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Agricultural Supply Response and Smallholders Market Participation – the Case of Cambodia

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Abstract

This paper explores the key causal factors behind agricultural supply response and farmers' market participation decisions in Cambodia. A stylized farm household model with market imperfections is considered and a two-step decision making process is outlined. Farmers decide, first, whether or not to participate in the market and then they decide how much to sell. The model is estimated using a Heckman type regression model. We compute the unconditional marginal effects for the full sample as well as for the samples for the small and large holders separately. Non-price factors such as risk, technology and rural infrastructure are important determinants of commercialization of agriculture in Cambodia. The marginal effects for the small and large holders differ substantially both in quantitative and qualitative terms. This suggests differential treatment in terms of intervention and incentives for small and large holders would be more effective to promote market access.

Keywords: *Agriculture, Supply response, Farm household model, Market participation, Switching model, Cambodia*

JEL classification: Q12, Q13, Q15, C24

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1. Introduction

A vast majority of rural smallholders in developing countries depend on traditional and subsistence farming, the characteristic features of which are, among others, low productivity and low marketed surplus. These smallholder subsistence farmers are most likely to be among the poorest and the most vulnerable of all groups. They remain mostly outside the mainstream exchange economy and unable to take advantage of the opportunities offered by an exchange economy. On the other hand, subsistence farming is often considered to be the only means of survival against adversaries caused by market failures of various kinds, uneven access to resources and the specific socio-economic and agro-climatic context under which they operate. Hence, it is important to identify and address underlying factors leading to subsistence farming and perpetuation of poverty and vulnerability of rural poor, because the integration of smallholder subsistence farmers into the market mechanism through increased participation and commercialization of agriculture would facilitate higher living standards and reduce vulnerability.

The structure of and access to markets is critical in shaping the behavioural responses of agricultural households in designing their livelihood strategy (Taylor and Adelman, 2003;Brooks, Dyer and Taylor, 2008). As long as markets are perfect for all goods (including labour), households remain indifferent between consuming own-produced and market-purchased goods. By consuming all or part of its own output, which could be sold at a given market price, the household implicitly purchases goods from itself. By demanding leisure or allocating its time to household production activities, it implicitly buys time, valued at market wage from itself. Under these circumstances, the household effectively behaves as a profit maximizing unit.

However, rural households in developing countries are often systematically exposed to market imperfections and constraints, referred to as "failures" (Thorbecke, 1993). In some cases, markets do not even exist, for example, in remote areas. In other cases where the market exists, high transaction costs must be incurred in accessing markets. In yet others, there are constraints on the quantities that can be exchanged (de Janvry and Sadoulet, 2006). Moreover, as rural households are often unable to sell surplus labour at the going wage rate on a year-round basis, they often have to pay more for foodstuffs than they can earn from selling the same commodities, and risk is an inescapable fact of life for them all. Market failures can therefore be pervasive and, coupled with uneven distribution and access to

operational land and other productive assets, and risks, poor rural households may be forced to devise countervailing strategies against these adversaries which are at best suboptimal. These countervailing strategies are likely only to compensate for a small fraction of the market failures under which households operate, in part because the effectiveness of these strategies is itself limited by poverty, and they are generally implemented at very high costs in foregone expected incomes. In this fashion, poverty changes the set of options available to households, making poverty hard to escape (Duflo, 2003).

There have been important theoretical advances on household behaviour under market failures since the beginning of the 1980s. These modelling frameworks have largely been successful in explaining and identifying strategic variables and some of the binding constraints such as transaction costs, risk and other factors affecting the marketing behaviour of subsistence/semi-subsistence farmers in developing countries. More importantly, the insights derived from these efforts could be used for effective policy design to reduce poverty and vulnerability. However, as noted by de Janvry and Sadoulet (2006 p177), more often than not many theoretical derivatives and predictions emanating from these models are "blindly accepted as truths when they remain to be empirically verified, their order of magnitude in explaining observed behaviour remained to be ascertained, and their usefulness in the design of policies to be shown".

In light of the above observations, this paper intends to contribute to the empirical literature by investigating the supply response of farm households under market failures due to transactions costs and heterogeneous endowments. We take Cambodia as a case, an overwhelmingly rural society characterized mainly by subsistence farming. In doing so, we have taken account of the interrelationships among market participation, production and sales decisions. We further investigate whether there are any systematic differences in behavioural responses between small and large holders in terms of market participation and sales decisions. This has strategic importance as this might call for differential policy interventions for these two sub-sets of farming community and it is also important to focus attention on policies to increase market participation of the smallholders (Sadoulet and de Janvry, 1995).

1.1. Background and Context[1]

Cambodia, a small Southeast Asian country, is an overwhelmingly agrarian society, where agriculture outsizes rest of the economy. The country has just come out of a three-decade long civil war and political conflict during which most of its social and physical infrastructure was either destroyed or badly damaged. However, it has successfully managed its transition to a market economy from a Soviet–style command-and–control economy during the 1990s. Since then in a relatively stable macroeconomic environment, Cambodia registered a decade of very high and sustained economic growth. In fact, it is one of only 46 countries to achieve 7 per cent average annual growth for 14 years in a row. As a result, the poverty head count fell from 47per cent of the population in 1994 to 35 per cent in 2004, and then to 30 per cent in 2007. The poverty magnitude has also fallen, from about 4.3 million people in 2004, to about 3.9 million in 2007. However, poverty methodology is conservative and the poverty lines are very low[2]. The stellar growth that led to poverty reduction of just 1per cent a year with increasing inequality means that growth has not been particularly inclusive (ADB, 2011).

Agriculture remains a crucial part of Cambodia's economy and accounts for 29 per cent of the GDP in 2007. It employs around 59 per cent of the labour force. Agriculture has been growing at 4.4 per cent over the past decade, against 4.0 per cent in Vietnam and 3.9 per cent in Lao PDR. Growth in this sector is driven by mainly rice and, to a lesser extent, livestock and fisheries. Eighty per cent of farmers grow rice, 60 per cent of them for subsistence. Rice covered 2.6 million hectare in 2007 (two thirds of arable land and 90 per cent of cultivated land) and production grew from 3.4 to 6.7 million tons between 1997 and 2007. Yields remain low, however, (at 2.6 tons/ha, against 3.5-4.0 tons/ha on average in the region). Cassava is a promising crop, but only 3 per cent of cultivated land is used for it. Considering the dominance of rice in the overall economy of Cambodia, a substantial productivity increase of rice culture is imperative. In view of the performance of its immediate neighbours, a doubling of production per hectare of cultivable land is conceivable. With rice culture being mainly the domain of family-farms, improved sector-performance as a whole depends on them.

[1] These stylized facts are drawn from (ADB, 2011)

[2] The average national poverty line for Cambodia in 2007 was KR 2,473 per capita per day, or $0.62 at the exchange rate of KR4,000=$1. The regional poverty thresholds were KR3,092 per person per day for Phnom Penh ($0.77); KR2,704 for other urban areas ($0.68); and KR2,367 in rural areas ($0.59)).

At the heart of the problem thus, lies the need for a transformation from a primarily subsistence- oriented agriculture, characterized by low use of inputs and low returns to land, to a more commercially-oriented, more intensive agriculture. Given that the agricultural sector is dependent mainly on family-based rice production, converting 'smallholder' households into an 'emerging' class of commercial farmers is of strategic importance. The scope for such a transformation remains large; yet the capacity to modernize and benefit from the opportunities of an evolving market economy seem limited. There are major obstacles, ranging from the poor physical infrastructure resulting in high transport costs and poor market integration, to low levels of education, training in new techniques and imperfect or virtually non-existent rural credit and insurance market (Acker, 1999). In addition, the specific topography of Cambodia may put a number of natural obstacles in the way of a sustained intensification. Overcoming these bottlenecks will be the main key for achieving sustained rapid economic growth based on expansion of increasingly productive employment opportunities. In other words, the sustained productivity growth and intensification of agriculture may lay ultimately with the limits of the rural development outreach itself. Given the above context, an in depth analysis of market participation behaviour and its determinants may help understand better appropriate policy choices for enhanced productivity and market integration of small holders.

2. Review of Literature

The literature on agricultural supply response is vast and varied. Rather than going for an exhaustive review of this enormous literature, this study sets out to review a subset of the literature which is concerned with market participation and commercialisation of agriculture in subsistence/ semi-subsistence agrarian economies. Even this subset of literature varies considerably in several dimensions as it evolves over time – differences span from motivational contexts to methodology and econometric methods employed; and thus they are not directly comparable. The review is structured in the following chronologically distinct phases: i) pre-farm household model era during the 1960s and 70s; ii) farm household model era of late 1970s and 1980s; and iii) recent studies focusing on market failures.

Initial attempts to construct models of peasant production taking into account the fact that peasant households have a dual character as both production and consumption units traces back to 1960s in the Indian subcontinent, particularly in India. The primary focus of these early modelling efforts was to explain the apparent lack of correlation between marketed

surplus and production of food grains. This generated a fair amount of scepticism and debate over the usefulness of price policy for increasing the marketed surplus of food grains (Krishnan, 1965; Nowshirvani, 1967; Askari and Cummings, 1974 and 1976). Some of these studies also attempted to show that, in the case of the marketed surplus from peasant farms, inverse/perverse responses were not only theoretically credible but in practice quite probable.

Askari and Cummings' (1976) contention that, given land reform, availability of fertilizers, pesticides, and irrigation, farmers will in fact respond to economic incentives by producing and marketing larger quantities has been questioned by many observers. The objection has been that while farmers may be responsive to price changes, their planting and marketing decisions are primarily governed by traditional behaviour and practices, thereby making price responses only of secondary importance in explaining output variation. Similarly, Mathur and Ezekiel (1961), and Enke (1963) are of the opinion that the marketed surplus of subsistence farmers may have fixed or relatively fixed monetary obligations and hence, only dispose of as much of their production as is necessary to obtain the desired money income. The subsistence farmers are most likely to be in debt because of social obligations or an unforeseen drought, and thus in order to meet commitments in such circumstances; they need to sell a portion of their produce. The result is that an increase in the price of product will be followed by a decrease in the quantity disposed of, since a smaller quantity marketed can meet their cash requirements. Olson (1960) and Krishnan (1965) have also suggested an inverse relationship between the marketed volume of subsistence crop and price. They argue that an increase in price for a subsistence crop may increase the producer's real income sufficiently so that the income effect on his demand for consumption of the crop outweighs the price effects on production and consumption, and hence the marketed surplus may vary inversely with market price.

