborn, 1998). It is important however that Government and donor disaster relief programs (i.e. programs that aim to protect vulnerable groups' access to food during transitory crises) are combined with strategies that aim to address the chronic causes of poverty (Jayne et al. 1994). When communities are faced with distressful shocks such as floods and droughts, the most essential principal (in the short run) is to support and not to undermine agricultural production (McPeak and Barrett, 2001).

Because food aid may be helpful in some circumstances and counterproductive in others, it is controversial (Barrett and Maxwell, 2004). Even though there is an appreciation for this contention, little is known about how policy shocks (such as food aid) affect African smallholders' livelihoods. This issue merits further investigation (Barrett, Bezuneh, and Aboud, 2001).

2.1 Food Aid Studies in sub-Saharan Africa

While there is some prior literature on the impact of food aid on recipient countries, especially for sub-Saharan countries as a whole, limited research has been conducted that provides a comprehensive, country-specific examination of food aid incidence and the consequences of such aid. There is some degree of consensus in the literature as to the desirability of reducing acute and chronic food insecurity in sub-Saharan countries through the delivery of food aid. However, there remains considerable dispute as to how effective food aid is in achieving this goal. Much of the concern arises because the ultimate impacts of food aid programs – like any other policy intervention – are not always as intended (Barrett 2006).

Using household-level data from Ethiopia to examine the impact of food aid on key household behaviors (such as labor supply, on-farm investment and mutual aid), Abdulai, Barrett and Hoddinott (2005) concluded that food aid has no disincentive effect on food production in sub-Saharan Africa, which includes Zambia. They assert that

Ethiopia is Africa's leading food aid recipient and, as such, offers a good place to study the potential disincentive effects of food aid at the household level. Abdulai, Barett, and Hazell (2004) also provide an analysis of the relationship between food aid and food production in sub-Saharan Africa. Their results reveal that, on average, food aid exerts a positive impact on food production. They conclude that food aid does not appear to depress food production.

Barrett, Bezuneh, and Aboud, (2001) use both longitudinal data related to macro policy shocks, such as the devaluation of the currency in Côte d'Ivoire, and cross-sectional data related to local policy shocks, such as the distribution of food aid to farmers in the Baringo District, Kenya, to draw inferences about the effects on smallholder diversification patterns. They find that, in the case of Kenya, policy changes tend to expand poorer households' opportunities to undertake more successful livelihood strategies while policy reforms in the Ivorian experience show that rural households tend not to be able to take advantage of emerging opportunities, especially in skilled non-farm activities.

Jayne and Molla (1995), review available evidence on the potential to promote access to food for vulnerable groups in Ethiopia through two main methods: (a) food transfer programs, and (b) policies designed to influence the food marketing system. They provide preliminary evidence of possible disincentive effects of food aid on agricultural production. They conclude that, in Ethiopia, strategies to promote rural productivity and income growth have been overshadowed by emergency and public-work food aid programs. By default, these food aid-driven programs have become the major forms of development assistance to rural households, but the long-run consequences of these programs on food production growth and the development of food markets are not fully understood.

In response to the threat of a Southern Africa Development Community (SADC) regional food security crisis, which began to emerge in early-2002, the Food Agriculture and Natural Resource Policy Analysis Network (FANRPAN) initiated a study to explore the policy and economic dimensions of food emergency response (i.e. food aid). As a consequence, Mano, Isaacson and Dardel (2003) identified policy determinants of food security response and recovery in the affected countries. They found that in countries that were hardest hit with the food security crisis (Malawi, Zambia, Zimbabwe), the level of preparedness was low: no contingency plans were in place, strategic grain reserves were low or exhausted and financial resources were inadequate to import the required food. One of the recommendations they made is that countries prone to recurrent drought or flooding should develop practical contingency plans to respond to different levels of production shortfalls. These plans should be prepared well in advance of an emergency and should be modified and updated as new information becomes available. In addition, they recommended that these countries should review their own responses that facilitated and supported efforts to avert food security crisis.

2.2 Food Aid Studies in Zambia

Note that most of the conclusions that the aforementioned studies draw are being generalized for a group of countries in the sub-Sahara region. However, conditions for agricultural production and productivity in each sub-Saharan country are very distinct.

This is one reason why country-specific studies are needed and why food aid studies for Zambia (in particular) need to be reviewed.

Literature on food aid for Zambia is limited. According to some accounts (Devereux, 2000), Zambia may have started to develop dependence on food aid in the 1990's. Ninno, Dorosh and Subbarao (2005) reveal that Zambia suffered three major droughts: in 1991-92, 1994-95 and 2001-02. These droughts severely affected farmers, who lost crops and livestock, and consumers, who faced sharply higher prices. In an effort to protect food security during these droughts, the Zambian government increased food supplies through a combination of government commercial imports, food aid, private sector imports, and a ban on exports. Food and cash transfer programs have been implemented as well, in an effort to increase access to food by food deficient households.

Chiwele and Sikananu (2004) conducted a study to explore Zambia's food aid dependency and its impact on food security and agricultural development. They argue that food aid seems to be perpetuating the situation of maize dependency (given that it is mainly maize that is distributed as food relief), even in areas where other crops such as cassava are emerging strongly as staple food crops. They also point out that in communities where food relief is consistently provided, a dependency syndrome has been observed to occur. They acknowledge that there are no quantitative studies to show this is the case but indicate that frontline development agents express concern that this is becoming a common pattern.

In a study that analyzed the impediments to agricultural growth in Zambia, Wichern, Hausner and Chiwele (1999) also observed that food aid has a negative effect on agricultural production because it decreases consumer prices and reduces the producer profit margin.

The IDL Group (2002) made an assessment of trends in the Zambian agriculture sector and observed that many of the global issues facing developing countries also apply to the Zambian agricultural sector. They recommended that specific data analyses to assess the role of food aid and its potential negative (i.e. “incentive depressing”) effects, as well as positive effects, on agricultural productivity should be undertaken. To date, no such study has been conducted. The present study, therefore, seeks to fill a void in this area by exploring the incentive effects of food aid and its implications for the development of Zambian agriculture.

CHAPTER III

CONCEPTUAL FRAMEWORK

While food aid today is widely considered an instrument for addressing acute and chronic food insecurity in low-income communities, it may result in undesirable dependency by reducing incentives for individuals, households or communities to undertake desirable behavior (e.g., to grow a crop or to allocate time to work), (Barret 2006).

For the rural population in Zambia, the underlying problem has been difficulties in attaining sustainable food sufficiency from their own production due to a number of problems including variations in rainfall patterns and inability to access inputs for increased production (Chiwele and Sikananu 2004).

It is assumed that farmers are rational and allocate their resources such as inputs and labor in a manner that will achieve higher returns for their efforts. However, distributing food aid to farming households may alter their behavior towards food production while expectations of assistance may induce increased risk taking, such as reduced time for land preparation, weeding, etc, resulting in moral hazard that may increase the frequency and severity of adverse shocks (Barret 2006). Key variables that may be affected by continued provision of food aid include household labor and inputs such as fertilizers and seed. This can result in reduced production output for the farmers.

In terms of labor supply, food aid may unintentionally discourage people from effectively working on their tracts of land. As a result, food aid transfers would increase the recipients' welfare and generate income effects that would tend to reduce their labor supply for food production. Food aid-based programs may also siphon productive labor supply away from local private production, creating a distortion due to substitution effects, rather than the income effects as in the case of food-for-work programs.

Moral hazard may also occur at the collective level as households and communities alter their behavior in the presence of external assistance. These households and communities can stop or reduce their productive activities (such as purchasing of fertilizers, seed or pesticides) in anticipation of food aid endowments.

Food aid flows can have two classes of effects: Ex ante effects that occur before the flow and the ex post effects after it. Both can change incentives, alter behavior and trigger negative dependency (Barrett 2006). This study focuses on the ex post effects of food aid.

3.0 Potential Effects of Food aid on the Price and Quantity of Maize Supplied

Figure 3.1 summarizes the potential effects of food aid on the price and quantity supplied for the local market. When food aid is introduced on the local market, the additional food supply pushes the supply curve to the right (i.e. from the curve labeled S_1 to the one labeled S_2). This new level of supply will cause the market clearing price to fall from the initial price P_1 to a lower price P_2. The outcome of this shift in supply is an increase in the quantity of locally available food from Q_1 to Q_2. It is clear from figure 2 that the total quantity of the food crop (i.e. adding local supply and food aid) is at point Q_2 while the locally produced quantity is at Q_3. The deference between the quantities Q_3 and Q_1 is the amount by which food aid reduces the quantity supplied from local production.

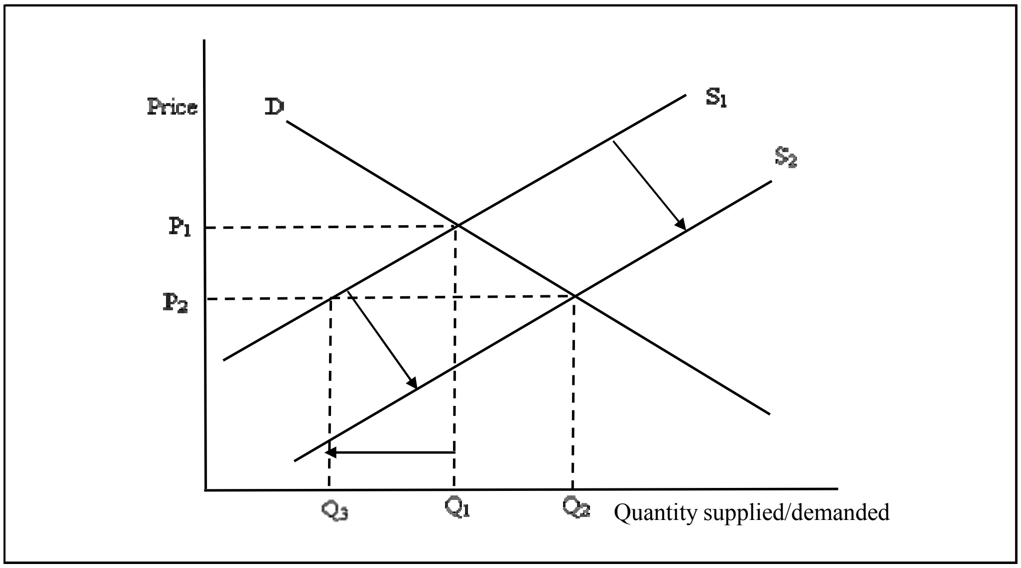

Figure 3.1 Potential effects of food aid on the price and quantity supplied for the local market

Although the total supply has increased from Q_1 to Q_2 due to food aid, only the quantity at Q_3 is available for sale on the local market. This means that the locally produced crop will be sold at a lower price P_2 instead of the price P_1, which is the price that would obtain without the food aid. These combined effects may lead to households reducing their farming activities. They may reduce input application and may generally reduce the investment portfolios on their farm. This will consequently lead to reduced household crop production, an undesirable effect of food aid.

3.1 Potential Effect of Food Aid on the Quantity of Input Use

Figure 3.2 below summarizes the potential effect of food aid on the quantity of an input, say fertilizer, a farmer will apply to his/her crop. A rational farmer, who wishes to maximize profit, will apply the quantity of input at a point where the marginal factor cost (MFC) is equal to the marginal value productivity (MVP). Food aid has the potential, as shown in figure 3.1, to cause the price of the output to fall. If this occurs, food aid will reduce the marginal value product for the produce since the additional dollars a farmer receives from the additional output that he sells will decrease. At the same level of input price (say of fertilizer) or what is known as the marginal factor cost, the farmer will apply the input at a lower level (X_2) than at a level (X_1) when there is no food aid.

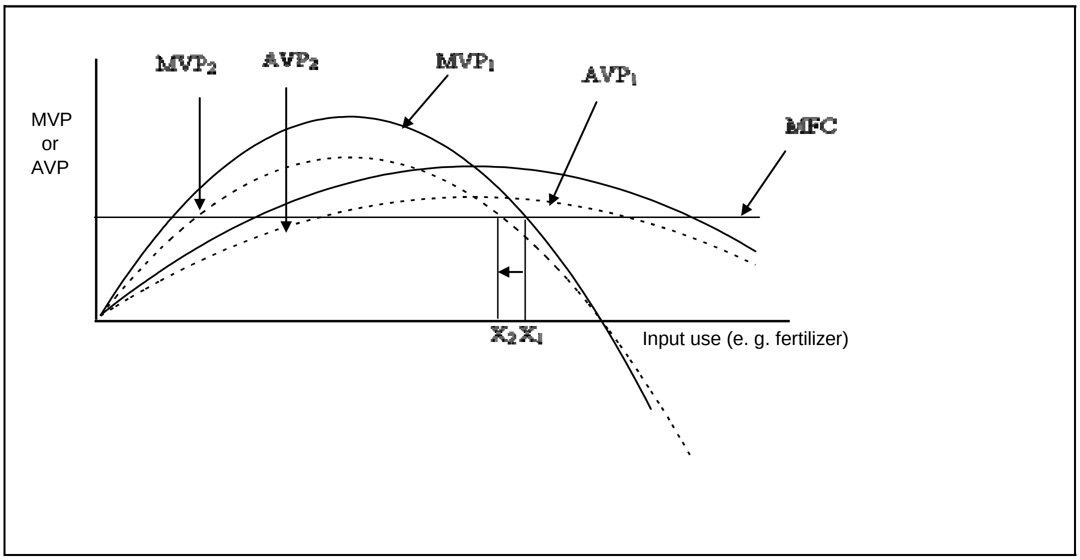

Figure 3.2 Potential effect of food aid on the quantity of an input, say fertilizer, a farmer will apply to his/her crop

CHAPTER IV

METHODS AND PROCEDURES

The purpose of this study is to investigate the effects of food aid on maize production in Zambia. The process for achieving this research objective involved obtaining appropriate data, selecting an approach for assessing the impact of food aid, and using the data to estimate the impact of food aid intervention on agricultural production in Zambia. This chapter begins with a description of the data and how it was obtained. This is followed by a section describing the variables used in the analysis. The chapter ends with the presentation and a discussion of the specified models and the estimation procedures.

