Supermarkets, farm household income and poverty:

Insights from Kenya

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Supermarkets, farm household income and poverty: Insights from Kenya[1]

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Abstract

Expansion of supermarkets in developing countries is increasingly providing opportunities for farmers to participate in modern supply chains. While some farmers are excluded by stringent supermarket requirements, there are important gains for participating farmers. However, studies analyzing income effects of high-value chains use approaches that either show no causality or ignore structural differences between farmers in different channels. Using endogenous switching regression and data from a survey of vegetable growers in Kenya, we account for systematic differences and show that participation in supermarket chains yields 50% gain in household income leading to 33% reduction in poverty. Supermarket expansion is therefore likely to have substantial welfare effects if more farmers are supported to overcome inherent entry barriers.

Keywords: supermarkets, per capita income, sample selection, endogenous switching regression, Kenya, Africa

1. Introduction

Increasing demand for high-value food products in developing countries is creating incentives for expansion of supermarkets (Neven *et al.*, 2006; Reardon *et al.*, 2003). And in order to meet arising consumer concerns, emerging supermarkets increasingly adopt tighter vertical coordination involving direct procurement from farmers. These changes have crucial implications for farm households. While there is potential for exclusion of some farmers due to stringent requirements imposed by supermarkets, there are also potential welfare gains for

farmers who have access to these channels. Stable prices and contractual arrangements offered by supermarkets for instance, improve income flows for farmers in supermarket channels. Expansion of supermarkets in developing countries can therefore have substantial effects on farm household income and on rural poverty in general.

In light of these changes, there is a growing body of literature analyzing implications of supermarket expansion for rural households (Neven and Reardon, 2004; Pingali *et al.*, 2007; Reardon *et al.*, 2009). Most studies focus on determinants of participation in supermarket channels and institutional innovations for integrating farmers into these modern supply chains (Hernandez *et al.*, 2007; Moustier *et al.*, 2009; Neven *et al.*, 2009). Some studies also evaluate welfare effects of emerging supermarket chains in developing countries. However, current studies on welfare effects employ gross margin analysis (Hernandez *et al.*, 2007; Neven *et al.*, 2009) that do not reveal causality. While there may be significant differences in gross margins across market channels, such differences cannot be attributed to participation in supermarket chains without analytical procedures that show causality.

On the other hand there are also studies on the welfare effects of global supply chains (Bolwig *et al.*, 2009; Maertens and Swinnen, 2009; Minten *et al.*, 2009; Miyata *et al.*, 2009; Warning and Key, 2002; Wollni and Zeller, 2007). These global chains involve contracting of farmers in developing countries for export markets and the respective studies use standard treatment effect models to measure welfare effects while accounting for sample selection. However, the treatment models assume uniform effect across groups of observations. Yet evidence from recent studies show systematic differences between farmers supplying supermarkets and their counterparts in traditional channels (Hernandez *et al.*, 2007; Neven *et al.*, 2009). Welfare measures such as

income are therefore likely to differ structurally, depending on the market channels, especially if participation in supermarket channels is also associated with the factors that affect income.

If income functions indeed differ across market channels, then assuming uniform effect conceals inherent interaction between channel adoption and other factors influencing income. This can lead to inappropriate policy recommendation. Furthermore, understanding how factors affecting income interact with decision to participate in supermarket channels is also crucial, particularly in developing innovations aimed at enhancing famer participation in these channels.

In this paper, we analyze income effects of participation in supermarket chains using more efficient correction for sample selection. We use a switching regression model that treats market channels as regimes and thus allows for structural differences in income functions of farmers across market channels. And to account for some unobserved factors that jointly influence household income and choice of market channel, we use an endogenous version of the switching model. This yields income effects that vary according to market regimes, thus providing more accurate information that can aid targeting of market access interventions. We hypothesize an intercept shift in income function due to supermarket participation and an interaction between the choice of market channel and other factors influencing income.

Moreover, our approach allows us to simulate potential poverty effects of modern supply chains. To our knowledge none of the previous studies on welfare effects of supermarket expansion has analyzed potential effects on household income and poverty. Our study therefore provides further insights into welfare effects of modern supply chain and yields more accurate information for targeted welfare intervention. The study builds on primary data from a survey of vegetable farmers in Kiambu district of Central Kenya. Supermarkets have been expanding rapidly in

Kenya and are already venturing into sales of Fresh Fruits and Vegetables (FFV) (Neven and Reardon, 2004). Given the role of horticulture in the Kenyan economy, continued expansion of supermarket channels into FFV sales is therefore likely to have substantial welfare effects for farm households.

The paper proceeds as follows. In the next section we present the analytical framework and estimation procedure for our study. In section three we describe the data and undertake some descriptive analysis. This is followed by section four where we present and discuss results of our estimation. Section five concludes the study.

2. Analytical framework and estimation procedures

Participation in supermarket chains can be viewed as a binary choice resulting from maximization of utility or returns. Utility is in turn determined by a set of exogenous variables $\boldsymbol{Z}$, which influence the cost of adjusting to a market option with new requirements. Variables in $\boldsymbol{Z}$ also determine the relative returns that a farmer can earn from supermarket and spot market channels. These variables can therefore include farm or household characteristics, asset ownership and human capital such as education that determine the cost of adjusting to requirements of a new market.

In choosing market options, farmers therefore compare expected utility of participation in supermarket chains I_s^* against utility of participating in traditional markets I_t^* and supermarket channel is chosen if $I_s^* \geq I_t^*$. However, I_s^* and I_s^* are latent and what is observed is participation in supermarket chains I where $I = 1$ if $I_s^* \geq I_t^*$ and $I = 0$ if $I_s^* \leq I_t^*$. Participation in supermarket chains can therefore be represented as follows;

$$I = Z\alpha - v \tag{1}$$

where α is a vector of parameters and v is an error term with zero mean and variance σ^2. Since farmers are heterogeneous in their characteristics, not all farmers will overcome the adjustment costs to be able to supply in supermarket chains. Nevertheless, participation in supermarkets often yield returns that can positively affect household income. This could be due to better and stable prices and steady flow of revenues due to market assurance.

2.1. Modeling income effects

The resulting income effects can be estimated using the following model:

$$y = f(X, I) \tag{2}$$

where y is income; X is farm and household characteristics known to be affecting household income; and I is a dummy variable for participation in supermarket chains. However, income response to supermarket participation can originate from two sources. First, differences may arise purely due to characteristic differences in market channels, even if farmers do not differ in characteristics. Stable prices and market assurance by supermarkets could lead to improved and continuous flow of revenues as opposed to fluctuations that are a general characteristic of spot markets.