It is also generally argued that the size of family in a household has a significant effect on the marketed surplus as evidenced by the findings of Sharma and Gupta (1970). Larger family size disposes of lower marketed surplus than smaller one, since the larger the family size, the higher will be the quantity consumed, and less will be available for disposal. In other words, an increase in the marketed surplus is likely to be siphoned- off by an increase in the family size. Many earlier studies have also indicated that there is a strong link between marketable surplus and output. They further suggest that the marketable surplus for the rice increases more than proportionally to the increase in output and that the elasticity of marketable surplus

with respect to output is very high relative to the partial and total price elasticities. Such findings were reported by Bardhan (1970), and Haessel (1975) in their respective studies. Haessel (1975) argues that the elasticity of marketed surplus with respect to output is substantially greater than unity. From the policy standpoint this means that, as output increases, farmers will retain a smaller proportion for consumption purposes and make a larger proportion available for off-farm consumption.

The development of farm household models in the late 1970s and early 1980s marked a significant advancement in the theoretical as well as conceptual understanding of the issues that hitherto remained unexplained or at best controversial. Building on the standard production economics and the early 20th century analysis by Chayanov (1926) of peasant agriculture in Russia, these farm household models developed by Barnum and Squire (1979) have been used to understand and analyse multitude of policy issues relating to rural economies of developing countries. Particularly, these models have largely been able to explain sometimes paradoxical – and even perverse – microeconomic responses of peasants to changes in relative prices (Strauss, 1986; Lopez, 1984; de Janvry, Fafchamps, and Sadoulet 1991). Several other theoretical and empirical studies have used similar modelling approaches to analyse farm household responses under imperfect labour (Lopez 1984; Benjamin 1992; Jacoby 1993; Sadoulet, de Janvry, and Benjamin 1998), or food markets (de Janvry, Fafchamps, and Sadoulet 1991; Goetz 1992; Skoufias 1994; Abdulai and Delgado 1999). The distinctive features of these models emanates from non-separability[3] rather than standard neo-classical seperabiltiy assumption. The conceptual derivatives and the predictions of these farm household models are, however, extremely sensitive to the set of assumptions on which they are based (Brooks, Dyer and Taylor, 2008). As household's decision- making is assumed to be "recursive" in the sense that consumption and labour supply decisions depend on its production decisions but not the other way round: production decisions are independent of the other decisions (Singh, Squire and Strauss, 1986a). This means that as far as production is concerned, the household acts as a profit-maximizing unit as it would have done in a standard neoclassical set up. The on-farm production effect of an increase, for example, in the price of staple unambiguously results in increases in labour input

[3] A household model is said to be non-separable when the household's production decisions are affected by its consumer characteristics (consumer preferences, demographic characteristics, etc.); whereas, in a separable model, households behave as a pure profit maximizing units. The profits, in turn, affect consumption, but without feedback on production decisions.

(waged/ or family, or both) and total production[4] (Barnum and Squire, 1979, Chapter 3; Singh, Squire and Strauss, 1986b, p.154). However, as a consumer, household now faces higher staple price but at the same time experiences higher income due to higher profits from farm production leading to a positive income effect competing with a negative substitution effect. The net effect becomes ambiguous depending on the slope of the household's utility function as well as the magnitude of the profit effect. Hence, as a result of the "recursive" relationship between the household's consumption and production decisions, the supply response of marketed surplus, especially at the market level, may turn out to be negative (Barnum & Squire, 1979; Singh, Squire and Strauss, 1986b). However, non-separability makes theoretical and, in particular, empirical analyses more difficult. Therefore, most empirical analyses assume separable farm household models or use reduced forms of a non-separable farm household model.

In contrast to early farm household model-based works, recent studies emphasize transaction costs and institutional factors in determining households' decisions on market participation (Goetz, 1992; Key, Sadoulet and de Janvry, 2000; Vakis, Sadoulet, and de Janvry, 2003; Vance and Goeghegan, 2004; Carter and Yao, 2002; Carter and Olinto, 2003). Goetz (1992), in his pioneering work, estimated a switching regression model of market participation and amount traded to grain market in Senegal – separating the decision of whether or not to participate in markets from the decision of how much to trade. He found that fixed transactions costs significantly hindered, while better information stimulated, smallholder's market participation. He also decomposed the impact of a rise in the price of grains between entries of new sellers and increase in the sale of producers already in the market. Elaborating the works by Goetz (1992), Key, Sadoulet, and de Janvry (2000) develop a model of supply response when transaction costs cause some producers to buy, others to sell, and others not to participate in markets. They consider fixed transaction costs (FTC) and proportional transaction costs (PTC). Fixed transaction costs are invariant to the quantity of the good traded, whereas proportional transaction costs increase proportionally in quantity. Thus, PTC corresponds to constant marginal transaction costs. They estimated the model using data consisting of Mexican corn producers and the results indicate that both types of transactions

[4] It is important to distinguish between the supply responses of agricultural output and the marketed surplus. The above analysis, which rules out perverse supply response, only applies to the former.

costs – fixed and variable – play a significant role in explaining household behaviour, with proportional transaction costs being more important in selling decisions.

Heltberg and Tarp (2002) use Goetz's approach to estimate reduced form equations for market participation and value of food crops (as a group), cash crops (as a group), and total value of crops sales, using data from a 1996-97 Living Standard Measurement Survey (LSMS). Factors significantly affecting market participation included farm size per household worker, animal traction, mean maize yield, age of household head, climate risk. Explaining variation in the value of sales for food crops or cash crops was much less conclusive, and the authors recognize that aggregation of sales into food or cash crop groups may mask underlying causal mechanisms related to individual crop decisions. Henning and Henningsen (2007) estimated a non-separable behavioural household model by incorporating non-proportional variable transactions costs as well as labour heterogeneity along with fixed and variable proportional transaction costs. The authors used household data from Mid-West Poland. They confirmed that both transactions costs, including the non-proportional ones as well as labour heterogeneity, significantly influence household behaviour, although in most cases price elasticities remain the same.

Only a handful of such studies are available despite theoretical advances and most of them are carried out in the sub-Saharan African context. To the best of our knowledge, there is hardly any such study undertaken in the Asian context. Cambodia with its remarkably undiversified and largely subsistence agriculture, lends itself to a very interesting case in this regard. An empirical investigation of agricultural supply response taking into account market participation behaviour of households under transaction costs would be a notable contribution to the literature.

3. Theoretical Considerations

3.1. Transaction costs

Transaction costs are the embodiment of barriers to market participation by resource-poor smallholders and have been used as a definitional characteristic of smallholders. It is also considered to be one of the factors liable for market failures in developing countries (de Janvry, Fafchamps, and Sadoulet, 1991; Sadoulet and de Janvry, 1995). Farmers generally face transaction costs relating to market and information search, screening, enforcement, bargaining, transfer, or monitoring. These costs tend to be higher for farmers living in remote

areas with poor infrastructures of communication and transportation. The farmers lack information about the prices of products at the local level, and at final consumer's level, about quality requirements, about places and best periods for selling their products, about potential buyers, about production in other areas; but also about their rights and the legislative frameworks. Information about market demand is difficult and costly to obtain for smallholders. Information may be obtained through contacts with other members of the community but the accuracy of information is not guaranteed since those actors might have 'opportunistic behaviour'. Thus, the distance to the market together with poor infrastructure and poor access to assets and information may be manifested in high exchange costs, which could be an impediment to enable many transactions to take place.

Transaction costs can explain why some farmers participate in markets while others are simply self-sufficient. Differences in transactions costs as well as differential access to assets and services to mitigate these transactions costs are possible factors underlying heterogeneous market participation among smallholders. Transactions costs are broadly categorized into fixed and variable (or proportional) transaction costs (Key, Sadoulet and de Janvry, 2000). Fixed transactions costs (FTCs) may include the costs of: (a) search for a buyer with the best price, or search for a market; (b) negotiation and bargaining – these costs may be important when there is imperfect information regarding prices; (c) screening, enforcement, bribing, and supervision – farmers who sell their product on credit may have to screen buyers to make sure they are reliable. Farmers may have to screen potential input sellers when there is asymmetric information as to the quality and the price of the inputs. FTCs are invariant to the volume of inputs and outputs traded and are often lumpy since, for example, a farmer may incur the same search cost to sell either one ton or ten tons of a product. Once the information about the market has been obtained and contacts made with the buyer, a household can sell any amount without having to incur extra costs.

Variable transactions costs (VTCs), on the other hand, include costs of transferring the product or inputs being traded, such as transportation costs and time spent to deliver the products to (or inputs from the) market. VTCs thus include the per-unit costs of accessing the markets, which raise the price effectively paid for inputs and lowers the price effectively received for output, thereby creating a price band within which some households find it unprofitable to sell output or buy inputs. In general, while information variables are expected to determine FTCs, measures of distance and transport are expected to determine VTCs.

3.2. *Modelling Market Participation and Amount Traded*

Agricultural output marketing decisions can be modelled as a two-step decision making process: first, households decide whether or not to participate in the market, and then, they decide on how much to sell. As opposed to much of the earlier empirical works on agricultural supply response and market participation, recent developments in farm household modelling under transactions costs (e.g., Key et al., 2000) allow interpretation of results by distinguishing between fixed transactions costs, which influence only whether to participate in the market or not, and variable transactions costs, which can influence both the decisions – market participation as well as the amount traded. In addition, this distinction is also important from technical as well as policy points of view. Technically, it helps to improve the estimation procedure while yielding valuable insights into the effectiveness of particular policy interventions for reducing transactions costs.

The conceptual framework of this study thus rests on a stylized static farm household model incorporating transaction costs in line with Key, Sadoulet and de Janvry (2000). In order to focus more on transaction costs, following Key, Sadoulet and de Janvry (2000) the model ignores some aspects of households' decisions, such as risk (price) and credit constraints. In addition, 'market participation' is treated as a choice variable in the model. Households are assumed to maximize utility with respect to consumption (c_i), production (q_i), input use (k_i), sales (s_i), and purchase (b_i) of each good $i = 1, 2, \ldots, N$. Goods consumed include self-produced agricultural goods, market commodities and leisure. Households produce agricultural products (q_i) using labour, other variable inputs and land (k_i).

In absence of transactions costs, households' problem is to maximize utility function (1) subject to constraints (2) – (4):

$$\max U(c, z^c) \tag{1}$$

$$\sum_{i=1}^{N} p_i^m (s_i - b_i) + A \geq 0 \tag{2}$$

$$q_i - k_i + E_i - c_i + b_i - s_i \geq 0 \tag{3}$$

$$G(q, z^q) = 0 \tag{4}$$

where p_i^m stands for the market price, E_i is the endowment of good i, A represents exogenous transfers and other incomes and z^c and z^q correspond to household and production characteristics, respectively. The cash constraint (2) states that all purchases of the household must be less than or equal to sales and other exogenous income (*A*) such as pensions, and remittances. The resource balance equation (3) states that the consumed and sold quantity cannot exceed the production, endowment and purchased quantity of each good i. In the case of inputs k, the resource balance states that sales, input use, and consumption cannot exceed endowment and purchased quantity of each input i. Equation (4) corresponds to the production function that relates all inputs and outputs.