4.0 Data Description

This research made use of the Post Harvest Survey (PHS) data sets for 2002/2003 and 2003/2004 to empirically test and measure the relationship that may exist between food aid in one production season and maize production in the following season. The PHS collects nationally representative household-level data and is conducted annually by the Central Statistical Office (CSO) in conjunction with the Ministry of Agriculture and Cooperatives (MACO) in Zambia. This survey is one of the most important sources of data in Zambia for the annual production of crops and livestock, as well as, socio-economic characteristics of agricultural households. In addition, it collects information on food aid in some years.

To select a household for inclusion in the PHS, CSO uses a three-stage sampling scheme based on the area-sampling frame as per the 1990 Census of Population, Housing and Agriculture. At the first stage, the Census Supervisory Areas (CSAs) are sampled from each district using the probability proportion to size (PPS). From each selected CSA, one SEA is sampled, again using PPS selection procedure. Each sampled SEA has a list of households from which farming holdings are selected. Finally, the selection of a household is done using a linear systematic sampling procedure. There are about 150-200 households in a SEA. The number of households located within each SEA determines the size of the SEAs. The selection of farming holdings takes consideration of the categories of farmers based on land area and livestock. For example, a household cultivating less than two hectares of land is in a different category from a household that is cultivating two hectares and above but less than twenty hectares. Those cultivating above twenty hectares are in another category and usually will not be part of the survey as they are considered large scale. The number of livestock owned by the households also determines the category to which a farmer is assigned. For detailed sampling procedures of the PHS, see Megill, 2004.

Figure 4.1 below is a diagrammatic presentation of the PHS sampling scheme, adapted from Donovan, 2007.

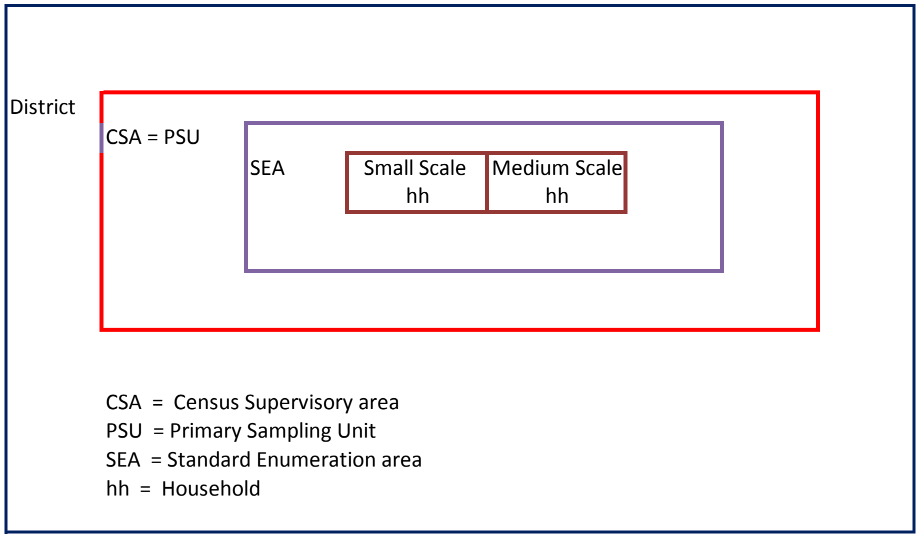

Figure 4.1 Post Harvest Survey sampling scheme

As earlier indicated, the data for the study is based on the cross sectional PHS data for the two agricultural seasons of 2002/2003 and 2003/2004, with both data sets providing the relevant variables that were used in this study. Because food aid can potentially have a lagged effect on crop production, the variable on food aid was obtained from the 2002/2003 PHS dataset. Maize and cassava stocks that a household held were also introduced in the model as lagged variables from the 2002/2003 dataset because they were stocks held from the preceding season. The rest of the variables came from the 2003/04 PHS.

A total of 7,851 households in 402 communities or SEAs were interviewed in the 2002/2003 agricultural season while 8,098 households in 408 SEAs were canvassed in 2003/2004. Table 4.1 below shows the distribution of SEAs between provinces.

Table 4.1 Number of households interviewed by SEA and province

	PHS 2002/2003		PHS 2003/2004	
Province	Number of households interviewed	Number of SEAs	Number of households interviewed	Number of SEAs
Central	802	42	835	42
Copperbelt	638	32	638	32
Eastern	1,437	72	1,437	72
Luapula	813	43	876	44
Lusaka	513	26	515	26
Northern	1,382	71	1,391	71
Northwestern	600	31	631	32
Southern	908	46	918	46
Western	758	39	857	43
Total	7,851	402	8,098	408

The use of the Post Harvest Survey data was preferred to other sources because it has the advantage that it is large and is nationally representative and has been collected annually for several years such that the survey procedures are well developed. It also has a wide range of variables to choose from. The other advantage of PHS is that it greatly minimizes the selection bias of the food aid recipients. As earlier indicated, the PHS selects households randomly such that a household that reported receiving food aid gets included in the sample only by chance and not by some other influence of say a government official. The main disadvantage is that the survey was not designed to meet the specific data needs of this study. As a consequence, information on food aid, a key variable for analysis, is only available in some years. A further limitation for the PHS is that it does not collect panel data but rather collects a set of repeated cross-sections over the years. This means that the households interviewed in one year are not the same in the following year.

For our analysis therefore, data were aggregated up from the household level to the Standard Enumeration Area (SEA) level so as to create a panel dataset at the SEA-level. A Standard Enumeration Area is the smallest geographical unit used by the Central Statistical Office of Zambia. SEA-level data can be viewed as equivalent to community level data. The aggregation of household-level data to community or SEA-level data resulted in the following:

- Categorical (dummy) variables at the household level became proportions at the SEA-level.
- Quantity variables at the household level became SEA averages.

The aggregation also meant that the number of observations was effectively reduced from over seven thousand households per year to just over 400 SEAs or communities.

4.1 Model Specification and Definition of Variables

4.1.1 Model Specification

To achieve the objective of this study, we specify a model where production level is a function of lagged food aid and other control variables that can systematically affect production:

$$y_t = \alpha_t + \beta F_{t-1} + \rho_1 X_{t-1} + \rho_2 X_t + \delta \mathrm{P}_t + \varepsilon_t \qquad (1)$$

where y_t is maize production at time t, F_{t-1} is Lagged Food Aid, X_{t-1} is a vector of lagged community (or SEA-level) characteristics (e.g. lagged maize produced, cassava and maize stocks), X_t represents a vector of current community (or SEA-level) characteristics, P_t represents a vector of provincial dummies and ε_t is the error term. The coefficients α, β, ρ_1, ρ_2 and δ are the parameters or conformable vectors of parameters to be estimated. Note that the current community or (SEA-level) characteristics used in this study can be grouped into four categories; (1) demographic variables (e.g. average age, average household size and proportion of female head of households), (2) variables that serve to indicate the level of farming diversification in the area (e.g. proportion of farmers producing livestock), (3) variables that reflect a community's fertilizer source (e.g. proportion of households using cash to purchase fertilizers, proportion of households acquiring fertilizer through a government loan), and (4) weather variables (e.g. rainfall levels). More detailed descriptions of these variables, reasons for including them in the specification, and a priori expectations about their effects on maize production are discussed below.

4.1.2 Dependent Variable

The dependent variable is the average quantity of maize harvested by households in a SEA during the 2003/2004 agricultural season.

4.1.3 Independent Variables

To estimate the impact of the food aid program on maize production in the following year, independent variables that were used are categorized into two types: (1) Continuous independent variables which include SEA or community level characteristics;

and (2) Dummy independent variables, representing the shifters in the model that would account for the outcome differentials between provinces.

The SEA or community level independent variables that were used in the analysis are defined in table 4.2. Here we will briefly explain the expected effect of these independent variables on average household maize production.

As the earlier discussion suggests, the expected effect of lagged food aid is ambiguous. Receiving food aid in the prior year potentially avoids disinvestment in important productive assets and enhances the wellbeing of the members of the household. This could improve productive capacity in the current year. However, expectations of food aid may decrease incentives to produce. Thus the expected effect is ambiguous.

There may also be an ambiguous relationship between the lagged maize produced in a community and the current year maize production. A failed agricultural system in a community (which results in lower quantities of lagged maize production) may consequently result in reduced maize output for the current year and hence having a negative effect. On the other hand, a consistently improving agriculture system in a community (which results in larger quantities of lagged maize production) may have a positive effect leading to an increase in community maize output for the current year. The expected effect of this variable is therefore ambiguous. It should be noted that a primary motivation for inclusion of this variable in the model was to attempt to compensate for data limitations which permitted only cross sectional estimation. If panel data had been available, it would have allowed us to control for the individual productivity effects of each SEA. Though less desirable than panel estimation, inclusion of lagged maize production in our cross sectional model should at least in part account for differences in productivity among SEAs.

Ambiguities also potentially arise in the case of age. We might expect that a SEA or community which on average has a higher proportion of older heads of households would produce more maize since each additional year of experience gained by the head of the household may lead to increased average household maize production. At the same time younger heads of households in a community are likely to be healthier and more energetic, increasing their productive capacity. Thus, the expected effect of age on average household maize production is ambiguous.

A high proportion of female headed households in a SEA is expected to reduce the average household productive capacity because typically such household are likely to be less endowed with the necessary productive assets.

We would expect an increase in the average rainfall in the SEA to have a positive effect on the average household maize produced since rainfall is often a crucial determinant of maize production.

It is quite possible that there might be a relationship between the lagged maize stock held by a community and the average household maize output. Large quantities of lagged maize stocks in a community may reduce the need for the household to produce more in the current agricultural season. However, large stocks may also be an indicator of high productive capability of the households meaning that such households may increase the current year maize production. The expected effect of the lagged maize stock could therefore be ambiguous.

Because cassava is often consumed as an alternative to maize in some communities, we might expect that a SEA which typically has higher quantities of lagged cassava stocks during an agriculture season will be associated with reduced average household maize production. This is because households in such a community may consider themselves to be food-secure and may therefore reduce their maize output in the current year.

The average size of the household in a community is an important determinant of human capital available to the household. Increased household size may be an indication of increased labor availability for agricultural production. We would therefore expect communities with larger average household size to increase average household maize output compared to communities with smaller average household size.

The proportion of households raising livestock, along with the proportion of households raising poultry and the proportion of households practicing fish farming in a community are all expected to have a positive relationship with the average household maize production. Raising of livestock, raising of poultry and fish farming are agricultural activities which are typically practiced by relatively well to do families. Wealth arising from these sources could positively affect average household maize production for most communities. The income gained from the sale of fish, livestock and poultry may be used to invest in maize production and increase output.

In a setting where households in a community acquire fertilizer from different sources, acquiring fertilizer from any of the sources may imply that a household has some access to fertilizer. We might therefore expect the impact of the proportion of households that acquired fertilizer through commercial cash purchases in a community, the proportion of households that acquired fertilizer through a government loan program in a community, the proportion of households that acquired fertilizer through a government cash program in a community, the proportion of households that acquired fertilizer through a direct cash exchange in a community, and the proportion of households that acquired fertilizer through other free sources in a community to display similar (and positive) relationships with maize production.

Dummy dependent variables were also included in the models to account for province-level productivity effects. If panel data had been available, either fixed or random individual SEA effects would have been incorporated into the models. In the absence of panel data, province level effects were included to account for productivity differences at the more aggregate province level.

Table 4.2 Variable Definition

Variable Name	Variable Definition
Dependent variable	
Maize Production	Average quantity of maize produced in Kgs per household in a SEA
Continuous independent variables	
Lagged Food Aid	Average quantity of lagged food aid per household in a SEA
Lagged Production	Average quantity of lagged maize produced in a SEA
Age	Average age of head of household in a SEA
Proportion Female	Proportion of female headed households in a SEA
Rainfall	Average rainfall in a SEA
Maize Stocks	Average quantity of lagged maize stocks per household in a SEA
Cassava Stocks	Average quantity of lagged cassava stocks per household in a SEA
Household Size	Average household size in a SEA
Proportion Livestock	Proportion of households raising livestock in a SEA
Proportion Poultry	Proportion of households raising poultry in a SEA
Proportion Fish	Proportion of households practicing fish farming in a SEA
Cash Fertilizer	Proportion of households t acquired fertilizer through commercial cash purchases in a SEA
Loan Fertilizer	Proportion of households that acquired fertilizer through a government loan program in a SEA
Government Fertilizer	Proportion of households that acquired fertilizer through a government cash program in a SEA
Exchange Fertilizer	Proportion of households that acquired fertilizer through a direct cash exchange in a SEA
Free Fertilizer	Proportion of households that acquired fertilizer through other free sources in a SEA
Dummy independent variables	
Central	1 if community is in Central province; 0 otherwise
Copperbelt	1 if community is in Copperbelt province; 0 otherwise
Eastern	1 if community is in Eastern province; 0 otherwise
Luapula	1 if community is in Luapula province; 0 otherwise
Lusaka	1 if community is in Lusaka province; 0 otherwise
Northern	1 if community is in Northern province; 0 otherwise
Nwestern	1 if community is in North Western province; 0 otherwise
Western	1 if community is in Western province; 0 otherwise
Sea	1 if a community is rural; 0 otherwise

4.2 Estimation Methods

An approach for estimating the effect of food aid on farmers' crop production was done in two stages. First, parameters in (1) are estimated using the ordinarily least squares (OLS) regression method. Second, quantile regression techniques are used to estimate the effect of food aid at different points of the conditional output distribution. The STATA software was used to estimate the model parameters in both cases.