Secondly, if participation in supermarket chains is associated with farmer characteristics, then we would still observe differences in income between market channels. However, due to the self-selection, this difference cannot be wholly attributed to differences in market channels. The dummy *(I)* in equation (2) would therefore provide a bias estimate for income effect of supermarket participation. Heckman selection-correction model corrects for the self-selection but assumes uniform effects across market channels. This can still lead to bias estimates if there are systematic differences across groups of farmers in different market channels. Maertens and

Swinnen (2009) use an alternative approach based on propensity score matching. However, propensity score matching controls for selection on observables and may still yield bias estimates if hidden bias is substantial. A more suitable approach that corrects for self-selection and accounts for systematic differences across groups of households is a switching model (Maddala, 1983). The model treats market channels as regime shifters and can be represented as follows:

$$y_s = X\beta_s + u_s$$

$$y_t = X\beta_t + u_t$$

$$I^* = Z\alpha - v \qquad (3)$$

where y_s and y_t represents household income for supermarket and traditional channel suppliers respectively while I^* is a latent variable determining which regime applies. β_s and β_t are sets of parameters to be estimated and the variable sets X and Z are allowed to overlap. Note that y_s and y_t are only partially observed - y_s is only observed for the sample belonging to supermarket regime and y_t for the sample belonging to traditional channels. So what is totally observed is a single variable y_i defined as follows:

$$y_i = \begin{cases} y_s & \text{iff } I^* > 0 \\ y_t & \text{iff } I^* \leq 0 \end{cases} \qquad \text{and}$$

$$I = \begin{cases} 1 & \text{iff } I^* > 0 \\ 0 & \text{iff } I^* \leq 0 \end{cases} \qquad (4)$$

From (3), u_s, u_t and v are residuals that are only contemporaneously correlated and are assumed to be jointly normally distributed with a mean vector 0, and covariance matrix as follows:

$$\Sigma = \begin{pmatrix} \sigma_s^2 & \sigma_{st} & \sigma_{sv} \\ \sigma_{st} & \sigma_t^2 & \sigma_{tv} \\ \sigma_{sv} & \sigma_{tv} & \sigma^2 \end{pmatrix} \qquad (5)$$

where $var(u_s) = \sigma_s^2$, $var(u_t) = \sigma_t^2$, $var(v) = \sigma^2$, $cov(u_s, u_t) = \sigma_{st}$, $cov(u_s, v) = \sigma_{sv}$, and $cov(u_t, v) = \sigma_{tv}$. The variance of v is set to one since α is estimable only up to a scale factor (Greene, 2008; Maddala, 1986). In addition $\sigma_{st} = 0$ since y_s and y_t are never observed together (Dutoit, 2007).

The switching model so far outlined only accounts for self-selection on observed factors. Yet there could be unmeasured factors that jointly determine participation in supermarket chains and household income. Better management skills and entrepreneurial ability can for instance lead to higher farm/household income. These innate abilities can also influence decision to participate in supermarket channels. Furthermore, income status may influence supermarket participation by enhancing farmers' ability to invest in equipment necessary for participation in supermarket chains. This implies correlation between the error terms of regime equations and the error term v in selection equation and hence the need for endogenous switching regression model.

Estimates of the covariance terms can therefore provide a test for endogeneity. If $\sigma_{sv} = \sigma_{tv} = 0$ then we have an exogenous switching and if either σ_{sv} or σ_{tv} is non-zero, then we have a model with endogenous switching (Maddala, 1986). The test is achieved by testing for significance of correlation coefficient computed as $\rho_{sv} = \sigma_{sv}/\sigma_s\sigma_v$ and $\rho_{tv} = \sigma_{tv}/\sigma_t\sigma_v$ (Lokshin and Sajaia, 2004). Assuming these correlations, the expected values of truncated error terms can be expressed as follows;

$$E(u_s|I = 1) = E(u_s|v < Z\alpha) = -\sigma_{sv}\frac{\phi(Z\alpha/v)}{\Phi(Z\alpha/\sigma)} = -\sigma_{sv}\lambda_s \quad (6)$$

$$E(u_t|I = 0) = E(u_t|v \geq Z\alpha) = \sigma_{tv}\frac{\phi(Z\alpha/\sigma)}{1-\Phi(Z\alpha/\sigma)} = \sigma_{tv}\lambda_t \quad (7)$$

where $\emptyset$ and Φ are probability density and cumulative distribution of the standard normal distribution respectively. λ_s and λ_t are the ratios of $\emptyset$ and Φ evaluated at $Z\alpha$ - Inverse Mills Ratios (IMR) (Greene, 2008).

Besides providing a test for endogeneity, the signs of correlation coefficients ρ_{sv} and ρ_{tv} have economic interpretation. If ρ_{sv} and ρ_{tv} have alternate signs, then farmers choose supermarket channels on the basis of their comparative advantage (Fuglie and Bosch, 1995; Maddala, 1983; Trost, 1981; Willis and Rosen, 1979). Thus, if $\rho_{sv} < 0$, then farmers having income above average income for supermarket suppliers have higher than expected chances of participating in supermarket channels. Similarly if $\rho_{tv} > 0$, then individuals with incomes above average income of farmers supplying traditional channels have lower than expected chance of supplying supermarkets. Consequently farmers who supply supermarket channels will have above average returns from supplying supermarkets. Similarly those who supply traditional channels have above average returns from supplying traditional channels.

Alternatively when $\rho_{sv} < 0$ and $\rho_{tv} < 0$, then there is evidence of "hierarchical sorting" (Fuglie and Bosch, 1995; Trost, 1981). In other words, supermarket suppliers have above average returns whether or not they participate in supermarket channels but are better off in supermarket channels. Similarly, traditional channel suppliers have below average returns in either case but are better off supplying traditional channels. Interpretation of the covariance terms also provides proof for consistency of the model which requires that $\rho_{sv} < \rho_{tv}$. This condition also implies that supermarket suppliers earn higher income than they would earn if they supplied traditional channels(Trost, 1981).