Now consider that market exchange involves transaction costs: proportional transaction costs (τ_i^{ps}) corresponds to the costs incurred for each unit of marketed output i sold and fixed transaction costs (τ_i^{fs}) which by definition are independent of the amount being transacted. Similarly, in the case of purchase, proportional (τ_i^{pb}) and fixed transaction costs (τ_i^{fb}) occur. With transaction costs equation (2) is transformed in equation (5):

$$\sum_{i=1}^{N}\left(s_i\left(p_i^m-\delta_i\tau_i^{ps}\right)-\delta\tau_i^{fs}-b_i\left(p_i^m+\gamma_i\tau_i^{pb}\right)-\gamma_i\tau_i^{fb}\right)+A\geq 0 \qquad (5)$$

δ_i takes the value 1 for the sellers and 0 for the autarkic households for each good i, while γ_i takes the value 1 for buyers and 0 for autarkic households. The equation suggests that in the cases when sales involve transaction costs, the price received by the farmer will be the market price p_i^m reduced by the amount of the proportional transaction costs τ_i^{ps}, since the farmer has to incur this amount for each unit of sold product as a proportional cost. In addition, marketing of each product i will cost a fixed amount τ_i^{fs} for the household. The fixed transaction costs include, for example, costs of search for buyers, costs of collecting information about the prices and the monitoring costs of the fulfilment of the contractual agreement. Inversely, when buying goods, the household has to pay an additional proportional transaction cost τ_i^{pb} besides the market price for each unit bought. The household also incurs a fixed one-time cost τ_i^{fb}. The first order conditions of the maximization problem of the utility function will yield the reduced form output marketed supply, conditional on market participation (Goetz, 1992, Key et al., 2000).

Output market participation:

$$Q_{si} = \left(p^m, \tau_i^{fs}, \tau_i^{ps}, z^q, z^c, E_i, A\right) \quad (6)$$

Output marketed supply:

$$q_s = \left(p_i^m - \tau_i^{ps}, z^q\right) \quad (7)$$

This implies that for those who sell output or buy, the amount of output sold or bought is unaffected by the fixed transactions costs. Once the fixed cost of participating in the market is paid, fixed transaction costs do not affect the sales volume. Participation in the market is determined by discrete comparisons of expected utility from the alternative marketing regime (i.e., participation vs. autarky) and hence it will be affected both by the fixed and variable transactions costs.

3.3. Reduced Form and Marketed Surplus

Based on the conceptual framework described above, following Strauss (1984) and later by Goetz (1992), and Heltberg and Tarp (2006), the reduced form of the underlying modelling framework could be explained as follows:

$$x_{ij}^q = X^q\left(p, z_i^q\right) \quad (8)$$

$$x_{ij}^c = X^c\left(p, \left[A_i + f\left(p, z_i^q\right)\right], z_i^c\right) \quad (9)$$

where x_{ij}^q is the production of crop j by household i, x_{ij}^c consumption of crop j, p are goods prices, z^q fixed factors pertaining to production, i.e., household characteristics and other factors affecting production, z^c household characteristics related to consumption, A_i exogenous income sources and $f(.)$ farm profits, not accounting for the cost of family labour inputs. Marketed surplus is then computed by taking the difference between production and consumption:

$$Q_i^m = x_{ij}^q - x_{ij}^c = x^q(.) - x^c(.) = f\left(p, A_i, z_i^q, z_i^c\right) = f(X_i) \quad (10)$$

This is the reduced form for marketed surplus expressed as the function of all the exogenous variables irrespective of whether they relate to household's production or consumption decisions. The theoretical restrictions of standard supply and demand functions do not apply to marketed surplus. Also, as Sadoulet and de Janvry (1995) noted, it does not require estimating the complete system of demand and supply of all products.

Using the results of equation (6 and 7), we further assume that both fixed and variable transactions costs impact on market participation while supply decisions, conditional on market participation, only depend on variable transactions costs. Technically, this implies that we can use fixed transactions costs to identify market participation:

$$\boldsymbol{Pr}(market\ participation) = f_i(X_i, T_i) \tag{11}$$

Finally, we postulate that variables that explain marketed quantities also explain the selection of marketing regime, whereas fixed transaction costs help determine market participation, but do not affect the amount traded conditional on being already in the market.

3.4. The Empirical Model and Estimation Strategy

While most empirical studies on output marketed supply or input demand have used Heckman's (1976) sample selection model or its variants of double hurdle and switching regression models (e.g., Goetz, 1992; Winter-Nesson and Temu, 2005), some used the more restrictive tobit model to analyse output marketed supply (e.g., Holloway et al., 2000). As fixed transactions costs are expected to affect the decision to participate in a market, but not the amount traded, the sample selection model has been considered more appropriate than the restrictive tobit model. While tobit model assumes that "zero" values associated with non-participation are outcomes of a rational choice (i.e., corner solutions), the sample selection model explains non-participation using prohibitive transactions costs and other factors.

We estimate the econometric model using the framework of the standard Heckman sample selection model, where the values of sales of agricultural outputs as well as the choice between autarky and selling regime were determined jointly. Three sets of regressions are run for: (i) total sales of all crops, (ii) sales value of marketed food crops, and (iii) sales value of marketed cash crops, and each regression has both a selection and a value component. We then split the sample into two parts: (a) a sample of small holders having operational land less than or equal to one hectare, and (b) a sample of large holders having operational land greater than one hectare and run each regression for them.

The econometric model is posited as follows:

$$Q_i^m = \beta X_i + \epsilon_i \tag{12}$$

$$Q_i^m\ is\ observed\ iff\ \theta X_i + \kappa T_i + \nu_i > 0 \tag{13}$$

$$\boldsymbol{corr}(\epsilon_i, \nu_i) = \rho \neq 0 \tag{14}$$

where, X is a vector of all the explanatory variables except fixed transaction costs (T), and β, θ, κ, and ρ are parameters to be estimated. Subscript i indexes households and crop aggregation (total sales, sales of basic food crops, and sales of cash crops) is suppressed for notational simplicity.

Sample selection model in marketed supply could be explained in two steps. In the first step, selection into regimes i.e. selling, and autarky is modelled in separate probit type equation, i.e., an equation for selling versus autarchy including fixed and proportional transaction costs as well as all other explanatory variables. In the second step, the determinants of marketed value conditional on market participation are analysed. Hence, both regressors and parameters are allowed to vary across the two-steps and across regimes. In practice, however, we estimate the model using maximum likelihood procedure which jointly estimates the parameters of the selection and marketing equation. Standard errors are based on the Huber-White estimator of variance and are considered robust against many types of misspecification of the model. Covariance between the probability of participation and the quantity traded (the ρ 's) is captured by modelling the joint likelihood of market participation and marketed values. However, interpretation of the coefficients is not straightforward as in the case of OLS. Only those variables appear in the outcome equation (in this case, quantity equation) but not in the selection equation, the coefficients of those could be interpreted as the marginal effects of a unit change in the independent variables. If, on the other hand, the variables appear in both the selection and outcome equations, the coefficients in the outcome equation is affected by its presence in the selection equation as well. This is because both regressors as well as the parameters are allowed to vary across the two-steps and across regimes (i.e., selling and autarky).

The other justification for employing Heckman sample selection model is to correct for selectivity bias because selling households are non-random subsets of all sampled households. Households might choose to participate in the market or not due to some unobserved characteristics – risk aversion, farmer's skill, or soil quality- and this is likely to be the case where transactions cost barriers are important and a large segment of subsistence farmers operate in autarky. Least squares without selectivity corrections would lead to invalid estimates of the parameters for the full sample. Unconditional marginal effects (i.e., for the full sample) cannot be derived from the least squares parameters and the possibility that

regressors might influence market regime and traded volume differently would completely escape least squares analysis (Heltberg and Tarp, 2002).

3.5. Specification of the Model

Unlike some of the previous studies (Goetz, 1992; Key, Sadoulet and de Janvry, 2000), this study uses aggregate value of sales as dependent variable. One of the major reasons for using sales value rather than quantity marketed (i.e., in tons or kgs') is to make most out of the data, that is, to use all available information in the data, including those who produce and sell crops other than rice or food crops. Moreover, due to substitution between crops, some exogenous variables may increase individual crop sales at the expense of other crops. It is, however, now well established that single crop supply is more elastic than the aggregate output supply. Arguably, aggregate supply is what ultimately matters to policy makers (Binswanger, 1990). Secondly, the choice of aggregating over multiple crops, on the other hand, makes it impractical to work with quantities, because quantities produced or sold of different crops cannot be aggregated directly. Values resolve this by using market prices as implicit weights (Heltberg and Tarp, 2002). The greyer side of this kind of aggregation is that aggregation conceals differences in the underlying causal mechanisms related to individual crop decisions. Farmers may view differently in their portfolio of crop production, in which case single crop estimation is necessary to provide the full picture. However, agriculture in Cambodia is remarkably undiversified and characterized by mono-cropping (largely due to its' agro-climatic conditions), where paddy is being produced predominantly. Aggregation over food crops is basically aggregation of paddy produced in dry and wet seasons. Therefore, the aggregation bias discussed above is unlikely to pose serious problems in our case.

Exogenous set of regressors include variables theoretically expected to affect quantities to be sold as well as whether to participate in the market or not, that is, to select marketing regime. Price of paddy is the most natural candidate to be included in the model. Paddy is the single most important crop in relatively less diversified Cambodian agriculture. Over 90 per cent of the cultivable land is devoted to paddy production. Hence, price of paddy is expected to be the principal determinant of agricultural supply response in Cambodia.

Three variables are included in the model to capture the effect of household endowments: land per worker, ownership of agricultural implements (plough, hand tractor, tractor or water

pump), and land title. Secured land ownership motivates farmers to invest in land development and maintain soil quality. Theoretically, all these are expected to have positive effects on marketed surplus and participation.

Ethnicity is included in the model to reflect the case that higher mutual trust and common belief and understanding might affect the market participation through information sharing thus reducing the fixed transaction costs. Theoretically, older and more experienced household heads have greater contacts; allowing trading opportunities to be discovered at lower costs; and this may also reflect increased trust gained through repeated exchange with the same party. Among the other background characteristics of a household, a dummy for households having any of its members employed in a paid job is included to take into account non-farm earning opportunities.

Village level *median* rice yield is included in the model with a three- pronged objective of capturing state of technology use, climatic condition, and past investment. A dummy for risky region seeks to capture production risks posed by natural disasters - excessive rain, flood or drought.

With a Heckman two-step approach, we first estimate a probit model of participation in the relevant market as a function of both variables that are also likely to determine crop sales volume, conditional on market participation as well as one or more variables that satisfy exclusion restrictions (Wooldridge, 2006). Our exclusion restriction variables focus on the factors affecting transactions costs. The exclusion restrictions we employ are similar to those used by Heltberg and Tarp (2006) in their analysis of the determinants of market participation in Mozambique.