4.2.1 Ordinary Least Squares (OLS) Regression

As a first step of analysis, ordinary least squares (OLS) estimation is used. The OLS is a procedure that allows one to examine the mean effect of one independent variable on the outcome variable while controlling for other factors. Our main interest in this study is to estimate the effect (if any) of lagged food aid on the average household quantity of maize produced in a community or SEA. The idea is to explore whether the average household quantities of maize produced systematically vary from one community to another depending upon the amount of food aid received in the previous year. We know that other factors besides lagged food aid (such as the proportion of female headed households in a community, etc) could also have an influence on the average household quantity of maize produced by farmers in a SEA.

The ordinary least squares estimation method (which minimizes the sum of the squared residuals) has some attractive properties that have made it one of the most powerful and popular methods of regression analysis (Gujarati 1988). However, we also recognize that it is important to undertake basic OLS model diagnostics – like testing for heteroskedasticity and multicollinearity – to assure that we have valid inferences. In this study, a test for heteroskedasticity is performed using the Breusch-Pagan/Godfrey test. Heteroskedasticity-robust standard errors are used to address heteroskedasticity in the model (if present).When some of the regressors are highly correlated, the estimated parameters will have large standard errors, reflecting low precision or accuracy in their estimation. This effect is known as multicollinearity and its presence or absence is checked using a variance inflation factor (VIF) or tolerance measures.

We also tested for overall model specification i.e. whether the model is properly specified. An incorrectly specified model can result in biased parameter estimates. Testing for overall significance of the regression was done using F-tests and utilizing R-squared measures of fit. These test results are presented in the following chapter.

4.2.2 Quantile Regression Estimation

Quantile regression allows for the estimation of the impact of an independent variable at different points of the dependent variable conditional distribution while controlling for other factors. In her study, Rangvid (2003) itemized some important features of quantile regression. First, the quantile regression estimator gives less weight to outlier data points on the dependent variable than OLS, which weakens the influence of such data points on the results. Second, by allowing the parameter estimates for the marginal effects of the explanatory variables to differ across the quantiles of the dependent variable, robustness to potential heteroskedasticity is achieved. Third, when the error terms are non-normal, quantile regression estimators may be more efficient than least squares estimators. Hence, when the conditional distribution of the outcome variable departs from normality the OLS method may not provide accurate inferences about the impact of food aid on household maize production. The main advantage of quantile regression according to Rangvid (2003) is the semi-parametric nature of the approach, which relaxes the restrictions on the parameters to be constant across the entire distribution of the dependent variables. In this study quantile regression allowed us to estimate the impact of lagged food aid at different points of the maize production conditional distribution.

For the θth quantile (see Buchinsky, 1998), the basic quantile regression model is specified as follows:

$$y_i = x_i'\beta_\theta + u_{\theta i}, \quad Quant\theta(y_i|x_i) = x_i'\beta_\theta \qquad \theta \in (0, 1) \tag{2}$$

Where $Quant\theta(y_i|x_i)$ denotes the quantile of y_i, conditional on the regressor vector x_i. The θth regression quantile ($0 < \theta < 1$) of y is the solution to the minimization of the sum of absolute deviations of residuals:

$$\min_\beta \frac{1}{n}\left\{ \sum_{i:y_i \geq x_i'\beta} \theta|y_i - x_i'\beta| + \sum_{i:y_i < x_i'\beta} (1-\theta)|y_i - x_i'\beta| \right\}$$

$$= \min_\beta \frac{1}{n} \sum_{i=1}^{n} \rho_\theta(u_{\theta i}), \tag{3}$$

where $\rho_\theta(.)$ is called the "check function" and can be defined as:

$$\rho_\theta(u_{\theta i}) = \begin{Bmatrix} u_{\theta i} & if \quad u_{\theta i} \geq 0 \\ (\theta - 1)_{u_{\theta i}} & if \quad u_{\theta i} < 0 \end{Bmatrix}. \tag{4}$$

The variation in the value of θ traces the entire conditional distribution of maize production and one can estimate the food aid effect on maize production at any given percentile. Changing the θ from zero to one relaxes the assumption made in least squares regression where parameter estimates are assumed to be the same at all points of the conditional outcome distribution (Yasar, Nelson and Rejesus, 2006).

In this study, we used the simultaneous equation quantile regression technique to estimate the parameters at different quantiles (θ = 0.1, 0.25, 0.5, 0.75, 0.9). In this approach, we use bootstrapped standard errors to take into account the correlation of the errors across quantiles. In a quantile-by-quantile estimation approach (rather than simultaneous equation approach) bootstrapping is not done. We also examine whether the food aid effect varies significantly across the conditional maize production distribution by testing for the equality of the food aid effect across the quantiles. This is done by estimating the variance co-variance matrix. For this test, the null hypothesis is that the j^{th} coefficient at θ_w quantile is statistically the same as the one in the θ_z quantile. The alternative hypothesis is that the coefficients are not equal across the different quantiles of the conditional maize production distribution examined.

CHAPTER V

RESULTS

The purpose of this study is to test whether any measurable effect on maize production exists in Zambia as a result of distributing food aid to farmers and if so to estimate the magnitude of that effect. We have postulated that if the influence of other factors is kept constant (e.g. average household size in a community, etc), food aid distributed to farmers in the preceding season may have some lagged negative effect on maize production for the following year.

This chapter presents our results, providing an estimate of the effect of food aid on average household maize production in defined communities or regions (i.e. a measure of how much maize production goes up or down as a result of changes in the quantity of lagged food aid received in a community). The results are presented in three sections. The first section presents the summary statistics of the variables incorporated in the models. The second section presents the ordinary least squares (OLS) regression results, while the last section discusses quantile regression results in comparison with the OLS results.

5.0 Summary Statistics

The results in Table 5.1 show the summary statistics for the dependent and independent variables used in the study.

Table 5.1 Summary Statistics

Variable	No. of Obs	Minimum	Maximum	Mean	Std. Deviation
Maize Production	396	57.50	5892.41	1057.12	757.16
Lagged Food Aid	395	0.00	523.05	31.25	49.97
Lagged Production	389	0.00	17133.53	1568.46	1716.00
Age	401	31.16	59.86	43.35	4.73
Proportion Female	401	0.00	0.69	0.24	0.13
Rainfall	400	396.00	1371.11	886.46	235.94
Maize Stocks	393	0.00	658.45	16.67	42.64
Cassava Stocks	393	0.00	990.07	20.18	80.58
Household Size	395	3.00	9.65	6.05	1.03
Proportion Livestock	395	0.00	0.95	0.32	0.24
Proportion Poultry	395	0.07	1.00	0.71	0.21
Proportion Fish	395	0.00	0.35	0.01	0.04
Cash Fertilizer	302	0.00	1.00	0.14	0.18
Loan Fertilizer	302	0.00	0.35	0.03	0.05
Government Fertilizer	302	0.00	0.52	0.04	0.08
Exchange Fertilizer	302	0.00	0.24	0.01	0.03
Free Fertilizer	302	0.00	0.49	0.02	0.05
Central	405	0.00	1.00	0.10	0.31
Copperbelt	405	0.00	1.00	0.08	0.27
Eastern	405	0.00	1.00	0.18	0.38
Luapula	405	0.00	1.00	0.11	0.31
Lusaka	405	0.00	1.00	0.06	0.25
Northern	405	0.00	1.00	0.18	0.38
Nwestern	405	0.00	1.00	0.08	0.27
Western	405	0.00	1.00	0.12	0.32
Sea	405	0.00	1.00	0.09	0.28

Table 5.2 below shows a breakout of food aid received and quantity of maize produced by province. The highest level of food aid was received in the Southern province which received a total of 4,892 Kgs of food aid, representing about 39 percent of the total food aid distributed during 2002/03 across provinces. The Copperbelt province received the smallest quantities of food aid of only 294 Kgs, representing about 2 percent of all the food aid that was distributed during the same season.

Table 5.2 Food Aid by Province

Province	Quantity of food aid received		Quantity of maize produced		Average age of head of household	Proportion of female headed households	Average household size
	Total	Percent	Total	Percent			
Central	814	7%	64,665	15%	44.4	0.23	6.5
Copperbelt	294	2%	45,071	11%	44.9	0.19	5.6
Eastern	2,125	17%	91,867	21%	43.8	0.26	5.9
Luapula	574	5%	22,209	5%	40.7	0.20	5.9
Lusaka	970	8%	31,803	7%	45.5	0.23	6.3
Northern	1,063	8%	51,466	12%	42.2	0.22	5.6
Nwestern	655	5%	23,940	6%	43.2	0.25	5.9
Southern	4,892	39%	70,975	17%	42.9	0.26	6.9
Western	1,102	9%	24,289	6%	44.5	0.35	6.0
Total	12,490	100%	426,286	100%	43.6	0.24	6.1

The summary statistics in Table 5.2 also show that the quantity of maize produced in the 2003/04 agricultural season was highest in the Eastern province which accounted for 21% of total maize produced during the season. This was followed by the Southern province which produced a total of 70,975 Kgs or 17% of the total maize output for the season. The Luapula province produced the smallest quantity of maize (22,209 Kgs), accounting for 5% of the total maize produced during the season. The summary statistics also reveal that the average age of the head of household was about the same across provinces with the national average at 43.6. However older heads of households are (on average) found in Lusaka province which had 45.5 as the average age of the heads of households compared with Luapula province which reported 40.7 as the average age of heads of households. The proportion of female headed households was highest in the Western province (0.35) with a national average of 0.24. The summary statistics also show that the average household size for the whole sample was 6.1 members. The Southern province had the highest average household size of 6.9 members.

There is some tendency for provinces with higher proportions of female headed households to be associated with larger quantities of food aid received. The results also show that the Southern province, which received the highest quantities of food aid, had the highest average household size.

When the quantity of maize produced is grouped and arranged in quartiles, some important insights emerge. The results in table 5.3 below show that there are fewer communities (SEAs) in Luapula, North Western, Western and Northern provinces that are associated with high production in these provinces. For instance, communities in Luapula province that are found in the upper quartile of the maize production distribution (and hence associated with higher production) represent only 5% of all the communities in the province. An estimated 64% of the communities in Luapula are in the lower quartile of the distribution, producing only small quantities of maize.

Table 5.3 Quantity of maize produced and percent of SEAs producing maize in a quartile by region

	Quartile of maize production							
	1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
Region	Quantity of maize produced	Percent of SEAs (within region) producing maize	Quantity of maize produced	Percent of SEAs (within region) producing maize	Quantity of maize produced	Percent of SEAs (within region) producing maize	Quantity of maize produced	Percent of SEAs (within region) producing maize
Central	1,717	10%	3,249	12%	10,855	24%	48,844	55%
Copperbelt	409	3%	6,095	28%	8,374	22%	30,193	47%
Eastern	1,438	6%	11,174	21%	34,110	40%	45,145	33%
Luapula	7,947	64%	6,615	24%	3,162	7%	4,485	5%
Lusaka	759	8%	4,404	23%	12,816	42%	13,825	27%
Northern	7,418	32%	15,928	35%	18,383	25%	9,737	7%
Nwestern	2,974	28%	8,915	41%	8,872	25%	3,179	6%
Southern	2,205	13%	4,932	15%	14,855	28%	48,983	43%
Western	6,992	58%	8,083	28%	3,395	7%	5,820	7%
Zambia	31,859	7%	69,394	16%	114,821	27%	210,212	49%

Luapula, North Western, Western and Northern provinces are all characteristically and predominantly cassava growing regions, so these results tend to confirm that maize is not an important crop in these regions. To the contrary, Central, Southern and Eastern provinces, which are typically the main growing regions for maize in Zambia, all have some of the highest percentages of communities in the upper end of the distribution. The results also show that, at the national level, the SEAs in the lower quartile account for 7% of all the SEAs in Zambia while those in the upper quartile account for 49%. The SEAs in the lower quartile produced a total of 31,859 Kgs of maize while the total quantity of maize produced by the SEAs in the upper quartile is 210,212 Kgs.

Table 5.4 shows that there are a lot more communities in the Southern province that received large quantities of food aid (and therefore on the upper end of the food aid distribution) compared to other provinces.