2.2 Estimation procedure

Assuming correlation of the error terms implied in equations (6) and (7), a two-stage method can be used to estimate the model. The first stage probit model [$I_i^* = Z\alpha - v$] provides estimates of α which are then used to estimate the IMRs [λ_s and λ_t]. The IMRs are then treated as "missing variables" in estimating regime equations in (3) by OLS. In order to identify the model we need to ensure that at least one variable in $\boldsymbol{Z}$ does not appear in $\boldsymbol{X}$. The coefficients of IMRs would then provide estimates of covariance terms σ_{sv} and σ_{tv}. This approach yields consistent but inefficient estimates of parameters especially if coefficients of λ_s and λ_t are nonzero (Fuglie and Bosch, 1995; Trost, 1981). A more efficient approach is the full information maximum likelihood (FIML) method for endogenous switching regression (Greene, 2008; Lokshin and Sajaia, 2004). This provides for joint estimation of regime equations and the selection equation.

Note that the coefficients β_s and β_t in equation (3) measure the marginal effects of independent variables on household income *unconditional* on farmers actual market choice, i.e. the potential effect of $\boldsymbol{X}$ on the sample. If there are variables that appear both in $\boldsymbol{X}$ and $\boldsymbol{Z}$, the coefficients can, however, be used to estimate conditional effects as follows;

$$\frac{\delta E(y_s|I=1)}{\delta X_j} = \beta_{sj} - \alpha_j \sigma_{sv} \frac{\phi(Z\alpha/\sigma)}{\Phi(Z\alpha/\sigma)}\left[Z\alpha/\sigma + \frac{\phi(Z\alpha/\sigma)}{\Phi(Z\alpha/\sigma)}\right] \quad (8)$$

Equation (7) decomposes effect of change in X_j into two parts: β_{sj} is the direct effect on the mean of y_s; the second part is the indirect effect from market choice that appears as a result of correlation between unobserved component of y_s and $\boldsymbol{I}$.

2.3. Estimating income effect of supermarket participation

In order to evaluate the income effect of participation in supermarket channels, we need to estimate conditional expectation of income per capita that participants would have without participation in supermarket channels (Maddala, 1983). This can be estimated, holding other characteristics constant via the following steps. Assuming a farmer with farm and individual characteristics ***(X, Z)*** who participates in supermarket chains, the expected value of y_s is:

$$E(y_s|I = 1) = X\beta_s - \sigma_{sv}\lambda_s \quad (9)$$

where the last term takes into account sample selectivity. For the same farm, predicted value of y_t (expected value of *y* if the same farm does not participate) is:

$$E(y_t|I = 1) = X\beta_t + \sigma_{tv}\lambda_s \quad (10)$$

The change in income per capita due to participation in supermarket channels would then be:

$$E(y_s|I = 1) - E(y_t|I = 1) = X(\beta_s - \beta_t) + (\sigma_{tv} - \sigma_{sv})\lambda_s \quad (11)$$

If self-selection is based on comparative advantage, $\sigma_{tv} - \sigma_{sv}$ would be greater than zero and supplying supermarkets will produce greater benefits under self-selection than under random assignment (Maddala, 1983).

3. Data and descriptive statistics

3.1. Farm survey

Data for this study was collected in 2008 from Kiambu District of Central Province in Kenya. Kiambu is located in relative proximity to Nairobi and even before the spread of supermarkets it has been one of the main vegetable-supplying areas for the capital city. Based on information from the district agricultural office, four of the main vegetable-producing divisions were chosen.

In these four divisions, 31 administrative locations were purposively selected, again using statistical information on vegetable production. Within the locations, vegetable farmers were sampled randomly. Since farmers that participate in supermarket channels are still the minority, we oversampled them using complete lists obtained from supermarkets and supermarket traders. In total, our sample comprises 402 farmers – 133 supermarket suppliers and 269 supplying vegetables to traditional markets. Using a structured questionnaire, these farmers were interviewed on vegetable production and marketing details, other farm and non-farm economic activities, as well as household and contextual characteristics.

Both types of farmers produce vegetables in addition to maize, bananas, and other cash crops. The main vegetables produced are leafy vegetables, including exotic ones such as spinach and kale, and indigenous ones such as *amaranthus* and black nightshade, among others.[1]

Insert Figure 1 here

Figure 1 shows the different marketing channels for vegetables used by sampled farmers. Some supermarket suppliers also sell vegetables in traditional spot markets when they have excess supply. However, for analytical purposes, farmers that supply at least part of their vegetables to supermarkets are classified as supermarket suppliers.

Spot markets sales are one-off transactions between farmers and retailers or consumers with neither promise for repeated transactions nor prior agreements on product delivery or price. Depending on the demand and supply situation, prices are subject to wide fluctuation. Farmers who are unable to supply directly to wholesale or retail markets sell their produce to spot market traders who act as intermediaries. Such traders collect vegetables at the farm gate without any prior agreement. In contrast, supermarkets do have agreements with vegetable farmers regarding

product price, physical quality and hygiene, and consistency and regularity in supply (Ngugi *et al.*, 2007). Price agreements are made before delivery, and prices are relatively stable. Payments are usually only once a week or every two weeks. All agreements are verbal with no written contract. Some farmers also supply supermarkets through special traders. Based on similar verbal agreements, these traders again maintain regular contacts with farmers, in order to be able to supply supermarkets in a timely and consistent way. Strict supply requirements by supermarkets have led to specialization among traders. Consequently supermarket traders tend to exclusively supply modern retail outlets.[2]

Given the risk of exclusion from emerging modern supply chains for disadvantaged farmers, there are various organizations in Kenya linking smallholders to supermarket and export channels. One such organization active in Kiambu is the NGO Farm Concern International (FCI). FCI trains farmer groups on production of indigenous vegetables before linking them to various supermarkets in Nairobi (Moore and Raymond, 2006; Ngugi *et al.*, 2007). FCI also promotes collective action and – through training efforts – helps farmers to meet the strict delivery standards imposed by supermarkets. Our sample covers 80 vegetable farmers currently involved in the FCI project in Kiambu District. Out of these, more than half were already supplying supermarkets at the time of our survey.

3.2. Descriptive analysis

Table 1 shows some descriptive comparison of the two groups of farmers. Farmers in the two market channels show differences in land ownership, vegetable area cultivated and in the use of irrigation equipment. They also show differences in education levels and farming experience. On average, supermarket suppliers own more land and cultivate significantly large area of vegetables. They also tend to specialize in vegetable production judging from the significant

difference in share of vegetable area. Significantly greater proportion of supermarket suppliers also use advanced irrigation technology, which is seemingly a move to meet supermarket requirement for consistent supply of vegetables.

Insert Table 1 here

Supermarket suppliers are also significantly younger but have shorter farming experience compared to spot market suppliers. Significantly larger proportion of supermarket suppliers also engages in off-farm employment.