Transaction costs are important determinants of market participation as well as the amount traded, but they pose serious empirical challenges relating to measurement. First, when transactions costs are too high to prevent exchanges to take place, then, by definition these costs cannot be observed because no transaction has taken place. Second, even when a transaction takes place, transaction costs cannot be easily recorded in a survey (Key, Sadoulet and de Janvry, 2000). Transaction costs are thus unlikely to be observable in standard household surveys. CSES-2004, 2007 data that we employ in our analysis is no exception in this case. Hence, building on the past empirical works elsewhere (particularly Heltberg and Tarp, 2002), this paper resorts to the observable exogenous variables that are theoretically

expected to capture or explain these transaction costs. Variables such as distance to market outlets, ownership of transport equipments, and information/communication assets are examples of exogenous determinants of transaction costs.

More specifically, variables used to capture transactions costs are: distance to nearest market, distance to the nearest bus-stop, distance to the provincial capital, ownership of transport equipments (cart, bi-cycle or motor-cycle), ownership of information/communication assets (radio, television or telephone), village population density, and education of the head of the households. By increasing travel time and transport cost, distance to market outlets (or bus-stop, provincial capital) is expected to have a negative effect not only on market participation but also on the amount traded. It is thus related to VTCs. The other VTCs – for example, ownership of transport equipments- are expected to have positive influence on market participation as well as quantity sold. Access to communication/information networks essentially mitigates the fixed transactions costs and is thus likely to facilitate market participation only. Other information variables included to capture fixed transactions costs are education of head of household,[5] and (log) of village population density. A better educated head of household is assumed to be capable of higher level of information processing and well- networked within the community. Similarly, in a densely populated close-nit society information flow is assumed to be faster and better than in a sparsely populated community. Both of these variables are expected to affect market participation positively.

While ownership of transport equipments is also supposed to enhance market participation, whether this is through its role in accessing information (FTCs) or in facilitating transportation to market outlets (VTCs) is a question of empirical validation. This variable might have dual roles: first, gathering market information by going physically to the nearest market place; second, transporting farm outputs to the market. The empirical approach proceeds by estimating and comparing the significance of two different versions of the Heckman model, one with the variable used only in the selection (first stage) relating to participation and another with the variable used in both participation and sales equations. The preferred model would suggest the dominant attribute of transport equipment ownership – information or transport attributes or both.

[5] Alternatively, education could be included as an endowment variable as well.

Finally, the issue of endogeneity needs to be addressed. One might suspect potential endogeneity of some of the variables used in the analysis; specifically 'price of paddy' and 'land per worker'. The data on 'price of paddy' in our sample show considerable variation both across villages and through the harvest season. As price varies depending on the place and time of sale, it is potentially endogenous. Moreover, it is observed only for those farmers who actually sold paddy during the period of the survey. Therefore, village level median paddy price is derived and used in the analysis.

Cambodian land market is largely inactive and passing through a transitional phase from a state-owned one to a market- based one. Land is largely state allocated and market turnover of land is very low. In our data, land turnover is in fact less than 7 percent, which is negligible from an analytical point of view. Hence, the variable 'land per worker' (defined as total arable land holding divided by the number of economically active members of the household) in our case is highly unlikely to be endogenous. In fact, the absence of an active land market is the rationale given for the treatment of landownership as an exogenous regressor in almost all the empirical works involving household behaviour in similar settings in Africa and South Asia (Khandker, 2005).

4. Data, Variables and Descriptive Statistics

Data used for this study come from Cambodian Socio-economic Survey -2004 (CSES) and CSES - 2007. Details about the data sets and variables used in the analysis are given below:

4.1. CSES - 2004

The CSES – 2004 is a standard LSMS type survey and is the first multi-objective household survey undertaken in Cambodia. Data were collected over a 15 month period from November 2003 through January 2005. A total of 14842 households were interviewed in 900 villages during a 15 month period The 2004 CSES is also the first household survey that covers the entire country.

The 2004 CSES collected data on household consumption using two different data collection methodologies, i.e., recall questions similar to those used in previous surveys and a calendar month diary in which all household economic transactions were recorded. Consequently, the CSES-2004 survey teams spent more than one month in each surveyed villages. In addition to data on household consumption and a wide range of social indicators, the CSES collected data on the daily time use of all household members, data on sources of household income,

village data on land use and access to community and social services (for examples, roads, electricity, water, markets, school and health facilities), and data on up to three prices from local markets for 93 food and non-food items.

2004 CSES sample was drawn from 45 strata (24 provinces, urban and rural) in three steps using the 1998 population census as the sampling frame. First, 900 villages were selected from the various strata using systematic random sampling. Second, one census enumeration area was chosen randomly from each sample enumeration area, yielding a total sample of 15000 households (of which 14984 were actually interviewed). One thousand households were interviewed each month of the survey in a randomly selected (and therefore nationally representative) sample of 60 villages. The 2004 CSES is not self-weighting. Two sets of adjusted sample design weight are provided, one for use with the calendar year 2004 sample of 12000 households (of which 11993 households were actually interviewed) and the other for use with the full sample of 15000 households (of which 14984 households were actually interviewed). Estimates presented in this paper are based on the calendar year 2004 sample of 11993 households actually interviewed and are weighted to be representative of the Cambodian population. Calendar year 2004 data are used to avoid introducing seasonal biases. Table 1 provides all the variables used in the estimation of the model.

Table 1 Variables used in the Model

Variables	Label
Dependent	
Log sales value food crops	Natural log of Marketed Surplus of basic Food Crops
Log sales value cash crops	Natural log of Marketed Surplus of Cash Crops
Log sales value-all crops	Natural log of Marketed Surplus of all Crops
Explanatory –	
Log price of paddy	Natural log of village level median Price of Paddy
Explanatory – households' background Characteristics	
Log age of hhh	Log age of head of the household in years
Dependency ratio	Dependency ratio
Dummy for ethnicity	Dummy for the Ethnicity (Khmer=1, 0 otherwise)
Dummy for paid job	Dummy for whether any member of the household has a paid job or not
Explanatory – households' Endowments	
Log land per worker	Natural log of farm size per worker
Dummy for land title	Dummy for whether household has land title or not
Dummy for ownership of ag. Equip	Dummy for ownership of agricultural Implement (Plough, hand tractor, tractor or water pump)
Explanatory – Geographical and technological Characteristics	
Log rice yield (village level)	Natural log of median village level rice yield
Dummy for risky region	Dummy for risky region – region reported most crop damage due to excessive rain, flood or draught last year
Explanatory – Variable Transaction Costs	
Log distance to market	Natural log distance to nearest market
Dummy for ownership of transport equipments	Dummy for ownership of transport equipment – cart, van etc.
Log distance to bus stop	Natural log distance to bus stop

Log distance to provincial capital	Natural log distance to provincial capital
Explanatory – Fixed Transaction Costs	
Log village population density	Natural log of village population density per square kilometre
Dummy for ownership of radio, tv, or telephone	Dummy for ownership of information equipment – radio, TV, or Telephone
Education of hhh	Educational level of the head of the household

Table 2 Descriptive Statistics (CSES – 2004)

Variables	Mean	Standard deviation	Minimum	Maximum
Log sales value-all crops	12.746	1.52	5.7	18
Log sales value food crops	12.779	1.44	5.7	18
Log sales value cash crops	12.379	1.59	7.1	18
Log price of paddy	6.088	0.24	3.9	7
Log land per worker	-1.240	1.22	-10.3	4
Log age of hhh	3.752	0.32	2.9	5
Dependency ratio	0.817	0.70	0.0	6
Dummy for land title	0.554	0.50	0.0	1
Dummy for paid job	0.283	0.45	0.0	1
Dummy for risky region	0.064	0.24	0.0	1
Log rice yield (village level)	7.340	0.56	6.2	12
Dummy for ownership of ag. Equip.	0.491	0.50	0.0	1
Dummy for ethnicity	0.961	0.19	0.0	1
Dummy for ownership of transport equipments	0.728	0.44	0.0	1
Log distance to market	1.528	1.20	-2.3	5
Log distance to bus stop	2.065	1.58	-2.3	6
Log distance to provincial capital	3.451	0.84	0.0	6
Dummy for ownership of radio, tv, or telephone	0.619	0.49	0.0	1
Log village population density	7.015	0.73	4.6	10
Education of hhh	5.729	10.54	0.0	19
Number of Observations	11862			

4.2. CSES – 2007

The Cambodian Socio-economic Survey -2007 is similarly a standard LSMS type survey comprising data from 3598 households from 360 villages. These villages are in fact subsample of the CSES-2004, but the households are not necessarily the same as in 2004. There are various modules containing detailed households and village characteristics including households' socio-economic characteristics, economic activities – crop production, consumption of food and non-food items, health and education status, access to social and community services. Table 3 gives descriptive statistics for all the variables used in the estimation of the model for CSES-2007.

Table 3 Descriptive Statistics (CSES - 2007)

Variables	Mean	Standard deviation	Minimum	Maximum
Log sales value-all crops	13.46	1.60	-3.47	17.74
Log sales value food crops	13.54	1.57	8.51	17.77
Log sales value cash crops	13.08	1.58	-3.46	17.76
Log rice yield (village level)	.93	.22	.39	1.34
Log price of paddy (village level)	4.38	2.93	0	7.17
Dummy for risky region	.53	.50	0	1
Log land per worker	-.92	1.19	6.50	3.91
Dummy for ethnicity	.98	.16	0	1
Age of head of households in years	44.86	13.80	16	91
Dependency ratio	.79	.68	0	5
Education of hhh	4.37	3.63	0	19
Dummy for land title	.58	.49	0	1
Dummy for ownership of ag. Equip.	.38	.49	0	1
Dummy for ownership of transport equipments	.25	.43	0	1
Dummy for ownership of radio, tv, or telephone	.74	.44	0	1
Log distance to market	1.58	1.20	-2.30	4.59
Log distance to bus stop	2.065	1.58	-2.3	6
Log distance to provincial capital	3.451	0.84	0.0	6
Dummy for paid job	.41	.49	0	1
Log village population density	7.015	0.73	4.6	10

5. Results

We estimated the model using two different sets of household survey data namely CSES – 2004 and CSES – 2007 for Cambodia as described in the previous section. CSES – 2004 is the most comprehensive household data and more representative than the CSES – 2007 data although they share same questionnaire and similar methodology in terms of sampling and other attributes. Hence they are comparable and the results from the CSES – 2007 data should provide some sense of validation of our initial estimates. In what follows, we first present the results of our initial estimates based on CSES – 2004 data and then the results based on CSES – 2007 in the next subsection.