Table 5.4 Quantity of lagged food aid received and percent of SEAs receiving food aid in a quartile by region in 2002/03 agricultural season

	Quartile of lagged food aid received							
	1st Quartile		2nd Quartile		3rd Quartile		4th Quartile	
Region	Average quantity of food aid received per hh	Percent of SEAs (within region) receiving food aid	Average quantity of food aid received per hh	Percent of SEAs (within region) receiving food aid	Average quantity of food aid received per hh	Percent of SEAs (within region) receiving food aid	Average quantity of food aid received per hh	Percent of SEAs (within region) receiving food aid
Central	17.0	19%	71.9	17%	227	21%	498.22	17%
Copperbelt	6.4	18%	27.8	16%	171	22%	88.35	6%
Eastern	3.8	8%	213.2	32%	512	31%	1,395.67	26%
Luapula	5.6	15%	80.1	26%	316	33%	172.95	7%
Lusaka	1.4	2%	36.1	19%	278	38%	654.77	35%
Northern	9.3	26%	172.0	34%	304	20%	578.12	10%
Nwestern	11.1	7%	80.5	35%	159	23%	404.91	19%
Southern	0.0	0%	9.4	2%	171	15%	4,712.29	83%
Western	3.2	5%	145.2	36%	286	28%	668.18	23%
Zambia	6.4	0.05%	92.9	7%	269	19%	1019.3	73%

The results show that 83 % of the SEAs in the Southern province are in the upper quartile and overall accounting for almost all the quantities of food aid received in the province. No single community or SEA in the Southern province was in the lower quartile and only 2% of the communities in the province were found in the second quartile. This shows that many communities in the Southern province receive larger quantities of food aid compared to the other communities of other provinces. On the other hand, 56% of all the communities in the Copperbelt were found in the lower tail of the food aid distribution compared to only about 6% found in the upper tail that received larger quantities of food aid. Copperbelt is an urban province and many communities typically do not attach a lot of importance to food aid. At the national level, the results show that 0.05% of the communities are in the lower quartile with households in this quartile receiving an average 6.4 Kgs of food aid. The results also show that 73% of the SEAs across the country are in the upper quartile and households in this quartile received an average of 1019.3 Kgs of food aid.

5.1 Estimation Results

5.1.1 Ordinary Least squares (OLS) Estimation

Table 5.5 below presents the estimated parameters of the model with robust standard errors. It summarizes the estimated relationships between food aid and the outcome variable (*Maize Production)* while controlling for other explanatory variables that affect maize productivity.

Testing the overall significance of the specified model, the computed F test value of 9.75 is highly significant at the 1% level as its *p* value is zero to three significant digits. This result indicates that the model is adequate for empirical testing. The R^2 from this regression indicates that the explanatory variables included in the model explain about 48% of the variability in maize production across communities. This is a satisfactory level of explanatory power given the data limitations that were outlined in the previous chapter. The variance inflation factor (VIF) shows that the mean VIF for all the explanatory variables is 2.39, revealing that the extent of collinearity is reasonably low among the variables. When we tested for heteroskedasticity to check if the variance in the error terms in our model differs across observations (and hence violating the assumption of constant error term for OLS), the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity shows that heteroskedasticity is present at 10% level of significance. To address the bias in standard errors caused by heteroskedasticity, we use heteroskedasticity robust standard errors to assure proper inference. This was achieved by computing a robust variance estimator based on a covariance matrix of variables using the STATA software.

The results in Table 5.5 show that the quantity of food aid received in the preceding season has a statistically significant mean effect on current maize production. The results show that the effect of lagged food aid is negative and significant. We find that food aid that was distributed during 2002/03 agricultural season had a negative impact on maize produced during the following season of 2003/04. Keeping the influence of other factors constant, every additional Kg of food aid that a community received in the preceding season reduces average household maize production in the following year by over 2 Kgs. This estimated impact is statistically significant at the 1% level.

The results also show that a number of other independent variables have statistically significant effects on average household maize production. Specifically, *Lagged Production, Age, Proportion Female, Maize Stocks, Cassava Stocks, Proportion*

Fish, Cash Fertilizer, Loan Fertilizer and *Free Fertilizer* all are statistically significant at the 10% level of significance.

Table 5.5 Ordinary least squares (OLS) results

Independent Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-2.160	0.768	-2.810	0.005	-3.672	-0.649
Lagged Production	0.096	0.025	3.860	0.000	0.047	0.144
Age	-12.146	6.869	-1.770	0.078	-25.672	1.381
Proportion Female	-426.538	255.782	-1.670	0.097	-930.187	77.112
Rainfall	-0.232	0.316	-0.740	0.463	-0.855	0.390
Maize Stocks	2.104	0.522	4.030	0.000	1.076	3.133
Cassava Stocks	-0.592	0.166	-3.570	0.000	-0.919	-0.265
Household Size	51.499	38.528	1.340	0.182	-24.365	127.364
Proportion Livestock	256.860	164.702	1.560	0.120	-67.448	581.168
Proportion Poultry	147.223	189.831	0.780	0.439	-226.566	521.011
Proportion Fish	2661.216	1048.615	2.540	0.012	596.430	4726.002
Cash Fertilizer	489.835	231.101	2.120	0.035	34.784	944.886
Loan Fertilizer	-1544.980	538.051	-2.870	0.004	-2604.434	-485.527
Government Fertilizer	194.466	444.581	0.440	0.662	-680.940	1069.871
Exchange Fertilizer	1488.848	1038.572	1.430	0.153	-556.163	3533.858
Free Fertilizer	1516.549	789.873	1.920	0.056	-38.757	3071.855
Central	68.960	154.323	0.450	0.655	-234.912	372.832
Copperbelt	76.156	210.476	0.360	0.718	-338.283	490.596
Eastern	47.040	175.853	0.270	0.789	-299.225	393.304
Luapula	-424.328	252.003	-1.680	0.093	-920.537	71.882
Lusaka	-165.677	178.162	-0.930	0.353	-516.489	185.136
Northern	-306.803	230.350	-1.330	0.184	-760.377	146.770
Nwestern	-231.631	181.352	-1.280	0.203	-588.725	125.463

Table 5.5 Continued

Independent Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf.Interval]	
Western	-385.099	189.805	-2.030	0.043	-758.836	-11.362
Sea	-25.140	255.682	-0.100	0.922	-528.593	478.314
Intercept	1363.369	603.411	2.260	0.025	175.217	2551.522

Number of obs = 288
F(24, 269) = 9.75
Prob > F = 0.000
R-squared = 0.4820
Adj R-squared = 0.4326
Root MSE = 525.7
Mean VIF = 2.39

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
chi2(25) = 36.86, Prob > chi2 = 0.0595

We shall begin our discussion with the effects of the other explanatory variables that are significant and have the expected sign. The positive parameter estimate on lagged maize produced in a community (*Lagged Production*) is highly significant at the 1% level, indicating that if community lagged maize production increases by say a hundred Kgs, current year average household maize production increases by 9.6 Kgs. This effect is as expected since if a community produced better in the previous season, it is likely that it will continue to do so in the current season, all other factors being equal. This is because community land attributes and farming practices are not expected to significantly differ from year to year.

The estimated parameter of -12.15 on the average age of the head of household in a community is negative and significant at the 10% level. This suggests that a one year increase in the average age of the head of the household will result in a decrease of the average household maize output by approximately 12.15 Kgs. This relationship supports the conclusion that older heads of households tend to have diminished physical capacity and lower productivity.

The negative sign on *Proportion Female* (which is significant at 10%) indicates that there is a negative impact of this variable on average household maize production while keeping the influence of other explanatory variables constant. To make it more economically interpretable, this suggests for example that average household maize production in a community with 50% of households headed by a female will be approximately 42.7 Kgs less than in a community with 40% female heads of household. Clearly, this indicates that a community with a higher proportion of female headed households will produce less maize. These results tend to support the widespread view that female headed households face severe agriculture constraints to produce more. Rural women in Zambia are only partially able to have access to land and other productive assets like oxen, ploughs and other farm implements as well as agricultural loans and credit due largely to the cultural norms that inhibit ownership of such assets by women. They also have a myriad of other social responsibilities besides agriculture (such as cooking for the family, taking care of the younger children and the sick, etc). It is likely that the economic situation for female headed households in rural Zambia is relatively less favorable compared to male headed households. Female headed households with such constraining social-economic characteristics may be forced to reduce their cultivation area and produce less.

The positive parameter estimate on lagged maize stocks per household (*Maize Stocks*) is highly significant at the 1% level and indicates that if community maize stocks increase by one Kg current year average household maize production increases by 2.1 Kgs. This effect is expected because communities with larger quantities (on average) of maize stocks from last season are more likely to draw on this maize for consumption thereby improving the famers' nutritional status, health and their productive capability for the current season, possibly accounting for an increase in maize production. While large quantities of lagged maize stocks may reduce the need for maize in current period (and therefore suggesting a negative effect), it is less likely that farmers will follow this option where they would rely heavily on the available lagged maize stock to sustain consumption to a point where they would reduce current production.

The estimated coefficient on lagged cassava stocks per household is negative and significant at the 1% level, indicating that a one Kg increase in these stocks in a community decreases average household maize production by 0.59 Kg. This effect is as expected because, a household which on average has higher quantities of dried cassava in storage up to the end of the preceding agricultural season (and by extension, at the beginning of the following season), would be expected to have reduced need for current year maize production because it is more food secure. In some regions of Zambia, cassava is an important substitute for maize, meaning that communities with large quantities of lagged cassava stocks will be expected to reduce the average household production of maize in the current year.

Our results show that the estimated coefficient on *Proportion Fish* indicates a positive effect. It shows that average household maize production in a community with for example 35% of households practicing fish farming will be approximately 266.1 Kgs more than in a community with 25% of households practicing fish farming. Fish farming in Zambia is typically associated with increased income. Households practicing fish farming are on average likely to have more income and use it for increased productivity (e.g. by buying more inputs, opening up more land for production and better managing their farms), possibly accounting for the increase in maize production.

Application of fertilizer is a crucial determinant of maize productivity for famers in Zambia. Under the null hypothesis, there is no influence of the source of fertilizer on the quantity of maize produced by the community. However, if *Cash Fertilizer, Loan Fertilizer, Government Fertilizer, Exchange Fertilizer* and *Free Fertilizer* are all of the sources from which farmers obtain fertilizer then we would expect access to fertilizer by a community from all of these sources to have positive effects on average household maize production relative to no fertilizer from any of the sources. In fact the results in table 5.5 tend to confirm that there is a relationship between the source of fertilizer and the average household quantity of maize produced in a community. The estimated coefficient on *Cash Fertilizer* is positive and significant at the 5% level, telling us that increasing the proportion of households that acquire fertilizer through commercial cash purchases in a community by 10 percentage points will, on average, increase mean household maize production by approximately 49 Kgs. Put differently, this means that average household maize production in a community with say 50% of households that acquired fertilizer through commercial cash purchases will be roughly 49 Kgs more than in a community with 40% of such households. These results suggest that increasing the number of households in a community that obtain fertilizer through commercial cash purchases will result in lager household maize production. This influence is as expected because an above-zero proportion of households that acquired fertilizer from this source means that a community has some fertilizer for use in maize production. Since fertilizer is an important input in maize production, it is likely that this will increase the average quantity of household maize production for the season. Similarly, the estimated parameter on *Free Fertilizer* is positive and significant, telling us that with the influence of other factors held constant, as the proportion of households that acquired fertilizer through other free sources in a community increases, for example by 10 percentage points, average household maize production goes up on average by 151.7 Kgs. This is the expected effect because having a proportion of household in a community that acquired fertilizer for free is an indication that households in a community have access to fertilizer for use in maize production. Again, since fertilizer is an essential input in maize production, maize output is likely to increase for such communities.

We also have significant effects that do not have expected signs. For example, the size and direction of the effect of the proportion of household that acquired fertilizer through a government loan program is negative and highly significant at the 1% level, revealing that if the proportion of households that acquired fertilizer through a government loan program in a community went up by say 10 percentage points average household maize production will decrease by approximately 154.5 Kgs. This effect is telling us for example that a community with 35% of households that acquired fertilizer through a government loan program will on average produce about 154.5 Kgs less of maize than a community with 25% of such households. This effect is contrary to our expectation because for as long as the proportion of households in a community that acquired fertilizer through a Government loan is above zero, average household maize production is expected to increase.

On the other hand, results show that the effects of other explanatory variables such as the average rainfall in a community (*Rainfall*) as well as the average household size in a community (*Household Size*), the proportion of households raising livestock in a community (*Proportion Livestock*), the proportion of households raising poultry in a community (*Proportion Poultry*), the proportion of households that acquired fertilizer through a government cash program (*Government Fertilizer)* and the proportion of households that acquired fertilizer through a direct cash exchange in a community (*Exchange Fertilizer*), are all not significant at the 10% level. This indicates that varying the levels of any of these variables, all other things being equal, will not have any significant mean effect on the average quantity of maize produced by the households in a community.

5.1.2 Quantile Regression Estimates

While the OLS results provide estimates of the mean effect of food aid on maize production, estimating only one regression coefficient for the whole sample may not tell a complete story about the impact of food aid in crop production for different categories of farmers (i.e. ranging from those that produce in smaller quantities to those that produce in larger quantities). As we saw from our earlier results, when the quantity of maize produced was grouped in quartiles, some communities in a number of provinces were associated with high production of maize and others with smaller quantiles of production. Farmers in these communities may be affected differently by food aid.

In this section we extend the analysis by examining the effect of the independent variables on the outcome variable at different points of the maize production conditional distribution using quantile regression. The results of the quantile regression provide further understanding about the effects of food aid distributed to famers by examining these impacts at different points of the conditional maize production distribution. As will be shown, the quantile regression results suggest some important differences in the impact of food aid across different points in the conditional distribution.