Apart from differences in various socioeconomic variables of interest, we carry out economic analysis of participation in supermarket channels. In Table 2 we present a comparison of gross margin between farmers in the two market channels.

Insert Table 2 here

The two groups of farmers show significant differences both in revenues and expenditure on inputs. The differences in revenue is driven both by yields and prices which are higher for supermarket suppliers. In terms of costs, supermarket suppliers spend significantly more on hired labour and purchased manure. These higher expenditures reflect higher use of respective inputs as shown in Table 1. Supermarkets use more labor partly due to extra workforce needed for packing of vegetables (Neven *et al.*, 2009) and partly due to more regular use of certain inputs such as purchased manure. This extra demand for hired labor by supermarket suppliers implies employment creation for rural landless households. Farmers supplying supermarkets, however use slightly less inorganic fertilizer. Instead, they use more farmyard manure, which they believe leads to quicker regeneration of leaves after harvest. This is particularly important for supermarket suppliers that have to supply vegetables more regularly.

These differences in revenues and costs result into significantly higher net income per acre for supermarket suppliers. The picture remains the same even after imputing values for own inputs such as family labor and own farmyard manure. Unsurprisingly, traditional channel suppliers use significantly more family labor in vegetable production. These differences in average values of gross margin are replicated across the entire distribution as can be seen from Figure 2. The CDF of gross margin for supermarket suppliers significantly dominate the CDF for spot market suppliers.

Insert Figure 2 here

The higher net margin somehow also contributes to higher farm incomes for supermarket suppliers. However, supermarket suppliers also have higher non-farm income and a combination of the two income sources yields higher total household income for supermarket suppliers. This is true both for farmers supplying supermarket on their own as well as for farmers supplying supermarket via institutional support from FCI. Compared to farmers supplying supermarkets on their own, FCI-supported farmers are nevertheless inferior in all the income classes. This already provides an indication of structural differences in household income between supermarket and traditional channel suppliers.

Insert Figure 3 here

Besides the average values in Figure 3, we also show cumulative distribution of per capita household income by market channels in Figures 4. The two figures show that supermarket farmers are significantly superior in both farm and household income nearly across the entire distribution.

Insert Figure 4 here

These superior income distributions translate into lower poverty incidence among supermarket suppliers as can be seen from Figure 5. Poverty incidences were calculated based on 1.25 dollar and 2 dollar poverty lines converted to local currency equivalents using purchasing power parity (PPP) exchange rates. The PPP rates for Kenya was 1 dollar to 29.52 Kenya shillings as at 2005 (International Bank for Reconstruction and Development, 2008). This has been updated to current rates using consumer price index. Relative to the rest of the country, Kiambu district has lower poverty rates and therefore lower poverty incidences in our sample should not be a surprise. Kiambu is indeed the least poor district in Kenya with a rural poverty incidence of 22% (Ndeng'e *et al.*, 2003).

Insert Figure 5 here

Besides income, land can also be a sign of wealth and may therefore influence participation in supermarket channels if channel choice is based on relative wealth status of farmers. We therefore show distribution of land ownership by market channels in Figure 6. While on average supermarket farmers tend to own significantly more land, a disaggregated analysis show a slightly different picture.

Insert Figure 6 here

Excluding supermarket farmers supported by FCI, it appears the two market channels have less difference in land ownership. This is true for the three categories of land ownership. We also realize that the FCI-supported group of supermarket suppliers has the largest share of farmers with relatively more land. Differences in average values shown in Table 1 are therefore largely driven the share of FCI farmers owning more than three acres of land. Most farmers currently

supplying supermarket through FCI-supported linkage are located in Githunguri and Lower Lari regions where farmers generally own more land. These are the regions much further from Nairobi where there is still relatively less subdivision of land. Looking at average values alone may therefore give an unrealistic impression that supermarket channels favor large farmers.

4. Econometric Analysis

The descriptive analysis explored so far reveal significant differences in income and other socioeconomic characteristics between farmers in the two market channels. While we have attempted some distributive analyses that reveal some facts usually concealed by averages, it still remains uncertain if revealed differences can be attributed to participation in supermarket channels. To confirm causality we need econometric approaches that link supermarket participation and income outcomes.

As outlined in the methodology we apply an endogenous switching regression model to estimate income effects of participation in supermarket channels. The income model is estimated jointly with the model for participation in supermarket channels. We therefore present results for channel choice before discussing income effects of participation in supermarket channels.

4.1 Determinants of participation in supermarket channels

Results for determinants of participation in supermarket channels are presented in Table 3. Alongside typical farm and household characteristics, we hypothesize that institutional support through FCI enhances farmer access to supermarket channels. Therefore, we include participation in the FCI market linkage program as an additional explanatory variable – defined as a dummy. Yet, participation in that program might potentially be endogenous, which would lead to a bias in the coefficient estimate. We test for endogeneity of the FCI dummy using a two-

step approach suggested by Rivers and Vuong (1988). Using membership in a farmer group, which is correlated with FCI but not with supermarket channel participation, as an instrument, we run a probit regression of FCI. Predicted residuals from this regression are then included as additional explanatory variable in supermarket participation model and the null hypothesis to be tested is that residuals are not significant – implying exogeneity of FCI variable. The test fails to reject this null hypothesis (p = 0.664). So we proceed with the analysis assuming the FCI variable to be exogenous. The probit model is estimated jointly with the income function using endogenous switching model as illustrated under section 2.2.

Insert Table 3 here

The findings show that participation in supermarket channels depends on level of education and age of the farmer. Better educated farmers are more likely to participate in supermarket channels. Bette educated farmers tend to be more innovative and are therefore more likely to adopt modern marketing channels. The relationship between age and participation in supermarket channels assumes an inverted U-shape indicating that middle-aged farmers are more likely to participate in supermarket channels.

Farmers who engage in off-farm employment are also more likely to participate in supermarkets. This could be due to capital investment necessary for participation in supermarket channels which is seemingly supported by income from off-farm activities. Ownership of land of land also has a positive and significant influence on supermarket participation. This result should, however, be interpreted with caution since as shown in the descriptive statistics, distribution of land ownership does not vary much when we exclude the sample of farmers supported by FCI.

Access to public transport and ownership of means of transport also enhances farmers' access to supermarket channels. This result underscores the general importance of infrastructure in meeting supermarket requirement for timely and regular delivery of vegetables.