5.1. Estimates Based on CSES - 2004

As noted earlier, the coefficients of the two stage selectivity models can not be interpreted as marginal effects when the same set of exogenous variables appear in both the selection and outcome equations. Accordingly, we have computed unconditional marginal effects (computational procedure is given in Appendix 1) for all the models. The marginal effects[6] for all households, large holders (farmers who have more than one hectare of operational land) and small holders (farmers with one hectare or less operational land) across crop types are presented in figure 1, 2, and 3 respectively along with the regression results (Table 4, 5, and 6). For each model, there are two columns: first column reports the log of annual sales

[6] For details about marginal effects of selectivity models please see Huang, Raunikar, and Mistra 199; Hoffmann, and Kassouf 2005; Sigelman and Zeng 1999.

given market participation and the second column shows the results of market participation probability model. However, our principal focus would be to disentangle distinctive (if any) features of agricultural supply responses between small and large holders emanating from their behavioural and other attributes and analyse welfare implications for subsistence(mostly smallholders) farmers. Accordingly, we will touch upon some of the main findings of the overall model in this section and then move on to the next section where we compare the marginal effects as well as the regression results for the small and large holders.

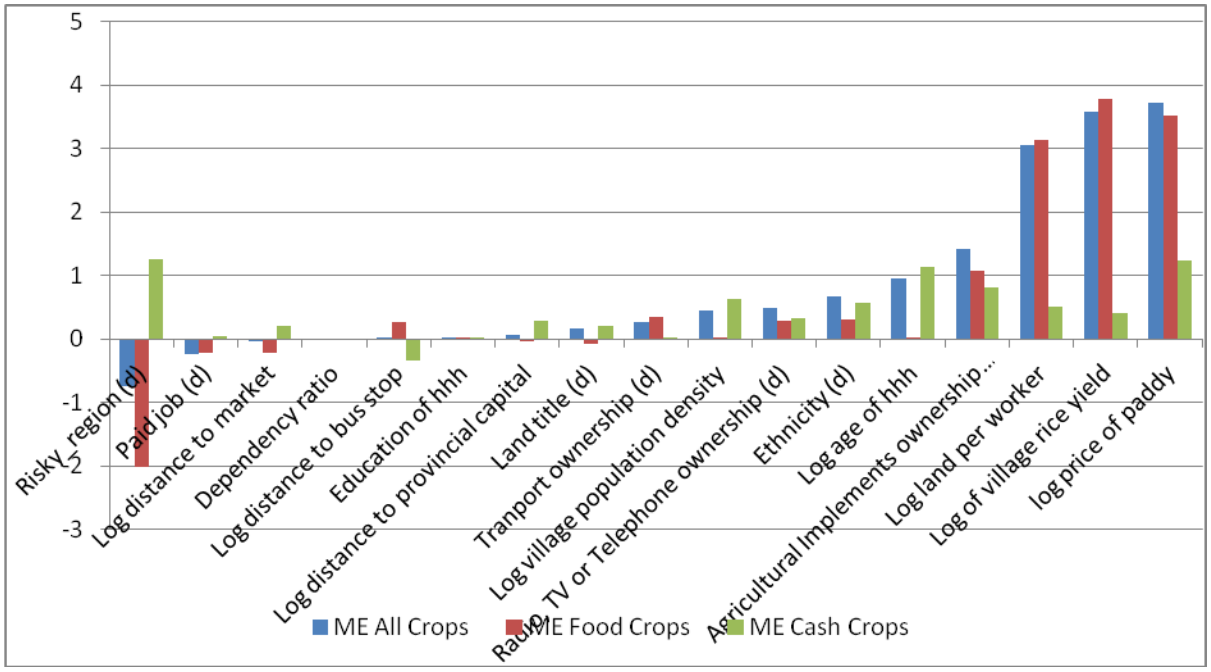

Figure 1 Marginal Effects across Crop

Table 4 Regression Results (Heckman Sample Selection Model), Dependent Variable = log Sales value of marketed Surplus

	Food Crops		Cash Crops		All Crops	
Variables	***Quantity***	***Select***	***Quantity***	***Select***	***Quantity***	***Select***
Log median price of paddy (vill)	0.347**	0.784***	-0.369*	0.366***	0.349***	0.737***
	(2.90)	(10.74)	(-2.09)	(4.96)	(3.38)	(10.64)
Log land per worker	0.772***	0.663***	0.257***	0.129***	0.734***	0.557***
	(15.99)	(33.28)	(5.28)	(7.08)	(19.35)	(30.21)
Log age of HH	0.420***	-0.0283	0.239	0.306***	0.498***	0.147*
	(4.27)	(-0.43)	(1.45)	(4.47)	(5.72)	(2.34)
Dependency ratio	-0.00217***	0.00345***	-0.000014	0.000181	-0.00209***	0.00245***
	(-4.59)	(-12.48)	(-0.02)	(-0.67)	(-5.43)	(-9.56)
Dummy for land title	-0.0699	-0.0122	-0.293***	0.0776*	-0.127**	0.0472
	(-1.32)	(-0.35)	(-3.62)	(2.17)	(-2.73)	(1.41)
Dummy for paid job	0.0825	-0.0573	0.0149	0.00889	0.0762	-0.0558
	(1.15)	(-1.23)	(0.15)	(0.19)	(1.23)	(-1.27)
Dummy for risky region	-0.638***	-0.484***	-0.442**	0.345***	-0.426***	-0.111
	(-5.01)	(-6.99)	(-2.99)	(5.46)	(-4.81)	(-1.81)
Log median rice yield (vill)	1.075***	0.787***	0.331***	0.0964**	0.932***	0.644***
	(15.87)	(23.47)	(4.80)	(3.06)	(17.66)	(20.58)
Dummy for ownership of ag. Implements	0.417***	0.220***	-0.139	0.244***	0.301***	0.264***
	(6.75)	(5.72)	(-1.41)	(6.15)	(5.58)	(7.33)
Dummy for ethnicity	-0.171	0.0837	-0.503	0.202	-0.144	0.150
	(-0.93)	(0.76)	(-1.91)	(1.79)	(-0.93)	(1.48)
Dummy for ownership of transport equipments	0.171*	0.0658	0.111	-0.00574	0.180**	0.0383
	(2.56)	(1.53)	(1.13)	(-0.13)	(3.16)	(0.95)
Log distance to market	-0.0459	-0.0484**	-0.108**	0.0663***	-0.0512*	-0.00394
	(-1.87)	(-2.92)	(-2.84)	(3.90)	(-2.39)	(-0.25)
Log distance to bus stop	0.0613**	0.0565***	-0.0554	0.0925***	-0.0259	0.00425
	(3.18)	(4.55)	(-1.81)	(-7.52)	(-1.64)	(0.36)
Log distance to provincial capital	-0.0236	-0.00821	-0.0772	0.0843***	-0.0255	0.0173
	(-0.60)	(-0.33)	(-1.39)	(3.43)	(-0.78)	(0.74)
Dummy for ownership of radio, TV, or telephone		0.0677		0.0919*		0.103**
		(1.83)		(2.54)		(2.89)
Log village population density		0.00501		0.179***		0.0910**
		(0.17)		(6.22)		(3.17)
Educational level of HH		0.00337*		0.00120		0.00216
		(1.98)		(0.73)		(1.27)
Constant	1.259	-10.15	13.86	-6.644	2.470	-9.981
	(1.10)	(-15.84)	(7.74)	(-10.34)	(2.54)	(-16.48)
N	6978		6978			

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2. Summary of Results:

All Households

- The price of paddy, the most important crop in Cambodian agriculture cultivated in more than 80% of the arable land, has expected positive sign and significance in almost all the equations. For all crops and food crops, price of paddy has significant positive effect and for cash crops it has negative but significant effect. This is theoretically consistent as higher paddy price induces households to produce more of the product rather than producing crops that are relatively less profitable. The marginal effect of price of paddy accordingly comes out to be highest in magnitude. An interesting finding is that higher price of paddy not only results in higher marketed surplus of rice, it also motivates households to diversify their portfolio of crop production. As price increases so does profit and income of the farmers and better- off farmers can now afford to produce more cash crops resulting in increased market participation and commercialisation of agriculture.
- Based on the CSES – 2004 data, except land title (which is very important for small holders that we will discuss later), the coefficients for other capital endowment variables, namely - land per worker, ownership of agricultural implements – are positive and highly significant for both quantity and market participation equations, indicating that relatively well-endowed farmers participate in the market and commercialize. The marginal effects for these two variables are also among the highest (3^{rd} and 4^{th}, respectively). This is even more important for the smallholders' group (fig.2).So interventions that build households' agricultural assets and intensify cropping pattern (expansion of new arable land is constrained by cost of demining, and redistribution is politically not feasible) could pay higher dividends in terms of poverty reduction, through increased market participation and commercialisation of agriculture by smallholders.
- The dummy for risky region, as expected, has the largest (absolute) negative marginal effect on food crop marketed surplus while the opposite is true for cash. This is an interesting finding. Food crop is dominated overwhelmingly by paddy in Cambodia which is susceptible to damage due to disasters such as excessive rain, flood, or drought. Farmers in disaster prone region opt for safer but low return crops such as mango/ or banana resulting in potential food insecurity/ persistent poverty and vulnerability (or possibly a geographic poverty trap). This is particularly true in a

subsistence economy characterised by imperfect credit and insurance markets. Hence living and farming in risky regions clearly does not help market integration and commercialization of agriculture.

- Marginal effect of village level median rice yield, a variable capturing combined effect of geographic features, state of technology use and the effect of other inputs is of considerable significance. Increased rice yield not only results in larger marketed surplus of rice itself, it also helps generate larger marketed surplus of cash crops. Improved rice/food productivity can drive commercialization of other crops as it potentially could free up land and other resources tied up in subsistence farming. For smallholders this has the highest marginal effect. This is true for both sets of estimates based on CSES – 2004 and CSES – 2007.
- Factors capturing variable transaction costs, except transport equipment ownership, have in most cases (both in selection as well as sales/quantity equations) expected signs and are significant. Thus variable transaction costs constitute one of the major binding constraints to market participation and commercialisation of agriculture in Cambodia which is an important finding with significant policy implications. This is particularly important for smallholders. The coefficient of (log) distance to market for this group is negative and highly significant in both participation and quantity equations. So providing better access to markets is likely to induce smallholders to commercialise.
- Variables (i.e. ownership of radio, television or telephone, education level of the head of the household, and the village population density) capturing fixed transaction costs and information processing have expected signs and are significant in all the specifications, suggesting that better access to information networks is likely to result in increased agricultural outputs, enhanced market participation and commercialisation.

5.3. Small Holders vs. Large Holders

Subsistence/semi-subsistence households might exhibit differential supply response for a number of reasons: first, the assets, technologies and incentives available to the poor and the non-poor may differ. This is, for example, the case if smallholders find themselves unable to share in the market- based growth for lack of skill, labour or land. Or, second, the behavioural responses (controlling for assets, technologies and incentives) may vary between small and large land holders. This is, for example, the case of risk aversion or lack of skill/or ability

preventing the poor from taking advantage of market opportunities (Heltberg and Tarp, 2002). If the poor/vulnerable are to be able to reap benefits out of larger economic growth process, it is important that their degree of market integration is increased.