Before running the quantile regression we tested the normality of the output variable (Maize Production). The p-value of the kurtosis tests is less than 0.1. This result suggests that the distribution of the outcome variable significantly departs from normality and justifies the use of quantile regression. Using quantile regression, we investigated the effect of the different regressors at different quantiles of the conditional maize production distribution. The results from the estimation of quantile regressions at the 10th, 25th, 50th, 75th and 90th conditional percentile are presented in table 5.6 below.

Table 5.6 Quantile estimation results compared to OLS results

Independent Variable	OLS Estimates	Quantile regression estimates 0.10	0.25	0.50	0.75	0.90
Lagged Food Aid	-2.160***	-2.761***	-2.194**	-2.664***	-2.679*	-1.600
	(0.768)	(0.958)	(1.028)	(1.028)	(1.546)	(2.942)
Lagged Maize	0.096***	0.035	0.113***	0.095**	0.161***	0.230**
	(0.025)	(0.045)	(0.040)	(0.042)	(0.061)	(0.099)
Age	-12.146*	-0.450	1.133	-7.984	-10.508	-25.580
	(6.869)	(8.198)	(7.698)	(7.895)	(9.320)	(17.416)
Proportion Female	-426.538*	-18.054	-327.326	-573.020	-625.632	93.694
	(255.782)	(281.655)	(231.318)	(360.288)	(386.844)	(694.774)
Rainfall	-0.232	-0.750**	-0.145	-0.717	-0.034	0.088
	(0.316)	(0.377)	(0.378)	(0.482)	(0.386)	(0.585)
Maize Stocks	2.104***	2.377	1.333	2.146*	0.635	4.574
	(0.522)	(1.675)	(1.532)	(1.186)	(1.565)	(4.738)
Cassava Stocks	-0.592***	-0.395	-0.368	-0.526	-0.729*	-0.721
	(0.166)	(0.477)	(0.284)	(0.362)	(0.439)	(0.677)
Household Size	51.499	20.803	17.464	43.461	-10.111	188.453*
	(38.528)	(37.285)	(38.151)	(53.672)	(67.214)	(110.945)
Proportion Livestock	256.860	9.355	356.481**	299.246	318.710	-355.319
	(164.702)	(163.970)	(150.445)	(182.797)	(254.117)	(519.526)
Proportion Poultry	147.223	119.837	185.243	289.750	182.420	-217.451
	(189.831)	(185.063)	(235.536)	(234.069)	(278.804)	(519.908)
Proportion Fish	2661.216**	1025.326	1499.991	1857.658	4747.403**	1464.963
	(1048.615)	(971.548)	(1049.186)	(1544.028)	(2184.924)	(3207.668)
Cash Fertilizer	489.835**	367.861	502.045*	560.830**	277.712	245.936
	(231.101)	(276.610)	(275.009)	(257.294)	(352.323)	(486.120)
Loan Fertilizer	-1544.980***	-62.921	-639.080	-1543.360**	-2263.815***	-2344.601*
	(538.051)	(723.584)	(672.653)	(701.394)	(743.648)	(1231.310)

Table 5.6 Continued

Independent Variable	OLS Estimates	Quantile regression estimates 0.10	0.25	0.50	0.75	0.90
Government Fertilizer	194.466	-4.688	169.594	425.475	704.617	-454.915
	(444.581)	(614.845)	(578.136)	(608.247)	(681.293)	(999.052)
Exchange Fertilizer	1488.848	1647.478*	1791.362**	249.068	2424.014	5468.812
	(1038.572)	(908.744)	(816.176)	(998.014)	(2478.885)	(2872.118)
Free Fertilizer	1516.549*	3268.506***	2503.424**	1227.285	1130.759	1477.665
	(789.873)	(1086.673)	(1133.953)	(1094.547)	(1277.690)	(2203.309)
Central	68.960	152.709	40.643	-108.560	-38.928	348.567
	(154.323)	(175.607)	(198.738)	(217.789)	(331.650)	(475.626)
Copperbelt	76.156	151.652	168.481	45.030	101.858	35.022
	(210.476)	(213.298)	(239.480)	(316.982)	(349.635)	(504.607)
Eastern	47.040	332.378*	108.694	139.503	-141.880	-239.454
	(175.853)	(193.132)	(229.278)	(308.531)	(292.984)	(466.581)
Luapula	-424.328*	74.515	-277.616	-361.727	-652.568*	-726.173
	(252.003)	(285.062)	(313.578)	(397.731)	(388.771)	(694.361)
Lusaka	-165.677	-113.902	52.392	-320.587	-423.023	62.841
	(178.162)	(166.567)	(177.116)	(223.873)	(304.961)	(469.111)
Northern	-306.803	158.103	-148.848	-203.668	-449.381	-284.052
	(230.350)	(247.561)	(297.153)	(400.378)	(397.402)	(538.062)
Nwestern	-231.631	116.774	6.826	-193.852	-377.444	-541.223
	(181.352)	(195.773)	(207.879)	(307.929)	(324.226)	(480.364)
Western	-385.099**	-213.195	-168.799	-398.418	-523.565	-679.433
	(189.805)	(176.002)	(207.316)	(313.190)	(323.429)	(559.951)
Rural	-25.140	121.357	129.604	-110.594	-218.914	186.503
	(255.682)	(215.907)	(300.430)	(386.094)	(487.278)	(682.066)
Intercept	1363.369**	671.167	196.151	1596.705*	2001.438**	1483.887
	(603.411)	(551.715)	(605.492)	(832.271)	(997.833)	(1450.737)

*** Significant at 1% level
** Significant at 5% level
*Significant at 10% level

The quantile regression results show that food aid has a statistically significant effect on crop production but the effect is different at each point of the conditional distribution. The estimated impact is greatest at the 10^{th} quantile where we see that keeping all other effects constant, the lagged food aid reduces average household maize production at this quantile by 2.76 Kgs. The impact of food aid at the 25^{th} quantile is negative and statistically significant at the 5%, revealing that increasing food aid at this quantile by a Kg will result in average household maize production declining by approximately 2.19 Kgs. At the median, the parameter estimate for food aid is -2.66 and highly significant at the 1% level. This result tells us that keeping the influence of all other effects constant, increasing the quantity of food aid distributed to a community by one Kg reduces average maize production for a community at this quantile by 2.66. At the 75^{th} quantile, the results show that the lagged food aid reduces average maize production by 2.68. The impact of food aid at the 90^{th} quantile is negative but is not statistically significant. This indicates that increased quantities of lagged food aid received by communities at this point in the distribution will tend to have no effect on the average household maize output.

The quantile regression results indicate that the effect of the lagged food aid is negative across the maize production conditional distribution and that this impact is greatest for communities at the lower end of the maize production distribution (10th quantile). These results suggest that food aid has different impacts for communities producing larger average quantities of maize compared to those communities producing smaller amounts of maize.

The effects of the other explanatory variables also have different magnitudes at different points of the conditional maize production distribution. For instance, the effect of the lagged maize produced in a community (*Lagged Production*) is positive and significant at all points of the distribution except at the 10th quantile where the effect is positive but not statistically significant at the 10% level. Some explanatory variables have significant OLS mean impacts while the quantile regression impacts are not significant anywhere across the distribution. For instance, while the estimated mean effects for given levels of the predictor variables such as the average age of the head of the household in a community (*Age*) and the proportion of female headed household in a community (*Proportion Female*) are statistically significant at the mean, the quantile results show that these are not significant at any of the quantiles that were used for analysis.

When we tested whether the effect of food aid on maize production is the same between quantiles, the pair wise test results show that the P-values are all above 0.10, indicating that the effect of food aid is not statistically different between quantiles. Table 5.7 below presents the pair wise test results where we tested whether the coefficient at the i^{th} quantile is statistically different from the j^{th} quantile.

Table 5.7 Pair wise test results between quantiles

i^{th} Quantile	j^{th} Quantile	F	Prob > F
10	25	0.330	0.565
10	50	0.010	0.935
10	75	0.000	0.963
10	90	0.140	0.707
25	50	0.260	0.610
25	75	0.090	0.763
25	90	0.040	0.838
50	75	0.000	0.992
50	90	0.140	0.706
75	90	0.210	0.650

These results tell us that if, for instance, the effect of food aid in one quantile is negative, it is also negative in another quantile. Also the F-test across quantiles indicates that the parameters are not statistically different across all quantiles, with the F-test result at 0.17 and the P-value at 0.954. These results show that although the magnitudes of the coefficients are different and statistically significant at some quantiles (0.1 to 0.8), they are not statistically different. This may be due to the high standard errors (especially at the higher quantiles where data is sparse) given the low number of observations used in this study.

Figure 5.1 below shows a graphical presentation of the estimated lagged food aid parameter from OLS as compared to those obtained from quantile regression. The 95% OLS confidence bounds are also plotted. The blue solid horizontal line shows the OLS estimate and its confidence bands are represented in dotted (straight) lines. The OLS estimate suggests a constant effect of lagged food aid on crop production. For the quantile estimate, there is a pattern of effects that are larger in magnitude at the lower quantiles and around the median as compared to the higher quantiles. The quantile regression coefficients (represented by the pink solid curve) do clearly show a varying effect over the distribution. However, it can be seen that, the OLS estimated parameter is fairly close to quantile regression coefficients across quantiles as the quantile regression estimates are within the confidence bands of OLS. The pointwise distances between the two curved dotted lines represent the 95% confidence interval for the quantile regression estimates. These tend to greatly widen at the upper end of the distribution where data is sparse (and consequently standard errors are large).

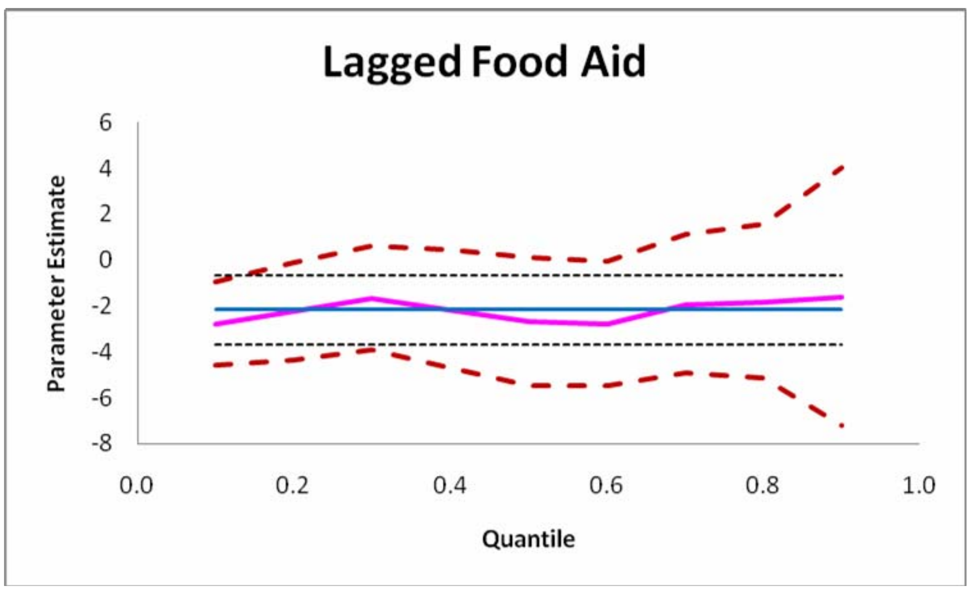

Figure 5.1 Parameter presentation of OLS and Quantile regression

We can see that the food aid has varying effects but remains within the OLS bounds across the distribution. It is nonetheless suggestive from figure 5.1 that the effect of food aid tends to reduce in magnitude as one goes from the lower end of the distribution to the upper end. However, based on the results of the pairwise tests and F-tests, even if there are differences in magnitudes as well as directions, the effects of food aid across quantiles are not statistically different from each other.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This chapter begins with a discussion of the study results and their implications, especially for policy response. It ends with a discussion of the limitations of the study and suggested directions for future studies.

6.0 Discussion of Study Results and their Implication

For an effective response and programming, the Government and implementation agencies require accurate information on the impact of increased distribution of food aid to farmers, especially in rural communities. Understanding the impact of food aid at the community level can be complicated by the fact that communities are affected differently by food aid given that other factors (such as the proportion of female headed households in a community, etc) can also affect average household productivity.

Using nationally representative data, this study attempted to find out whether food aid distributed to communities can have some impact on the maize output of farmers in such communities. We examined the relationship that may exist between lagged food aid and maize production (while controlling for the influence of other factors) using two approaches. First we estimated the impact of food aid using OLS regression procedures and followed it with an estimation of the food aid impact using the quantile regression technique. The OLS results show an important relationship between lagged food aid and maize output. We find significant and robust evidence that food aid given to communities in the previous season causes households in the recipient communities to reduce their average maize production for the current season by over 2,000 Kgs for every 1,000 Kgs of food aid received. The OLS results further show that average household maize production is also sensitive to other factors. For instance, we find that the effect of the lagged average quantity of maize produced in a community is positive and significant. This result offers evidence that communities with higher average lagged maize production will on average have higher current maize production. The results further show that communities with higher average age of the head of household will decrease average household maize production, indicating that this control variable has a negative influence on maize production. We also find that the proportion of female headed household in a community has a negative and significant impact on average household maize production. This is evidence that a community with a higher proportion of households headed by a female will on average have lower average household maize production. Our findings also show that communities with large quantities of lagged maize stocks will on average increase average household maize production. This may be due to the fact that the available maize from the previous season can be used for consumption to improve energy requirements for household members and enhance productivity. Clearly, this result tells us that food aid recipients that are already food secure (since maize is an important food crop) will increase their maize production. The effect of lagged cassava stock is negative and significant. This result also provides evidence that a community with large quantities of lagged cassava stocks will on average reduce average household maize output in the current year. In many situations in Zambia, cassava is a perfect alternative choice for consumption to maize and hence it is not surprising that the effect is negative. The effect of the proportion of households engaged fish farming is positive and significant. This result offers evidence that communities with higher proportions of households that are engaged in fish farming will on average increase maize output. We also find that the impacts of the proportion of households that acquired fertilizer through commercial cash purchases in a community, the proportion of households that acquired fertilizer through a government cash program, and the proportion of households that acquired fertilizer through other free sources are all positive and significant. This result underscores the fact that acquiring fertilizer from any of these sources may imply that households in a community had some access to fertilizer and could have applied the fertilizer to maize to increase production.