Finally, institutional support by FCI has a positive and significant influence on supermarket participation. FCI negotiates with supermarkets on behalf of farmers, facilitates collective marketing approach by farmers and offers training to farmer groups on production technique and supermarket requirements. This reduces transaction costs and makes smallholder farmers more reliable trading partners for supermarkets. Equally important is the invoice discounting service by FCI, which enables even relatively poor households with immediate cash needs to participate in supermarket channels, despite the lagged payment schedule. These are important findings from a policy perspective. Where no NGO like FCI is operating, public agencies might potentially take on such roles of institutional support.

4.2 Income effect of participation in modern supply chains

While there could be limited access to supermarkets for disadvantaged farmers, those with access could realize improvement in household income due to better price and steady flow of revenues. Given possibility for systematic differences between farmers in the two channels, we expect income responses to control variables to vary depending on market channels. Results for the endogenous switching model are presented in Table 4. To identify the model, two variables in the probit model – dummy for participation in FCI project and access to public transportation are excluded from the income function.

Results indicate that suppliers to the two market channels indeed have incomes that differ structurally from each other. For supermarket farmers, off-farm employment and ownership of

own means of transport have a positive and significant effect on household income per capita. The significance of off-farm employment in both channel choice and income model for supermarket suppliers is an indication of joint determination of income status and channel choice. Off-farm employment also has a positive and significant impact on income per capita for spot market suppliers but the effect is smaller.

Insert Table 4 here

Ownership of own means of transport is also significantly positive for both channels but the effect is much higher for supermarket suppliers. This could be an indication of the activities that the means of transport supports. For supermarket suppliers own cars are used for delivery of vegetables to supermarkets which could be generating more returns than sport market suppliers' activities supported by own cars.

Land ownership also influences income positively and significantly but only for spot market suppliers. More land often implies more output and this can positively affect farm income leading to higher household income. Farmers with more land can also lease out portions of their land for income. Use of advanced irrigation technology also matters for income of spot market suppliers. This could be an indication of self-selection into supermarket on the basis of use of advanced irrigation technology. It is also an indication that spot market suppliers who use irrigation have the chance to supply vegetable during off-season when prices are generally higher and are thus able to generate more revenues than farmers without advanced irrigation technology. Ownership of livestock also has a positive and significant effect on income for spot market suppliers. In response to seasonal fluctuation in vegetable market especially in the traditional channels, most farmers diversify into dairy activities where prices of milk remain relatively stable. It is therefore likely that farmers facing uncertainty in vegetable markets will

diversify into dairy farming. Hence the relative importance of livestock keeping for spot market suppliers.

The lower panel of Table 4 reports estimates for the covariance terms. The terms have similar signs, which is an indication of "hierarchical sorting". Supermarket suppliers therefore have above average returns whether or not they participate in supermarket channels but are better off in supermarket channels. The covariance estimate for spot market suppliers is, however, insignificantly different from zero. Furthermore, since $\rho_{zu} < 0$, we find evidence of self-selection based on comparative advantage. Farmers with income above average per capita income for supermarket suppliers therefore have higher than expected chances of participating in supermarket channels. The model also fulfils the necessary condition for consistency [$\rho_{zu} < \rho_{tu}$]. Supermarket suppliers therefore earn higher income than they would earn if they supplied traditional channels.

We also show the likelihood ratio test for joint independence of the three equations. The test shows significant dependence between selection and income equations; thus indicating further evidence of endogeneity. It is also important to note that in the absence of supermarket participation, there would be no significant difference in average behavior of the two categories of farmers caused by unobserved effects. This is evident from the insignificance of the covariance estimate for spot market suppliers.

Finally we also estimate income effects as illustrated in equation (10). Results for estimation of equation (11) are presented in Table 5, where effects are presented for different categories of farmers. We also use the predicted household income to simulate poverty incidence. Poverty incidence is estimated using predicted income with participation in supermarket channels. This is

then compared to potential poverty incidence that would be realized if supermarket suppliers were supplying traditional channels. Results are shown in the lower panel of Table 5.

Insert Table 5 here

Results show significant gains in per capita income due to participation in supermarket channels. This is true for the whole sample of supermarket suppliers and for different categories of supermarket suppliers. For the whole sample of supermarket suppliers, participation in supermarket channels yields a fifty-percentage increase in per capita income. However, smaller farmers owning less than one acre of land and the extremely poor supermarket suppliers benefit over-proportionally. Poorer farmers tend to engage largely in subsistence farming. Participation in supermarket channels for such households thus provides an avenue for commercialization farm activities leading to substantial gains in household income.

Farmers supplying directly to supermarkets also gain more from supermarket participation as compared to their counterparts supplying through traders. In the absence of intermediaries, a bigger share of price premium paid by high-value consumers accrues to producers leading to significant gains for direct suppliers. The over-proportional gains in income for poor farmers lead to larger significant reduction in poverty for the poorer category of supermarket suppliers. These results should, however, be interpreted with caution since the proportion of poorer farmers supplying supermarkets is quite small and may not reflect the general extent of benefit for the wider poor households. The estimation also assumes constant characteristics of household in alternative market channels. This is a strong assumption since we cannot guarantee that supermarket farmers would exhibit similar characteristics if they were in spot market channels. Nevertheless, the findings show that there is scope for improving household income via

participation in modern supply chains.

5. Conclusion

Increasing demand for high-value food commodities and resulting expansion of supermarkets in developing countries is providing opportunities for farmers to participate in modern supply chains. While stringent conditions by supermarkets may limit some farmers from accessing supermarkets channels, participating farmers stand to gain substantially. Recent studies on high-value chains in developing countries have looked into determinants of access and potential gains from participation. However, these studies either adopt gross margin analyses which show no causality or use treatment effect models that assume uniform effect across farmers in different market channels.

Based on primary survey data of vegetable growers in Kenya, we find that better educated and middle-aged farmers are more likely to participate in supermarket channels. Land and off-farm employment which are indications of wealth status also increase the chances for participation in supermarket channels by farmers. Supermarkets also favor farmers with better access to infrastructure and those with own means of transport. More importantly, institutional support is shown to enhance participation of farmers in supermarket channels.

Furthermore, we have also shown that participation in supermarket channels yields significant income gains. Yet the two groups of farmers have different income structures. Since, our analysis shows joint determination of income and supermarket channel choice, having accurate information on income determinants is crucial in designing policies aimed at enhancing farmers' access to high-value markets. Given the joint role of off-farm employment for instance, policies supporting off-farm enterprises are likely to yield greater returns for spot market suppliers. Far

from directly improving household income, such policies would facilitate spot market suppliers' access to high-value chains. This would lead to further improvements in household income – producing a ripple effect of such income diversification programs. Consequently, there would be significant reduction in poverty among farming households. These effects can particularly be stronger given the overall importance of horticultural production in the Kenyan economy and the likely spread of supermarkets to regional cities of the country.