Table 5 Regression Results (CSES – 2004; Small holders), Dependent Variable = log Sales value of marketed Surplus

	Food Crops		Cash Crops		All Crops	
Variables	***Quantity***	***Select***	***Quantity***	***Select***	***Quantity***	***Select***
Log median price of paddy (vill)	0.323	0.765***	-0.392	0.241*	0.231	0.634***
	(1.49)	(7.66)	(-1.55)	(2.29)	(1.32)	(6.94)
Log land per worker	0.248*	0.474***	0.138*	0.0426	0.242***	0.348***
	(2.53)	(16.63)	(2.02)	(1.61)	(3.50)	(13.96)
Log age of HH	0.0669	-0.130	0.265	0.180	0.146	0.0375
	(0.43)	(-1.49)	(1.10)	(1.88)	(1.10)	(0.47)
Dependency ratio	-0.00137	-0.0028***	-0.0000427	-0.00034	-0.00123	-0.002***
	(-1.62)	(-7.49)	(-0.05)	(-0.91)	(-1.92)	(-6.13)
Dummy for land title	-0.103	-0.0262	-0.205	0.151**	-0.0843	0.0713
	(-1.12)	(-0.54)	(-1.60)	(2.95)	(-1.12)	(1.62)
Dummy for paid job	0.169	-0.115	0.147	-0.0303	0.152	-0.101
	(1.35)	(-1.82)	(0.98)	(-0.47)	(1.56)	(-1.78)
Dummy for risky region	-0.674**	-0.338***	-0.616**	0.344***	-0.470***	-0.00313
	(-3.16)	(-3.50)	(-2.81)	(3.90)	(-3.40)	(-0.04)
Log median rice yield (vill)	0.787***	0.724***	0.0997	0.271***	0.668***	0.653***
	(5.26)	(16.51)	(0.83)	(6.20)	(5.51)	(16.21)
Dummy for ownership of ag. Implements	0.265**	0.159**	-0.165	0.230***	0.207*	0.199***
	(2.73)	(3.24)	(-1.27)	(4.41)	(2.55)	(4.49)
Dummy for ethnicity	0.322	0.0356	-0.551	0.277	0.200	0.208
	(1.02)	(0.23)	(-1.28)	(1.66)	(0.76)	(1.50)
Dummy for transport equipments	0.0691	0.0419	0.264	-0.0404	0.119	0.00553
	(0.64)	(0.74)	(1.90)	(-0.68)	(1.38)	(0.11)
Log distance to market	-0.139**	-0.0768***	-0.146*	0.0208	-0.148***	-0.0460*
	(-3.10)	(-3.30)	(-2.52)	(0.84)	(-4.10)	(-2.17)
Log distance to bus stop	0.0343	0.0718***	0.0312	-0.067***	0.000900	0.0118
	(0.96)	(4.13)	(0.73)	(-3.83)	(0.04)	(0.76)
Log distance to provincial capital	-0.0390	-0.0517	-0.117	0.0143	-0.0517	-0.0359
	(-0.61)	(-1.53)	(-1.50)	(0.42)	(-1.04)	(-1.19)
Dummy for radio, TV, or telephone	3.746	-0.00274	15.58***	0.0771	5.372**	0.0393
	(1.62)	(-0.05)	(5.94)	(1.54)	(2.75)	(0.83)
Log village population density		-0.0354		0.164***		0.0510
		(-0.86)		(4.07)		(1.36)
Educational level of HH		0.000450		-0.00232		-0.00083
		(0.17)		(-0.84)		(-0.34)
Constant		-9.042		-6.661		-9.010
		(-10.31)		(-7.32)		(-11.31)
N	3982		3982			

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6 Regression Results (CSES 2004 – Large holders), Dependent Variable = log Sales value of marketed Surplus

	Food Crops		Cash Crops		All Crops	
Variables	*Quantity*	*Select*	*Quantity*	*Select*	*Quantity*	*Select*
Log median price of paddy (vill)	-0.158	0.868***	-0.332	0.565***	0.0525	1.001***
	(-1.05)	(8.19)	(-1.31)	(5.25)	(0.39)	(9.15)
Log land per worker	0.448***	0.614***	0.245**	-0.140**	0.610***	0.358***
	(7.28)	(14.28)	(2.73)	(-3.25)	(11.42)	(7.84)
Log age of HH	0.543***	-0.0396	0.251	0.221*	0.581***	-0.00541
	(4.08)	(-0.40)	(1.20)	(2.14)	(5.01)	(-0.05)
Dependency ratio	0.000801	-0.0036***	0.0000552	0.00104*	-0.00104*	-0.002***
	(1.37)	(-8.53)	(0.07)	(2.46)	(-2.09)	(-4.14)
Dummy for land title	-0.0744	0.00969	-0.343***	0.0406	-0.192**	0.0398
	(-1.12)	(0.20)	(-3.31)	(0.79)	(-3.27)	(0.76)
Dummy for paid job	0.0404	0.0155	-0.124	0.0161	0.0270	-0.00188
	(0.45)	(0.23)	(-0.92)	(0.23)	(0.34)	(-0.03)
Dummy for risky region	0.204	-0.553***	-0.342	0.420***	-0.273*	-0.195*
	(1.33)	(-5.68)	(-1.72)	(4.42)	(-2.40)	(-2.05)
Log median rice yield (vill)	0.568***	0.771***	0.531***	-0.0328	0.743***	0.588***
	(7.72)	(15.49)	(6.04)	(-0.70)	(11.65)	(11.33)
Dummy for ownership of ag. Implements	0.118	0.148*	-0.0874	0.0929	0.0504	0.118
	(1.39)	(2.38)	(-0.64)	(1.41)	(0.67)	(1.81)
Dummy for ethnicity	-0.561*	0.236	-0.468	0.173	-0.362	0.156
	(-2.50)	(1.52)	(-1.44)	(1.08)	(-1.92)	(1.00)
Dummy for transport equipments	0.0539	-0.0217	-0.0500	-0.0562	0.0874	-0.103
	(0.61)	(-0.34)	(-0.37)	(-0.83)	(1.15)	(-1.52)
Log distance to market	0.0289	-0.0222	-0.0635	0.0796**	0.00174	0.0289
	(0.94)	(-0.96)	(-1.27)	(3.26)	(0.06)	(1.17)
Log distance to bus stop	0.0407	0.0309	-0.129**	-0.120***	-0.0370	0.00123
	(1.72)	(1.76)	(-3.04)	(-6.70)	(-1.82)	(0.07)
Log distance to provincial capital	-0.0913	0.0247	-0.0512	0.136***	-0.0780	0.0370
	(-1.81)	(0.67)	(-0.65)	(3.65)	(-1.81)	(0.98)
Dummy for ownership of radio, TV, or telephone		0.179***		0.0818		0.250***
		(4.05)		(1.53)		(4.96)
Log village population density		0.0665		0.181***		0.209***
		(1.82)		(4.19)		(4.96)
Educational level of HH		0.00470*		0.00299		0.00344
		(2.06)		(1.34)		(1.41)
Constant	9.32	-11.07	11.95	-6.613	6.615	-11.36
	(7.05)	(-11.91)	(5.05)	(-7.04)	(5.44)	(-11.62)
N	2996		2996			

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Hence it is vital to understand the factors underlying systematic differences in market integration for various crops across farm households.

- As revealed by regression results in table 5 and 6 and the corresponding marginal effects in fig. 2 and 3, while price of paddy, rice yield capturing the state of technology use, among other factors, farm size and ownership of agricultural equipment have similar positive and significant marginal effects, there are notable differences between small and large holders' responses. For smallholders it is the rice yield rather than the price of paddy which has the highest marginal effect. Similarly, ownership of agricultural implements is far more important to smallholders than to large holders. The implication is that interventions meant to build smallholders' agricultural assets, provide access to technology through better extension services, irrigation during dry season, among others, are likely to payoff in terms of increased production (both food and cash crops) and greater market integration of smallholders.
- The dummy for risky region affects large holders' supply response more severely than small holders'.
- One of the major findings of this analysis is that for small/subsistence holders, transaction costs turn out to be one of the main barriers for generating marketed surplus of food crops. Variables capturing variable transaction costs, that is, distance to market, distance to bus stop, distance to provincial capital and ownership of transport equipments all have expected sign and significant marginal effects on supply response. But the same is not true for large holders. This has far reaching policy implications – developing rural infrastructures such as road networks connecting markets and storage facilities and access to information networks- would potentially pay high dividends in terms of increased food production resulting in higher marketed surplus and commercialisation. This could potentially ensure better nutritional status and food security of the poor and reduce vulnerability of small and subsistence farmers.
- Similarly, secure land ownership facilitates market integration of subsistence farmers. For large holders group land title variable does not have significant marginal effect. Obviously, large holders are likely to be powerful rural elites and would feel more assured about their possession than smallholders.
- Subsistence households having alternative earning sources (these are mostly paid domestic workers as suggested by data) to meet their cash requirements produce food

crops only for their own consumption, not for sale. The intuition is that smallholders do not need to commit forced sale of part of their produce to meet their emergency/urgent obligation as they have alternative sources of cash.