While the OLS results show that food aid has a constant (and negative) mean impact on average household maize production in a community (keeping other variables constant), the quantile regression results provide additional insights as to the effect of food aid at different points of the maize production distribution. The results of the quantile regression show that food aid has distinct impacts at different points of the conditional maize production distribution. For instance, the results show that communities at the lower end of the distribution i.e. those producing small quantities of maize are affected differently relative to those communities that produce large quantities of maize. The quantile regression results actually show that food aid given to communities at the lower end of the maize production conditional distribution (at the 10^{th} quantile) will have a stronger negative effect on maize output. We find that the effect (in magnitude) actually reduces as one goes toward the upper end of the distribution.

Furthermore, the effects at the 90th quantile are not statistically significant, so there is no evidence of a food aid impact going beyond this quantile. The results provide further evidence that while the magnitudes of the effects are different across quantiles and the estimated effects at lower quantiles are statistically different from zero, the pairwise tests and f-tests across quantiles indicate that the food aid impact may not be statistically different across quantiles.

Clearly the OLS results tell us that policy makers concerned with food aid programming and distribution should not only be aware of the effects of food aid on crop production (such as maize, rice or sorghum, etc) but also recognize the value of the impact of the other factors (such as the head of the head of the household, etc) when considering food aid as a response action.

Based on the OLS findings, this study provides evidence that food aid distributed to communities does reduce average household maize productivity significantly in a community.

When we take into account the quantile regression results, we see again that, in general, food aid has a negative impact on crop production. The estimated impact of food aid is greatest in magnitude for the communities up to the 75th quantile of the maize production conditional distribution and tends to decrease for the communities in higher quantiles. Overall, we provide evidence -using the quantile regression results- that food aid has negative but distinct impacts at the lower end of the conditional maize production distribution as opposed to a negative and constant mean effect of the OLS across the entire distribution. However, based on the results of the pairwise tests and F-tests, even if there are differences in magnitudes, the effects of food aid across quantile are not statistically different from each other. These results are nonetheless suggestive of a differential effect and may merit further investigation in the future using better data (household-level data with more observations).

In conclusion, the findings of the study suggest that there is need for policy makers to carefully evaluate the net benefit to a community that is targeted for food aid. Given that most communities are low producers (the average maize output in a community in the sample is 1057.78 Kgs) and possibly the most vulnerable to food insecurity, policy makers concerned with improving agricultural productivity for small scale farmers should take into account immediate benefits for human health and welfare and also the potential negative effect on long run productivity and food security.

Overall, these results question the usefulness of food aid alone as a suitable policy response to improving agricultural productivity in the affected communities. There are immediate considerations of human welfare that also have to be factored into the decision.

6.1 Data Limitations

There is no doubt that the effect of food aid would have been better investigated at the household level to examine how individual households respond to food aid. But our data would not support household-level analysis. This is because each year, a different household is included in the survey thereby making it difficult to have panel data at the household level. To address these limitations encountered in this study, information at the household level was aggregated to a SEA or community level so that lagged variables could be included in the analysis. This aggregation means that the data was not robust enough to take into account household heterogeneity in analyzing the food aid effects. Future studies may give a more accurate picture of food aid impact on household maize productivity by using panel data at the household level (with a longer time dimension). This would be made possible if data on relevant variables were repeatedly collected for several years at the household level and households were identifiable across years. Furthermore, having household panel data with a longer time horizon would allow for more sophisticated econometric techniques (e.g. fixed effects estimation, dynamic panel estimators) to more accurately estimate the effect of food aid on maize production.

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APPENDIX

Tables A.1 to A.9 report a set of results of the quantile regression. The tables present the simultaneous quantile regressions at the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th and 90th conditional quantiles and include the estimated coefficient, the bootstrapped standard error, the t-value, the p-value and the 95% confidence interval. Related results are presented in figures A.1 to A.4, showing the quantile regression results compared to the OLS results in a graphical form. Each of the graphs shows a similar presentation of the findings. The black solid line represents the OLS estimate and its confidence bands are represented in dotted (straight) lines. The quantile regression coefficients are represented by the pink solid curve while the pointwise distances between the two curved dotted lines represent the 95% confidence interval for the quantile regression estimates.

Table A.1. Full parameter estimates at the 10th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-2.761	0.921	-3.000	0.003	-4.574	-0.948
Lagged Production	0.035	0.046	0.770	0.440	-0.055	0.125
Age	-0.450	8.410	-0.050	0.957	-17.009	16.109
Proportion Female	-18.054	281.279	-0.060	0.949	-571.908	535.801
Rainfall	-0.750	0.405	-1.850	0.065	-1.547	0.048
Maize Stocks	2.377	1.797	1.320	0.187	-1.162	5.915
Cassava Stocks	-0.395	0.451	-0.880	0.381	-1.282	0.492
Household Size	20.803	40.730	0.510	0.610	-59.396	101.002
Proportion Livestock	9.355	159.064	0.060	0.953	-303.851	322.561
Proportion Poultry	119.837	174.839	0.690	0.494	-224.431	464.105
Proportion Fish	1025.326	1016.735	1.010	0.314	-976.686	3027.337
Cash Fertilizer	367.861	250.453	1.470	0.143	-125.296	861.019
Loan Fertilizer	-62.921	678.275	-0.090	0.926	-1398.484	1272.643
Government Fertilizer	-4.688	665.750	-0.010	0.994	-1315.590	1306.214
Exchange Fertilizer	1647.478	774.452	2.130	0.034	122.536	3172.420
Free Fertilizer	3268.506	1046.021	3.120	0.002	1208.828	5328.184
Central	152.709	150.727	1.010	0.312	-144.082	449.499
Copperbelt	151.652	235.939	0.640	0.521	-312.926	616.229
Eastern	332.378	215.681	1.540	0.125	-92.311	757.067
Luapula	74.515	301.464	0.250	0.805	-519.085	668.116
Lusaka	-113.902	186.241	-0.610	0.541	-480.622	252.817
Northern	158.103	267.240	0.590	0.555	-368.108	684.313
Nwestern	116.774	192.885	0.610	0.545	-263.029	496.577
Western	-213.195	192.055	-1.110	0.268	-591.363	164.972
Sea	121.357	235.580	0.520	0.607	-342.513	585.227
Intercept	671.167	612.628	1.100	0.274	-535.135	1877.469

Table A.2. Full parameter estimates at the 20th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-2.242	1.087	-2.060	0.040	-4.383	-0.102
Lagged Production	0.086	0.034	2.510	0.013	0.018	0.154
Age	0.802	8.092	0.100	0.921	-15.131	16.736
Proportion Female	-210.179	251.275	-0.840	0.404	-704.954	284.597
Rainfall	-0.241	0.349	-0.690	0.489	-0.928	0.445
Maize Stocks	1.552	1.647	0.940	0.347	-1.690	4.794
Cassava Stocks	-0.333	0.249	-1.340	0.183	-0.824	0.158
Household Size	32.287	40.124	0.800	0.422	-46.720	111.293
Proportion Livestock	312.854	160.283	1.950	0.052	-2.753	628.461
Proportion Poultry	158.957	201.124	0.790	0.430	-237.069	554.982
Proportion Fish	1331.388	1015.738	1.310	0.191	-668.661	3331.437
Cash Fertilizer	425.405	230.183	1.850	0.066	-27.840	878.650
Loan Fertilizer	-770.598	698.944	-1.100	0.271	-2146.861	605.665
Government Fertilizer	-21.978	639.542	-0.030	0.973	-1281.274	1237.318
Exchange Fertilizer	1641.373	768.552	2.140	0.034	128.050	3154.697
Free Fertilizer	2524.282	1196.422	2.110	0.036	168.455	4880.109
Central	72.216	165.179	0.440	0.662	-253.032	397.463
Copperbelt	68.966	257.844	0.270	0.789	-438.745	576.677
Eastern	144.692	222.911	0.650	0.517	-294.234	583.617
Luapula	-238.182	288.492	-0.830	0.410	-806.239	329.875
Lusaka	30.235	217.534	0.140	0.890	-398.103	458.573
Northern	-113.076	273.685	-0.410	0.680	-651.978	425.825
Nwestern	32.340	209.073	0.150	0.877	-379.337	444.018
Western	-305.609	199.715	-1.530	0.127	-698.859	87.640
Sea	89.391	254.428	0.350	0.726	-411.593	590.376
Intercept	243.199	559.413	0.430	0.664	-858.319	1344.716

Table A.3. Full parameter estimates at the 30th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-1.666	1.153	-1.440	0.150	-3.936	0.604
Lagged Production	0.113	0.034	3.330	0.001	0.046	0.179
Age	-6.678	8.983	-0.740	0.458	-24.366	11.010
Proportion Female	-326.935	293.919	-1.110	0.267	-905.680	251.809
Rainfall	-0.145	0.367	-0.400	0.692	-0.867	0.576
Maize Stocks	2.569	1.397	1.840	0.067	-0.181	5.319
Cassava Stocks	-0.406	0.265	-1.530	0.128	-0.928	0.117
Household Size	31.106	46.816	0.660	0.507	-61.077	123.289
Proportion Livestock	402.164	159.995	2.510	0.013	87.124	717.203
Proportion Poultry	129.230	206.256	0.630	0.531	-276.900	535.359
Proportion Fish	1401.140	1252.496	1.120	0.264	-1065.098	3867.379
Cash Fertilizer	610.123	260.085	2.350	0.020	98.001	1122.245
Loan Fertilizer	-770.580	710.525	-1.080	0.279	-2169.646	628.487
Government Fertilizer	285.940	569.599	0.500	0.616	-835.634	1407.514
Exchange Fertilizer	1430.571	834.276	1.710	0.088	-212.168	3073.309
Free Fertilizer	1650.791	1116.674	1.480	0.141	-548.007	3849.588
Central	65.846	186.054	0.350	0.724	-300.505	432.198
Copperbelt	234.823	287.705	0.820	0.415	-331.685	801.331
Eastern	124.403	224.514	0.550	0.580	-317.678	566.485
Luapula	-272.920	286.711	-0.950	0.342	-837.471	291.631
Lusaka	33.479	194.208	0.170	0.863	-348.927	415.886
Northern	-123.466	268.304	-0.460	0.646	-651.772	404.841
Nwestern	56.037	201.986	0.280	0.782	-341.686	453.761
Western	-82.109	229.317	-0.360	0.721	-533.647	369.430
Sea	101.167	278.634	0.360	0.717	-447.480	649.814
Intercept	502.889	593.468	0.850	0.398	-665.684	1671.462

Table A.4. Full parameter estimates at the 40th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-2.141	1.306	-1.640	0.102	-4.712	0.431
Lagged Production	0.104	0.035	3.000	0.003	0.036	0.173
Age	-9.179	8.829	-1.040	0.299	-26.565	8.206
Proportion Female	-569.837	340.674	-1.670	0.096	-1240.645	100.971
Rainfall	-0.642	0.445	-1.440	0.150	-1.519	0.235
Maize Stocks	2.430	1.293	1.880	0.061	-0.117	4.977
Cassava Stocks	-0.453	0.325	-1.390	0.164	-1.093	0.187
Household Size	21.168	58.438	0.360	0.717	-93.901	136.237
Proportion Livestock	349.706	174.420	2.000	0.046	6.263	693.149
Proportion Poultry	274.772	237.999	1.150	0.249	-193.863	743.407
Proportion Fish	2355.803	1208.359	1.950	0.052	-23.527	4735.133
Cash Fertilizer	632.826	254.517	2.490	0.014	131.668	1133.984
Loan Fertilizer	-1060.621	673.501	-1.570	0.117	-2386.784	265.543
Government Fertilizer	484.377	551.082	0.880	0.380	-600.737	1569.490
Exchange Fertilizer	938.848	961.928	0.980	0.330	-955.246	2832.941
Free Fertilizer	1384.286	1095.597	1.260	0.208	-773.009	3541.582
Central	33.631	215.287	0.160	0.876	-390.282	457.544
Copperbelt	177.761	321.154	0.550	0.580	-454.610	810.131
Eastern	201.631	275.218	0.730	0.464	-340.290	743.551
Luapula	-136.615	359.732	-0.380	0.704	-844.948	571.718
Lusaka	-134.201	214.315	-0.630	0.532	-556.200	287.798
Northern	-44.820	355.724	-0.130	0.900	-745.261	655.622
Nwestern	2.834	255.572	0.010	0.991	-500.403	506.071
Western	-151.364	268.198	-0.560	0.573	-679.462	376.735
Sea	54.343	324.078	0.170	0.867	-583.785	692.471
Intercept	1241.019	698.732	1.780	0.077	-134.826	2616.863