More importantly we have shown that poorer farmers benefit over-proportionally from supplying supermarkets. Yet it is this category of farmers who face the threat of exclusion from modern supply chains. Interestingly, our analysis has also shown that institutional support enhances farmer participation in supermarket channels. However, proper targeting of such institutional support is necessary to ensure wider benefit by poorer households. This is particularly important in light of the revealed self-selection of farmers into supermarket chains. Such targeted intervention will become more crucial as supermarkets expand in the developing world and the targeting can benefit from the accurate estimation undertaken here.

1. Recently, African indigenous vegetables have received renewed attention from upper and middle income consumers (Moore and Raymond, 2006; Ngugi et al., 2007).

2. Initially, supermarkets in Kenya purchased fresh vegetables in traditional wholesale markets, which can still be observed today. However, meanwhile supermarkets have diversified their procurement to include contracted farmers and traders, in order to ensure price stability and consistency in quality and supply.

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Table 1: *Differences between farmers supplying supermarket and spot markets*

Variables	**Supermarket (133)**	**SD**	**Spot market (269)**	**SD**
Household and farm characteristics				
Total area owned *(acres)*	2.692**	5.607	1.870	2.485
Total vegetable area cultivated *(acres)*	1.168***	1.457	0.697	0.992
Share of vegetable area *(%)*	68.8*	31.9	62.8	32.5
Use of advanced irrigation equipment *(%)*	87.9***	32.7	71.4	45.3
Age of operator *(years)*	47	12	49	15
Educations *(years of schooling)*	10.3***	3.14	8.72	4.05
General farming experience *(years)*	16.16**	11.60	17.89	13.33
Farmer participation in off-farm employment (%)	61***	47	43	50
Plot-level variables				
Fertilizer use *(kg/acre)*	362.56**	548.76	494.21	640.19
Pesticide use *(ml/acre)*	2,251.22	4,083.44	2,745.51	4,382.22
Purchased manure use *(kg/acre)*	15,926**	28,107	11,108	19,329
Own manure use *(kg/acre)*	5,550	15,693	6,107	14,473
Hired labor use *(labor days/acre)*	215.36**	296.29	164.28	276.98
Family labor use *(labor days/acre)*	307***	395	489	632
Total labor use *(labor days/acre)*	522**	472	653	734

****,** and * Significantly different at 1% , 5% and 10% levels respectively*
[a] 1US dollar = 75 Ksh.

Table 2: *Gross margin differences over market channels*

	Supermarket (n=133)		**Spot market (n=269)**	
	Mean	**SD**	**Mean**	**SD**
Gross revenue *(Ksh/acre)*	**116,636*** **	**129,370**	**73,179**	**60,136**
Seed cost *(Ksh/acre)*	2,175	5,428	1,660	3,021
Hired labor cost *(Ksh/acre)*	6,330**	10,019	4,722	7,481
Cost of other inputs				
Fertilizer *(Ksh/acre)*	4,846*	7,485	5,781	6,379
Purchased manure *(Ksh/acre)*	8,666***	14,099	5,712	8,751
Pesticides *(Ksh/acre)*	1,104	1,922	1,179	1,835
Other costs *(Ksh/acre)*	1,271**	4,723	623	2,167
Net income *(Ksh/acre)*	**92,244*** **	**114,202**	**53,502**	**54,677**
Family labor *(Ksh/acre)*	9,775**	21,297	13,951	16,570
Own manure *(Ksh/acre)*	2,520	7,253	2,687	7,575
Net income *(Ksh/acre)*	**79,950*** **	**112,246**	**36,865**	**54,004**

****,** and * Significantly different at 1% , 5% and 10% levels respectively*
[a] 1US dollar = 75 Ksh.

Table 3: *Probit model for determinants of participation in supermarket channel*

	Coefficient	**SE**
Gender of operator *(male dummy)*	0.383	0.286
Education of operator *(years)*	0.044*	0.026
Total area owned *(acres)*	0.060**	0.028
Limuru region *(dummy)*	-0.637	0.490
Kikuyu/Westland region *(dummy)*	0.900*	0.459
Githunguri and Lower Lari region *(dummy)*	0.497	0.496
Off farm employment *(dummy)*	0.342**	0.159
Use of advanced irrigation equipment *(dummy)*	0.155	0.222
Household access to electricity *(dummy)*	0.181	0.208
Own means of transportation *(dummy)*	0.615***	0.229
Household size *(number of people)*	-0.161***	0.051
Proximity to tarmac road *(dummy)*	0.110	0.182
Household access to public piped water *(dummy)*	-0.311*	0.178
Age of operator *(years)*	0.136***	0.045
Age of operator squared *(years)*	-0.002***	4.650^{-04}
Credit accessed in last 12 months *(dummy)*	0.012	0.260
Ownership of livestock *(dummy)*	0.010	0.186
Availability of public transportation in village *(dummy)*	0.432*	0.242
Participation in FCI market linkage program *(dummy)*	0.835***	0.243
Constant	-5.003***	1.199
Number of observations		*402*

*, **, *** Significant at the 10%, 5%, and 1% level, respectively.

Note: Regions represent agro-ecological conditions; regional boundaries differ slightly from administrative divisions.

Table 4: *Full information maximum likelihood parameter estimates for household income*

	Supermarket suppliers		Spot market suppliers	
	Coefficient	**SE**	**Coefficient**	**SE**
Dependent variable: household income per capita				
Gender of operator *(male dummy)*	7.935	39.000	11.730	9.551
Education of operator *(years)*	1.430	3.282	1.324	0.884
Total area owned *(acres)*	1.176	1.958	7.234***	1.412
Limuru region *(dummy)*	126.000	84.540	11.210	12.330
Kikuyu/Westland region *(dummy)*	-35.230	75.440	5.584	13.110
Githunguri and Lower Lari region *(dummy)*	-62.180	78.900	5.160	13.640
Off farm employment *(dummy)*	50.990**	20.400	25.380***	6.299
Use of advanced irrigation equipment *(dummy)*	9.440	29.830	18.000**	7.257
Household access to electricity *(dummy)*	8.532	28.070	16.680**	7.281
Own means of transportation *(dummy)*	87.920***	23.720	34.470***	11.720
Household size *(number of people)*	-6.807	5.691	-1.783	1.762
Proximity to tarmac road *(dummy)*	-1.202	19.700	5.251	6.467
Household access to public piped water *(dummy)*	-42.540**	21.230	9.426	6.991
Age of operator *(years)*	0.900	0.910	-0.143	0.249
Credit accessed in last 12 months *(dummy)*	-62.180**	30.490	-10.620	10.040
Ownership of livestock *(dummy)*	14.250	25.390	20.550***	6.371
Constant	76.810	102.800	-36.870*	21.520
ln σ_s	4.652***	0.082		
ρ_{sv}	-0.455**	0.215		
ln σ_c			3.853***	0.043
ρ_{cv}			-0.020	0.189
Likelihood ratio test of independent equations χ^2				*2.870**
Number of observations				*402*
Log likelihood				*-2401.445*
F-statistics χ^2				*67.700****

*, **, *** Significant at the 10%, 5%, and 1% level, respectively.