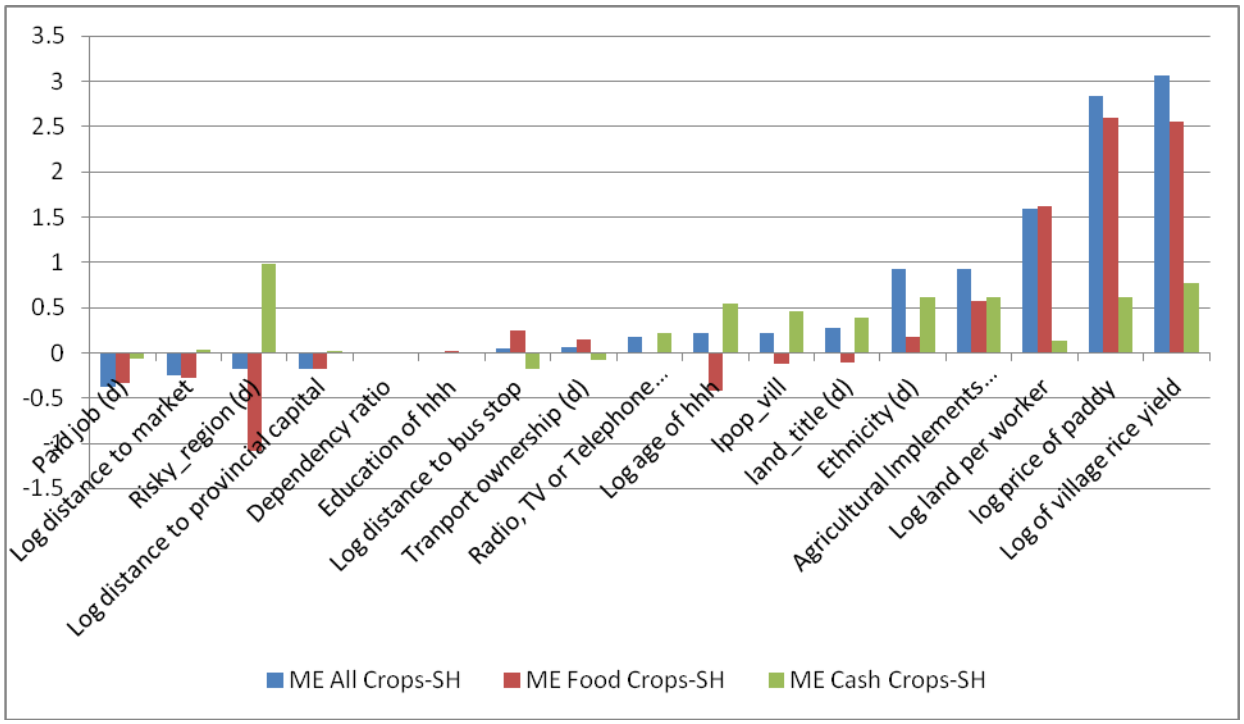

Figure 2 Marginal Effects Across Crop types – Small Holders

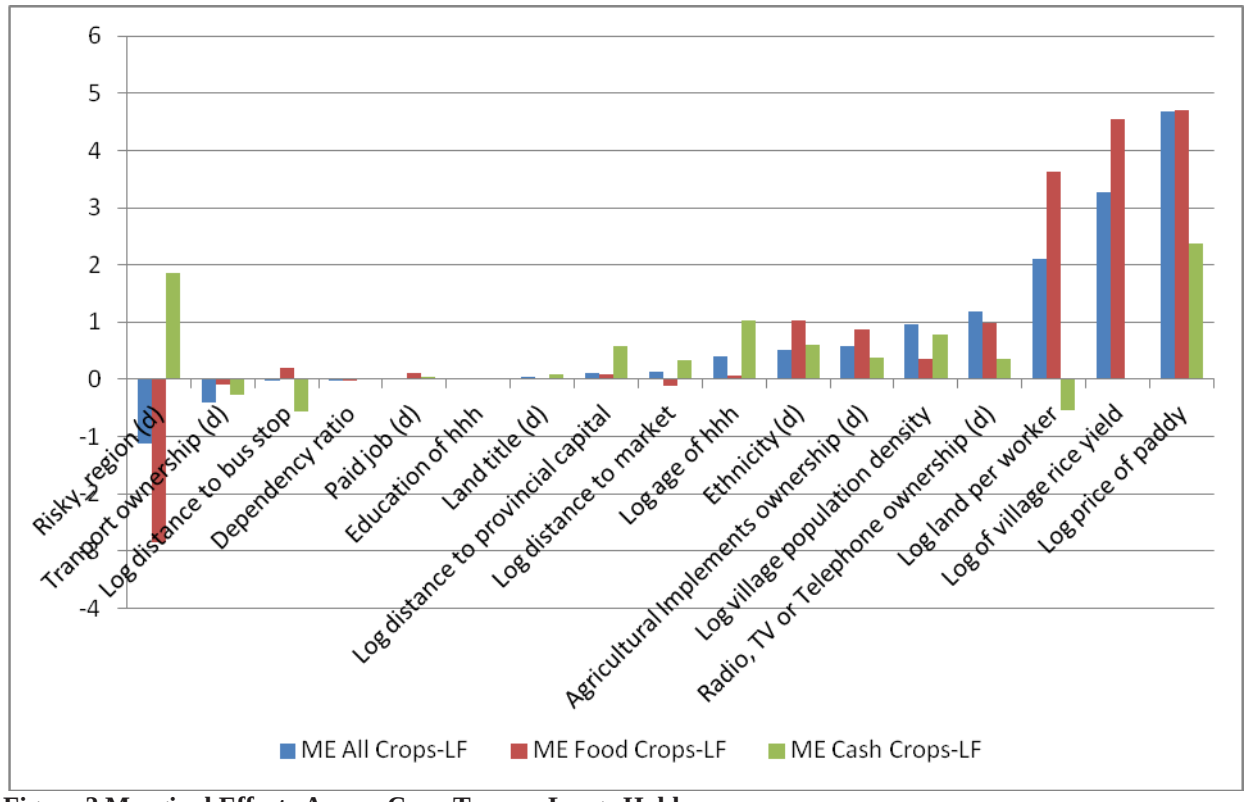

Figure 3 Marginal Effects Across Crop Types – Large Holders

Figure 4 compares unconditional marginal effects of small and large holders for all crop categories. Clearly, the differences between the marginal effects of small and large holders are substantial.

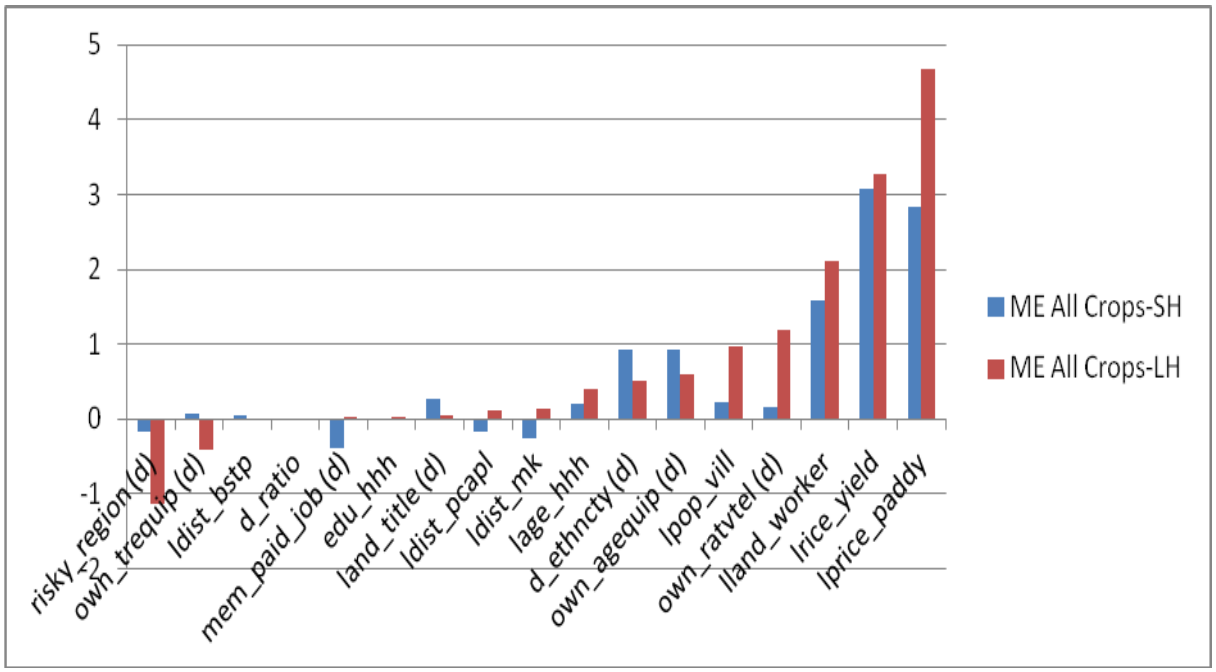

Figure 4 Marginal Effects of Small vs Large Holders

5.4. Estimates Based on CSES – 2007 Data

Table 7 gives the regression results based on CSES – 2007 data for all households and the corresponding unconditional marginal effects are reported in figure 5 and in appendix 2. As before, for each model there are two columns – the first column (quantity) reports the log of annual sales given market participation and the second column (select) shows the results of market participation probability model.

Table 7 Regression Results (CSES-2007), Dependent Variable = log Sales value of marketed Surplus

	Food Crops		Cash Crops		All Crops	
Variables	Quantity	Select	Quantity	Select	Quantity	Select
Log median price of paddy (vill)	0.0148	0.175***	-0.109*	0.0782***	-0.0781**	0.0640**
	(0.42)	(8.04)	(-2.37)	(4.13)	(-3.22)	(3.16)
Log land per worker	0.687***	0.584***	0.181**	0.0404	0.635***	0.436***
	(10.15)	(15.86)	(2.61)	(1.33)	(13.09)	(13.40)
Log age of HH	0.00170	0.000336	-0.00669	0.00770**	0.00194	0.00267
	(0.50)	(0.13)	(-1.08)	(3.03)	(0.64)	(1.03)
Dependency ratio	-0.513***	-0.421***	-0.143	-0.0392	-0.461***	-0.353***
	(-6.46)	(-8.00)	(-1.22)	(-0.77)	(-6.86)	(-6.93)
Dummy for land title	0.238*	0.0729	-0.170	0.123	0.148	0.139
	(2.35)	(1.00)	(-0.99)	(1.71)	(1.69)	(1.93)
Dummy for paid job	0.124	-0.142	-0.269	0.0622	0.0116	-0.108
	(1.21)	(-1.93)	(-1.65)	(0.87)	(0.13)	(-1.48)
Dummy for risky region	-0.104	-0.0971	0.104	0.137	0.0728	0.0644
	(-0.97)	(-1.27)	(0.59)	(1.83)	(0.80)	(0.85)
Log median rice yield (vill)	1.388***	0.983***	0.157	0.0636	1.194***	0.809***
	(10.49)	(12.16)	(0.96)	(0.89)	(11.41)	(10.75)
Dummy for ownership of ag. Implements	0.134	-0.0260	-0.431*	0.177*	0.150	-0.0389
	(1.14)	(-0.30)	(-2.10)	(2.06)	(1.45)	(-0.45)
Dummy for ethnicity	0.589	0.358	-1.519*	0.160	-0.487	0.507*
	(1.52)	(1.42)	(-2.34)	(0.62)	(-1.36)	(2.15)
Dummy for transport equipments	0.0166	0.326***	0.162	0.126	0.0582	0.352***
	(0.14)	(3.55)	(0.77)	(1.41)	(0.54)	(3.77)
Log distance to provincial capital	-0.120*	-0.111**	0.0811	-0.0719	-0.0565	-0.0764
	(-2.48)	(-3.17)	(1.05)	(-1.37)	(-1.37)	(-1.41)
Log distance to bus stop	0.178*	0.0586	-0.149	-0.145**	0.0633	-0.0397
	(2.38)	(1.08)	(-1.21)	(-2.74)	(0.98)	(-0.74)
Log distance to market	-0.0457	-0.0149	0.420***	0.0631	0.0164	-0.0251
	(-0.61)	(-0.27)	(3.44)	(1.84)	(0.26)	(-0.72)
Dummy for radio, TV, or telephone		0.273*		-0.0710		0.155
		(2.46)		(-0.81)		(1.39)
Log village population density		-0.0956***		0.0610**		-0.0309
		(-3.77)		(3.10)		(-1.24)
Educational level of HH		0.0236*		0.0132		0.0248*
		(2.08)		(1.38)		(2.21)
Constant	12.16	-0.570	16.46	-0.904	13.87	-0.0210
	(20.15)	(-1.32)	(17.05)	(-2.19)	(27.51)	(-0.05)
Number of Observations	1698		1698		1698	

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.5. Summary of Results

All households:

- For market participation decision – the coefficients for log price of rice are positive and highly significant in all three models. However, for all quantity equations they are

negative and significant for cash crops. For food crops it is still positive but non-significant. The marginal effects seem to be weaker compared to the estimates based on CSES – 2004 data. This could be due to the fact that the sample size for CSES – 2007 is much smaller than that of CSES – 2004 and that there is very little price variation in the data.