Table A.5. Full parameter estimates at the 50th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-2.664	1.420	-1.880	0.062	-5.461	0.132
Lagged Production	0.095	0.040	2.370	0.018	0.016	0.174
Age	-7.984	8.199	-0.970	0.331	-24.128	8.160
Proportion Female	-573.020	319.508	-1.790	0.074	-1202.151	56.111
Rainfall	-0.717	0.433	-1.650	0.099	-1.570	0.137
Maize Stocks	2.146	1.072	2.000	0.046	0.035	4.257
Cassava Stocks	-0.526	0.332	-1.580	0.115	-1.180	0.129
Household Size	43.461	64.704	0.670	0.502	-83.946	170.868
Proportion Livestock	299.246	195.927	1.530	0.128	-86.546	685.037
Proportion Poultry	289.750	259.687	1.120	0.266	-221.588	801.088
Proportion Fish	1857.658	1317.540	1.410	0.160	-736.657	4451.973
Cash Fertilizer	560.830	234.483	2.390	0.017	99.119	1022.542
Loan Fertilizer	-1543.360	688.688	-2.240	0.026	-2899.428	-187.292
Government Fertilizer	425.475	524.294	0.810	0.418	-606.890	1457.840
Exchange Fertilizer	249.068	1213.100	0.210	0.837	-2139.598	2637.734
Free Fertilizer	1227.285	1052.453	1.170	0.245	-845.058	3299.628
Central	-108.560	229.666	-0.470	0.637	-560.786	343.667
Copperbelt	45.030	324.523	0.140	0.890	-593.975	684.035
Eastern	139.503	274.997	0.510	0.612	-401.983	680.988
Luapula	-361.727	355.144	-1.020	0.309	-1061.027	337.572
Lusaka	-320.587	223.314	-1.440	0.152	-760.306	119.133
Northern	-203.668	344.440	-0.590	0.555	-881.891	474.554
Nwestern	-193.852	273.505	-0.710	0.479	-732.400	344.696
Western	-398.418	280.903	-1.420	0.157	-951.532	154.697
Sea	-110.594	358.899	-0.310	0.758	-817.288	596.100
Intercept	1596.705	751.012	2.130	0.034	117.918	3075.493

Table A.6. Full parameter estimates at the 60th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-2.774	1.389	-2.000	0.047	-5.509	-0.040
Lagged Production	0.125	0.045	2.770	0.006	0.036	0.214
Age	-8.401	9.159	-0.920	0.360	-26.436	9.634
Proportion Female	-379.544	352.091	-1.080	0.282	-1072.831	313.744
Rainfall	-0.323	0.437	-0.740	0.460	-1.183	0.537
Maize Stocks	1.588	1.070	1.480	0.139	-0.520	3.695
Cassava Stocks	-0.692	0.393	-1.760	0.080	-1.466	0.082
Household Size	13.189	68.280	0.190	0.847	-121.258	147.635
Proportion Livestock	350.128	239.555	1.460	0.145	-121.569	821.826
Proportion Poultry	106.383	242.894	0.440	0.662	-371.890	584.656
Proportion Fish	2148.741	1787.099	1.200	0.230	-1370.165	5667.646
Cash Fertilizer	394.759	272.589	1.450	0.149	-141.986	931.503
Loan Fertilizer	-1312.794	739.833	-1.770	0.077	-2769.570	143.982
Government Fertilizer	172.123	550.171	0.310	0.755	-911.198	1255.443
Exchange Fertilizer	755.890	1327.871	0.570	0.570	-1858.768	3370.547
Free Fertilizer	1194.204	1055.676	1.130	0.259	-884.485	3272.892
Central	-22.821	238.497	-0.100	0.924	-492.436	446.794
Copperbelt	74.137	329.889	0.220	0.822	-575.434	723.708
Eastern	-69.006	271.557	-0.250	0.800	-603.717	465.705
Luapula	-636.534	357.432	-1.780	0.076	-1340.338	67.271
Lusaka	-374.724	235.258	-1.590	0.112	-837.961	88.514
Northern	-421.640	325.952	-1.290	0.197	-1063.459	220.179
Nwestern	-291.766	279.403	-1.040	0.297	-841.928	258.397
Western	-557.027	277.377	-2.010	0.046	-1103.200	-10.855
Sea	-206.801	394.867	-0.520	0.601	-984.317	570.715
Intercept	1839.143	791.684	2.320	0.021	280.270	3398.016

Table A.7. Full parameter estimates at the 70th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-1.923	1.538	-1.250	0.212	-4.951	1.105
Lagged Production	0.164	0.058	2.830	0.005	0.050	0.278
Age	-10.632	11.264	-0.940	0.346	-32.811	11.547
Proportion Female	-607.991	376.242	-1.620	0.107	-1348.834	132.852
Rainfall	0.027	0.431	0.060	0.951	-0.823	0.876
Maize Stocks	0.733	1.237	0.590	0.554	-1.703	3.169
Cassava Stocks	-0.838	0.372	-2.250	0.025	-1.572	-0.105
Household Size	-37.548	70.306	-0.530	0.594	-175.984	100.888
Proportion Livestock	340.677	273.764	1.240	0.214	-198.380	879.734
Proportion Poultry	341.092	235.196	1.450	0.148	-122.023	804.208
Proportion Fish	4910.954	1628.027	3.020	0.003	1705.271	8116.637
Cash Fertilizer	298.262	313.018	0.950	0.342	-318.090	914.614
Loan Fertilizer	-2008.557	739.129	-2.720	0.007	-3463.946	-553.168
Government Fertilizer	377.909	669.540	0.560	0.573	-940.456	1696.274
Exchange Fertilizer	1463.618	2142.832	0.680	0.495	-2755.745	5682.982
Free Fertilizer	757.997	1089.435	0.700	0.487	-1387.166	2903.159
Central	15.723	260.950	0.060	0.952	-498.104	529.550
Copperbelt	58.561	337.096	0.170	0.862	-605.201	722.322
Eastern	-106.284	281.881	-0.380	0.706	-661.324	448.756
Luapula	-616.343	372.521	-1.650	0.099	-1349.859	117.174
Lusaka	-328.110	274.744	-1.190	0.233	-869.098	212.878
Northern	-506.575	354.826	-1.430	0.155	-1205.248	192.098
Nwestern	-283.607	279.030	-1.020	0.310	-833.034	265.820
Western	-441.242	292.062	-1.510	0.132	-1016.329	133.846
Sea	-274.070	394.593	-0.690	0.488	-1051.048	502.908
Intercept	1953.727	865.727	2.260	0.025	249.059	3658.396

Table A.8. Full parameter estimates at the 80th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-1.810	1.706	-1.060	0.290	-5.170	1.550
Lagged Production	0.159	0.076	2.100	0.037	0.010	0.307
Age	-13.621	13.194	-1.030	0.303	-39.601	12.360
Proportion Female	-517.299	469.986	-1.100	0.272	-1442.729	408.130
Rainfall	0.057	0.489	0.120	0.907	-0.905	1.020
Maize Stocks	0.896	1.998	0.450	0.654	-3.039	4.831
Cassava Stocks	-0.702	0.436	-1.610	0.108	-1.560	0.156
Household Size	28.602	68.683	0.420	0.677	-106.638	163.843
Proportion Livestock	292.644	324.398	0.900	0.368	-346.115	931.403
Proportion Poultry	113.188	302.674	0.370	0.709	-482.795	709.172
Proportion Fish	3685.742	1474.328	2.500	0.013	782.702	6588.781
Cash Fertilizer	392.406	375.614	1.040	0.297	-347.200	1132.012
Loan Fertilizer	-2260.858	937.981	-2.410	0.017	-4107.798	-413.917
Government Fertilizer	294.568	789.146	0.370	0.709	-1259.308	1848.444
Exchange Fertilizer	3688.243	2632.170	1.400	0.162	-1494.656	8871.142
Free Fertilizer	578.849	1347.428	0.430	0.668	-2074.317	3232.014
Central	212.378	314.892	0.670	0.501	-407.664	832.419
Copperbelt	181.460	399.216	0.450	0.650	-604.620	967.540
Eastern	-44.856	334.996	-0.130	0.894	-704.482	614.771
Luapula	-553.323	445.467	-1.240	0.215	-1430.473	323.828
Lusaka	-332.030	345.687	-0.960	0.338	-1012.708	348.648
Northern	-342.750	409.418	-0.840	0.403	-1148.918	463.418
Nwestern	-322.182	366.363	-0.880	0.380	-1043.572	399.208
Western	-406.130	357.267	-1.140	0.257	-1109.611	297.351
Sea	-248.611	491.499	-0.510	0.613	-1216.401	719.180
Intercept	1815.844	1078.114	1.680	0.093	-307.027	3938.714

Table A.9. Full parameter estimates at the 90th quantile

Independent Variable	Coef.	Bootstrap Std. Err.	t	P>|t|	[95% Conf.Interval]	
Lagged Food Aid	-1.600	2.845	-0.560	0.574	-7.201	4.001
Lagged Production	0.230	0.102	2.260	0.024	0.030	0.430
Age	-25.580	20.029	-1.280	0.203	-65.018	13.858
Proportion Female	93.694	570.608	0.160	0.870	-1029.867	1217.256
Rainfall	0.088	0.726	0.120	0.904	-1.341	1.517
Maize Stocks	4.574	4.009	1.140	0.255	-3.320	12.468
Cassava Stocks	-0.721	0.737	-0.980	0.328	-2.172	0.729
Household Size	188.453	110.723	1.700	0.090	-29.566	406.472
Proportion Livestock	-355.319	499.700	-0.710	0.478	-1339.257	628.620
Proportion Poultry	-217.451	507.973	-0.430	0.669	-1217.681	782.779
Proportion Fish	1464.963	2744.040	0.530	0.594	-3938.215	6868.141
Cash Fertilizer	245.936	434.921	0.570	0.572	-610.450	1102.322
Loan Fertilizer	-2344.601	1517.083	-1.550	0.123	-5331.829	642.627
Government Fertilizer	-454.915	1075.875	-0.420	0.673	-2573.377	1663.547
Exchange Fertilizer	5468.812	3034.772	1.800	0.073	-506.836	11444.460
Free Fertilizer	1477.665	2037.456	0.730	0.469	-2534.208	5489.537
Central	348.567	519.269	0.670	0.503	-673.905	1371.040
Copperbelt	35.022	586.380	0.060	0.952	-1119.596	1189.640
Eastern	-239.454	481.375	-0.500	0.619	-1187.310	708.403
Luapula	-726.173	735.135	-0.990	0.324	-2173.696	721.351
Lusaka	62.841	650.295	0.100	0.923	-1217.629	1343.311
Northern	-284.052	585.803	-0.480	0.628	-1437.533	869.428
Nwestern	-541.223	529.658	-1.020	0.308	-1584.150	501.705
Western	-679.433	562.035	-1.210	0.228	-1786.113	427.248
Sea	186.503	613.955	0.300	0.762	-1022.412	1395.418
Intercept	1483.887	1424.668	1.040	0.299	-1321.368	4289.143