Note: Regions represent agro-ecological conditions; regional boundaries differ slightly from administrative divisions.

Table 5: *Simulated effect of participation in supermarket on income and poverty incidence*

Description	Expected value of incomes			
	No. Of obs.	**Without supermarket**	**With supermarket**	**Net change (%)**
Household income per capita (1,000 Ksh)				
All supermarket suppliers	133	72.977	109.260	50***
By land holdings				
Supermarket suppliers owning < 1 acres of land	62	52.039	87.494	68***
Supermarket suppliers owning 1-2 acres of land	29	70.360	100.543	43***
Supermarket suppliers owning >2 acres of land	42	105.691	147.411	39
By income category				
Extremely poor supermarket suppliers	5	58.605	110.337	88*
Moderately poor supermarket suppliers	12	45.210	68.356	51
Non-poor supermarket suppliers	116	76.469	113.445	48***
By supply category				
Direct suppliers	52	76.595	131.582	72***
Suppliers through traders	35	71.567	101.677	42**
FCI supported suppliers	46	69.959	89.797	28*
		Household distribution (%)		
Category				
Extremely poor		3	2	-33
Moderately poor		3	3	0
Non-poor		94	95	1

*, **, *** Significant at the 10%, 5%, and 1% level, respectively.

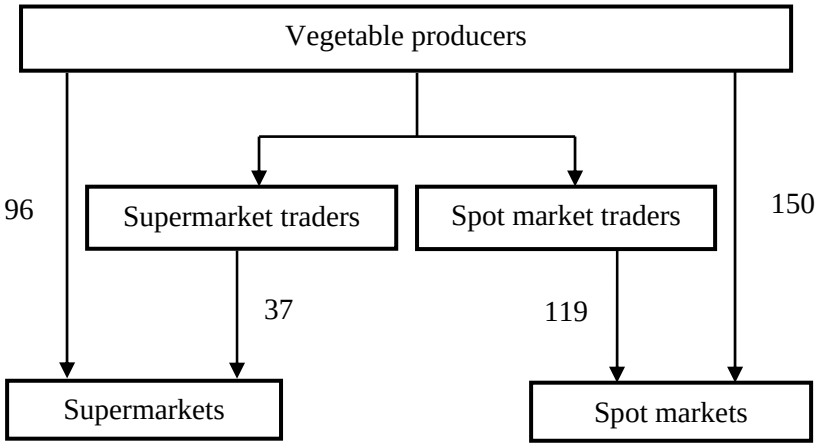

Figure 1. *Vegetable marketing channels among Kenyan sample farmers*

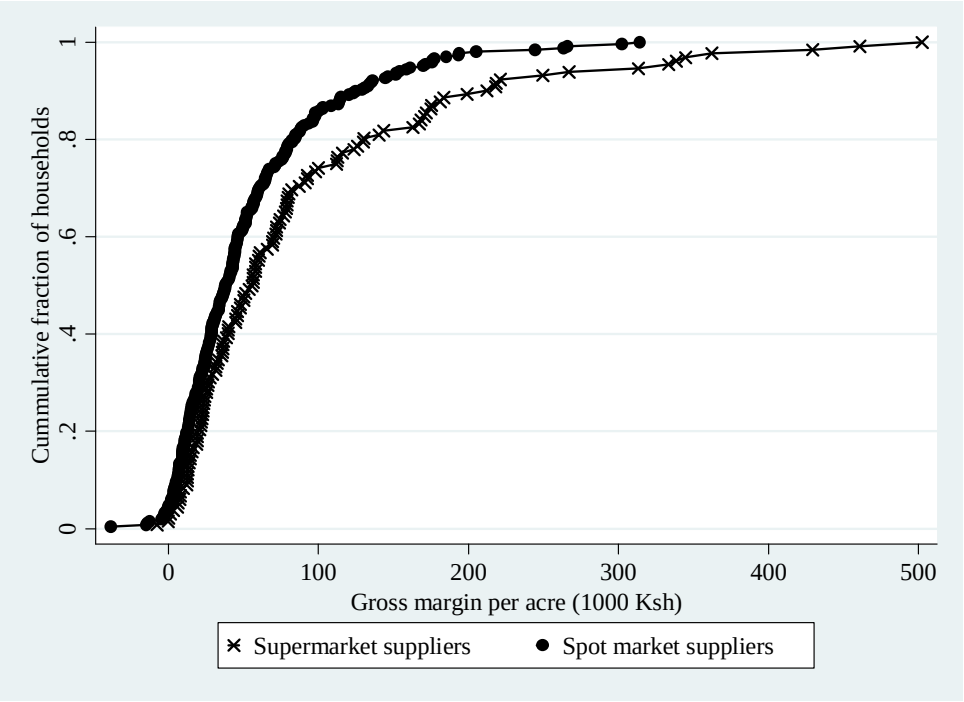

Figure 2: *Cumulative distribution of gross margin by market channel (K-S D-statistics =0.170 (p=0.009))*

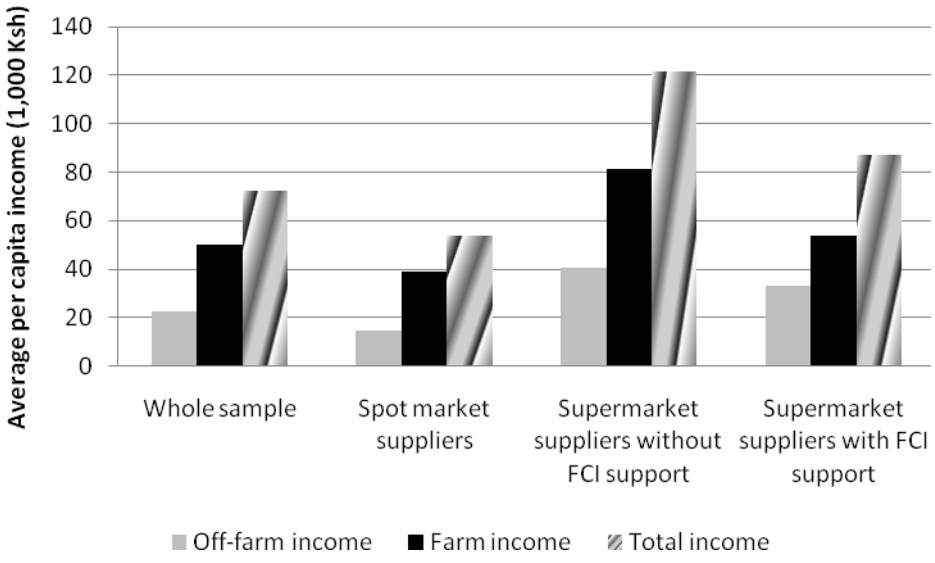

Figure 3: *Average per capita income by market participation*

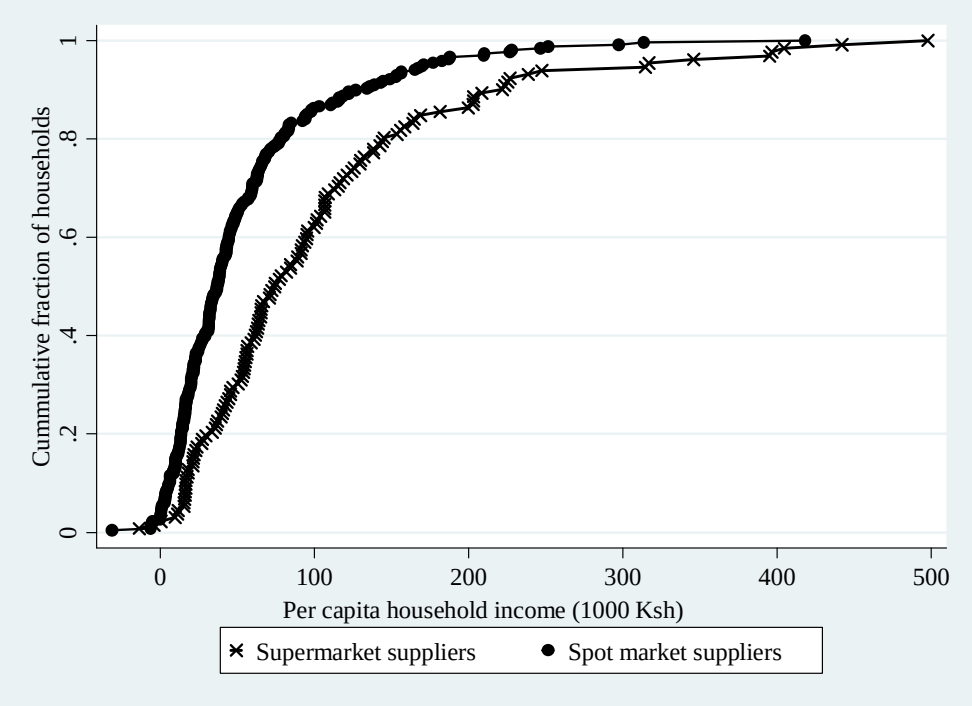

Figure 4: *Cumulative distribution of per capita household income by market channel (K-S D-statistics =0.361 (p=0.000))*

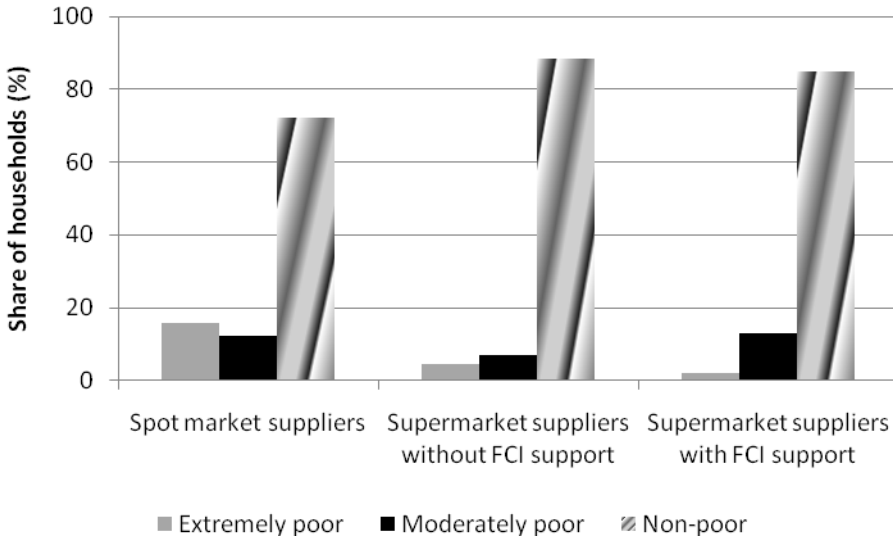

Figure 5: *Incidence of poverty by market participation*

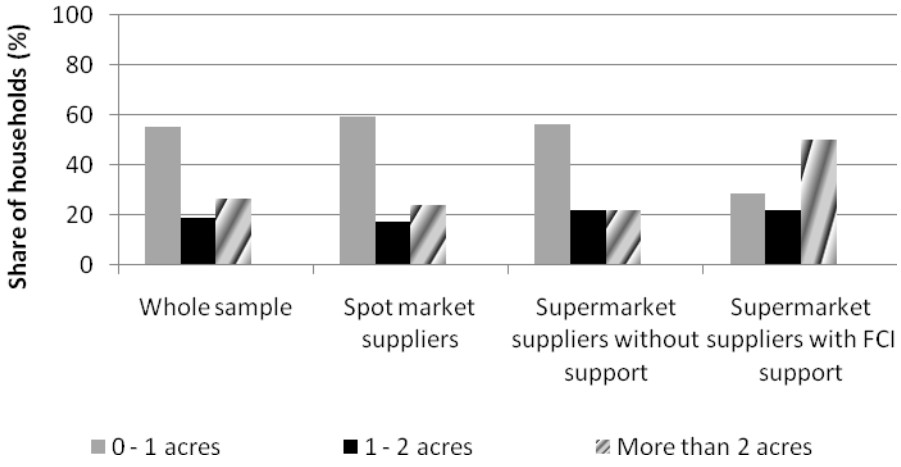

Figure 6: *Distribution of land ownership by market participation*