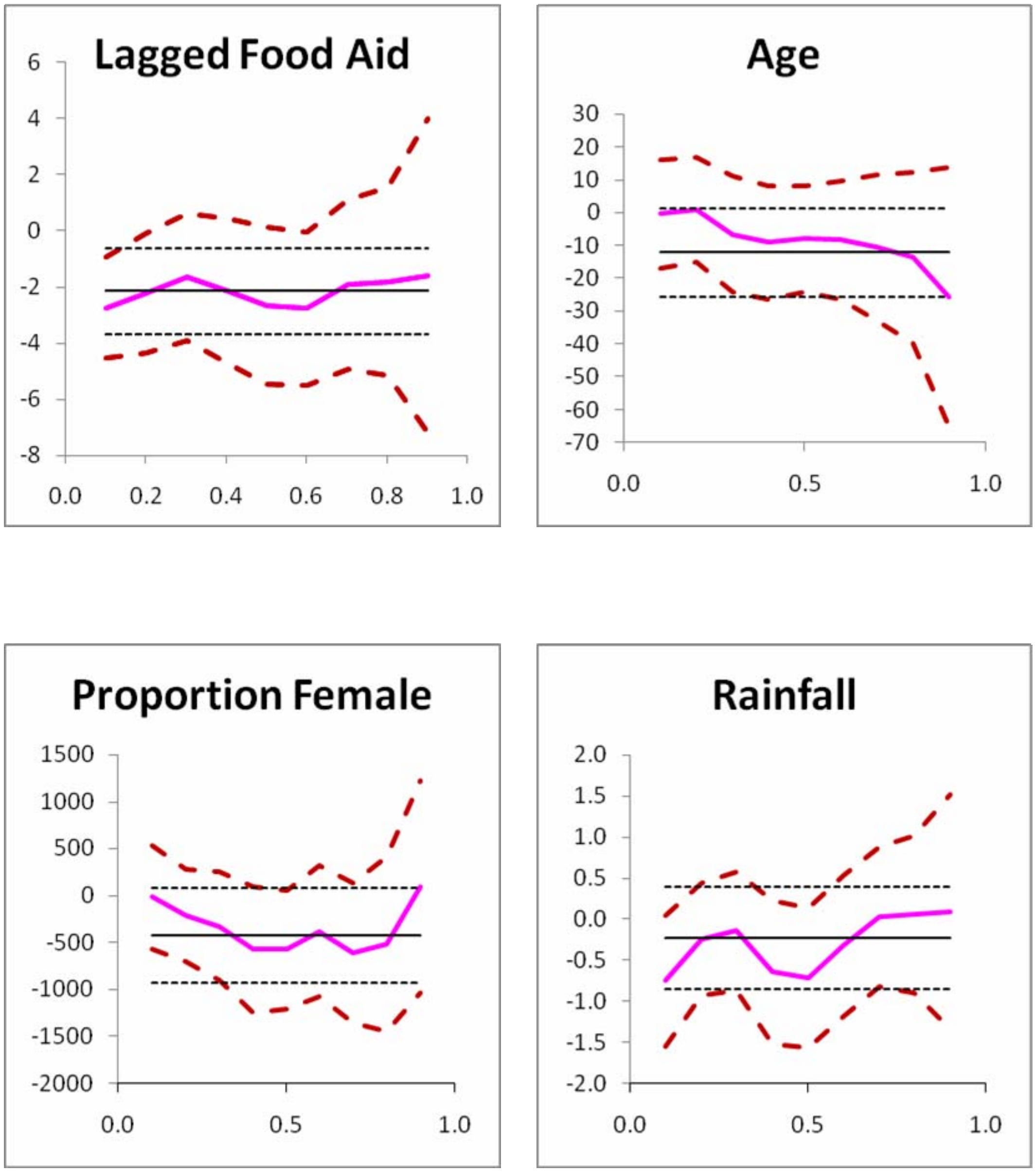

Figure A.1. Quantile regression results for selected control variables

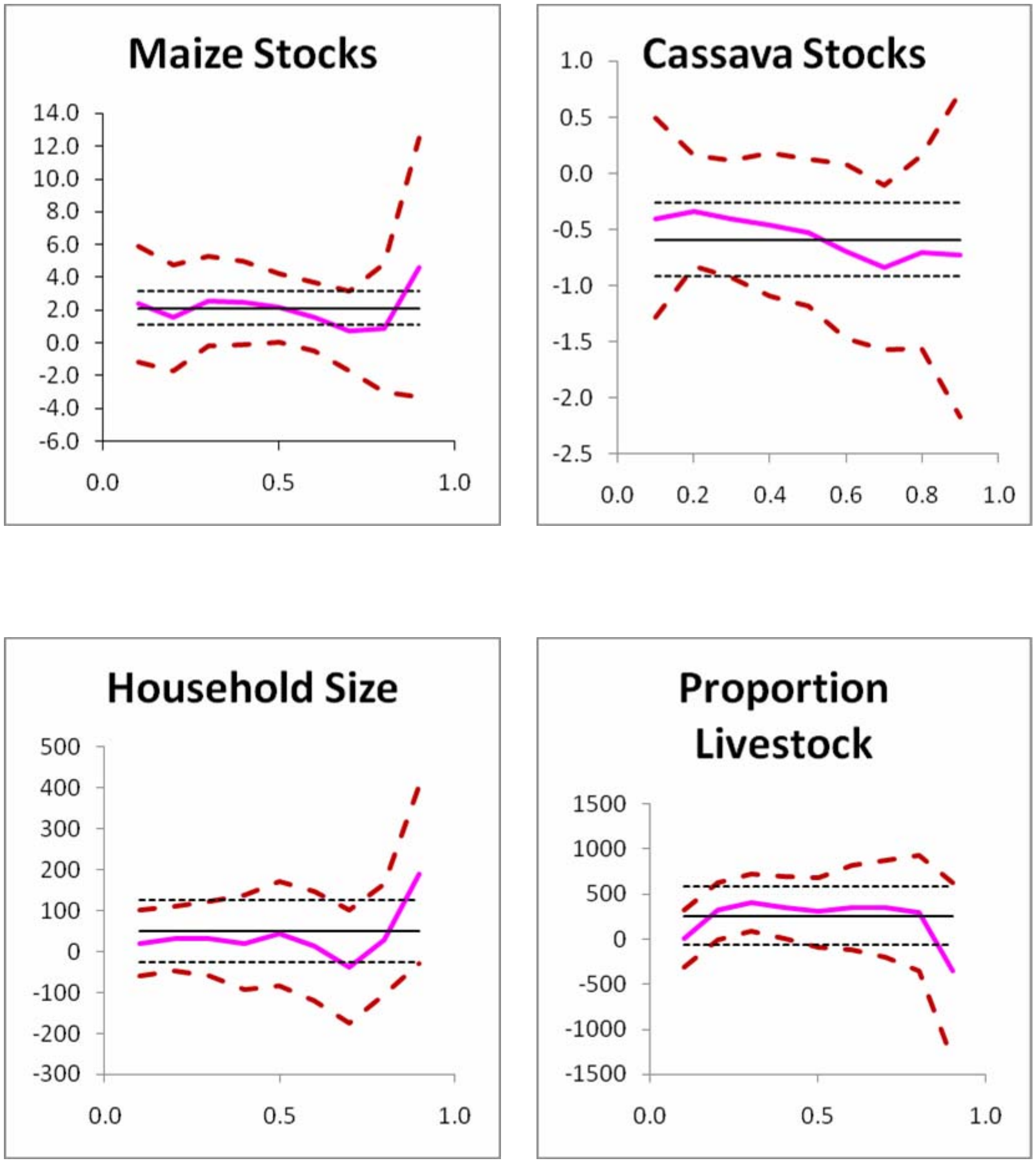

Figure A.2. Quantile regression results for selected control variables

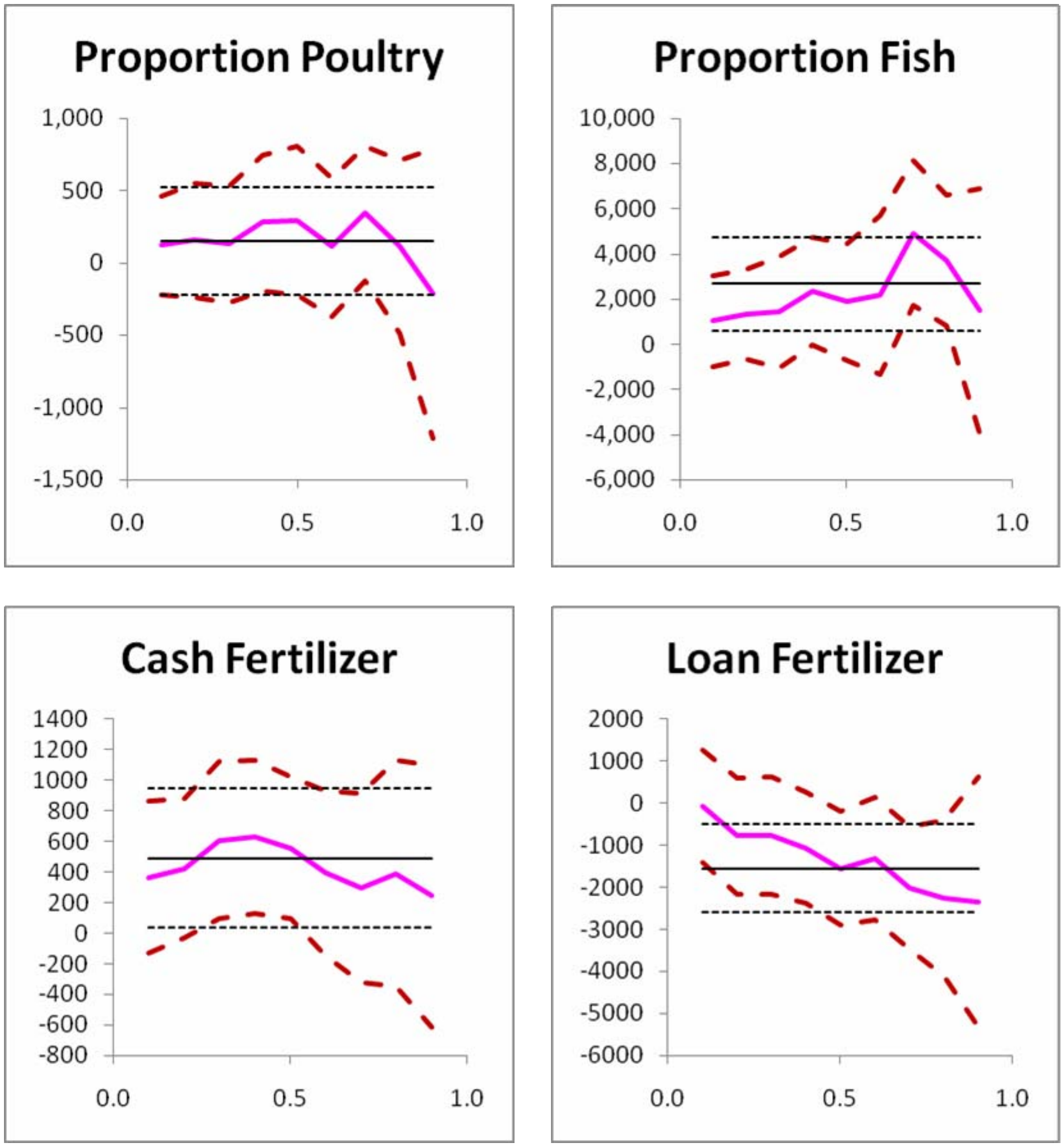

Figure A.3. Quantile regression results for selected control variables

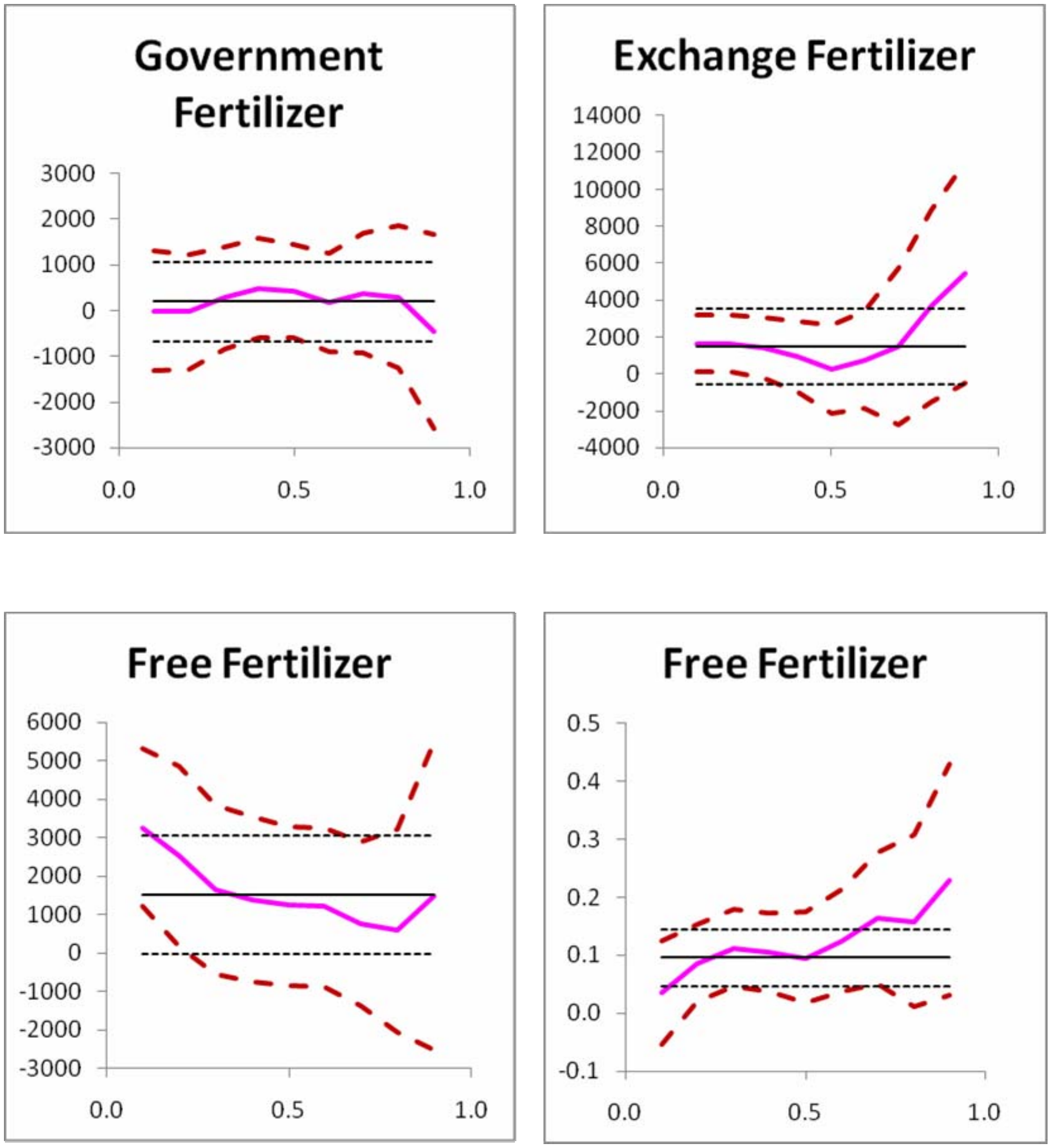

Figure A.4. Quantile regression results for selected control variables

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