- The coefficients for the capital endowment variable – land per worker – are positive and significant for both quantity and market participation equations indicating that relatively well-endowed farmers participate in the market and commercialize. This is completely in line with the initial estimates based on CSES – 2004 data. The marginal effects for this variable are also the second largest, implying that for generating marketable surpluses and commercialization of agriculture in Cambodia land redistribution/allocation has significant policy implications.
- Among the household background characteristic variables – dependency ratio has the expected sign in all the models and is highly significant. The Cambodian population is relatively young and the higher dependency ratio seems to be a deterrent for generating marketable agricultural surpluses and commercialization as suggested by the size of the marginal effect for this variable (largest negative). Other background variables such as 'Log of age of head of household' and 'any member has paid job' have the expected signs, but are non-significant in most cases.
- Geographical features such as median village rice yield per hectare, dummy for risky region in most cases (in both market participation and quantity equations) have the expected signs and are significant. So improved rice/food productivity can drive commercialization of other crops as it potentially could free up land and other resources tied up in subsistence farming.
- Variables capturing transaction costs (both fixed and variable) have in most cases similar estimates as with CSES – 2004 data in terms of the sign and size of the coefficients and marginal effects. Ownership of transport equipment, and distance variables have in most cases expected signs and are significant, indicating that measures to reduce transactions costs could help farmers to produce beyond subsistence level. Similarly, variables such as ownership of radio, TV or telephone, village population density, and the educational level of head of household, which are expected to capture fixed transaction costs and information processing, all have sizeable marginal effects.

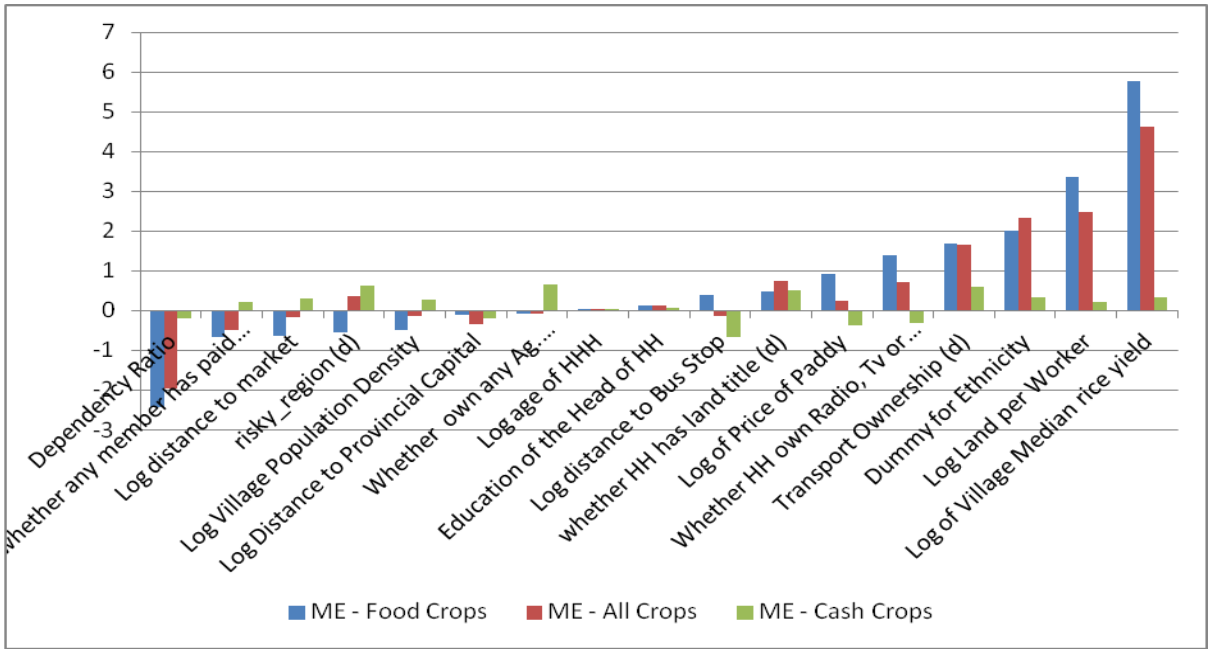

Figure 5 Marginal Effects - All (CSES- 2007)

5.6. Small vs. Large Holders

As with the case of all households, regression results and the corresponding marginal effects for small and large holders based on CSES – 2007 data are largely in line with our initial estimates based on CSES – 2004 data. The main findings are highlighted below:

- Results based on CSES – 2007 are largely similar to our initial estimates based on CSES – 2004. As revealed by the regression results in table 8 and 9, and the corresponding marginal effects in fig. 6 and 7, variables such as price of paddy, rice yield (capturing the state of technology use), land per worker, and land title continue to have similar positive and significant marginal effects, with notable differences between small and large holders' responses. Price of paddy is no longer the dominant determinant of supply response; however, it remains the case that for small holders it is far less important for commercial production of agricultural outputs than for large holders. Similarly, land title, transaction costs variables, capital endowment and household background characteristics such as land per worker and ethnicity are far more important to smallholders than to large holders.
- Transaction costs continue to be one of the main barriers for generating marketed surplus of food crops for small/subsistence holders. Variables capturing variable transaction costs, that is, distance to market, distance to bus stop, distance to provincial capital and ownership of transport equipments all have the expected signs and significant marginal effects on supply response. However, the same is not true for large holders.

Similarly, the land title variable has sizeable and significant positive marginal effects, consistent with our earlier findings with CSES – 2004 data. Thus, it is safe to argue that secure land ownership facilitates market integration of subsistence farmers in Cambodia.

Table 8 Regression Results (CSES – 2007; Small holders), Dependent Variable = log Sales value of marketed Surplus

	Food Crops		Cash Crops		All Crops	
Variables	**Quantity**	**Select**	**Quantity**	**Select**	**Quantity**	**Select**
Log median price of paddy (vill)	-0.237***	0.128***	-0.150*	-0.0899***	-0.155***	0.0153
	(-3.40)	(4.61)	(-2.44)	(-3.64)	(-3.60)	(0.66)
Log land per worker	0.623***	0.390***	0.227*	-0.0920	0.0700	0.19***
	(4.46)	(7.64)	(2.34)	(-1.91)	(0.83)	(4.35)
Log age of HH	0.0113	-0.00114	-0.0094	0.00495	-0.000184	0.0028
	(1.50)	(-0.35)	(-1.27)	(1.35)	(-0.03)	(0.89)
Dependency ratio	0.227	-0.291***	-0.179	0.00823	-0.00415	-0.20**
	(1.29)	(-4.15)	(-1.29)	(0.11)	(-0.03)	(-3.13)
Dummy for land title	0.0757	0.189	0.0879	0.213	0.217	0.150
	(0.32)	(1.90)	(0.38)	(1.96)	(1.21)	(1.63)
Dummy for paid job	-0.0222	-0.162	-0.0351	0.0940	-0.00477	-0.0874
	(-0.10)	(-1.69)	(-0.18)	(0.91)	(-0.03)	(-0.97)
Dummy for risky region	0.185	-0.139	-0.426	0.195	-0.124	0.0221
	(0.74)	(-1.33)	(-1.64)	(1.68)	(-0.64)	(0.23)
Log median rice yield (vill)	0.549	0.925***	0.670*	0.329**	0.108	0.84***
	(1.69)	(7.68)	(2.19)	(2.69)	(0.46)	(7.86)
Dummy for ownership of ag. Implements	0.350	-0.0671	-0.125	0.374**	0.254	-0.0021
	(1.22)	(-0.56)	(-0.38)	(2.87)	(1.15)	(-0.02)
Dummy for ethnicity	-0.125	1.126*	-0.397	-0.183	-1.770*	0.590
	(-0.08)	(2.02)	(-0.52)	(-0.48)	(-1.97)	(1.57)
Dummy for transport equipments	-0.643*	0.299*	0.0533	-0.0582	-0.442	0.216
	(-1.97)	(2.20)	(0.19)	(-0.39)	(-1.74)	(1.66)
Log distance to provincial capital	0.0900	-0.116*	-0.0904	-0.0967	0.0291	-0.0621
	(0.68)	(-2.27)	(-0.78)	(-1.32)	(0.30)	(-1.31)
Log distance to bus stop	0.367	0.0608	0.167	-0.176*	0.430**	-0.0619
	(1.95)	(0.80)	(0.88)	(-2.08)	(3.07)	(-0.87)
Log distance to market	-0.0981	0.0111	0.363*	0.0996	0.0725	-0.0082
	(-0.58)	(0.16)	(2.52)	(1.75)	(0.59)	(-0.13)
Dummy for radio, TV, or telephone		0.349**		-0.202		0.165
		(2.84)		(-1.21)		(1.40)
Log village population density		-0.0393		0.0403		-0.0084
		(-1.39)		(1.19)		(-0.34)
Educational level of HH		0.0203		0.0266		0.0259*
		(1.79)		(1.79)		(2.45)
Constant	14.18	-1.936	13.71	-0.995	15.32	-0.879
	(7.56)	(-2.69)	(10.20)	(-1.60)	(13.59)	(-1.58)
Number of Observations	917		917		917	

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9 Regression Results (CSES 2007 – Large holders), Dependent Variable = log Sales value of marketed Surplus

	Food Crops		Cash Crops		All Crops	
Variables	**Quantity**	**Select**	**Quantity**	**Select**	**Quantity**	**Select**
Log median price of paddy (vill)	0.00844	0.216***	-0.123	-0.061*	-0.0293	0.178***
	(0.15)	(6.32)	(-1.67)	(-1.97)	(-0.91)	(4.85)
Log land per worker	0.769***	0.651***	0.390	-0.128	0.782***	0.496***
	(6.50)	(7.21)	(1.90)	(-1.61)	(10.41)	(5.06)
Log age of HH	-0.00337	-0.00128	-0.00615	0.011**	0.00230	-0.00017
	(-0.92)	(-0.30)	(-0.65)	(2.74)	(0.67)	(-0.03)
Dependency ratio	-0.435***	-0.434***	-0.136	0.0350	-0.471***	-0.429***
	(-4.15)	(-5.19)	(-0.75)	(0.46)	(-6.20)	(-4.76)
Dummy for land title	0.141	-0.0241	-0.195	0.0460	-0.0185	0.183
	(1.40)	(-0.22)	(-0.80)	(0.45)	(-0.19)	(1.53)
Dummy for paid job	0.242*	-0.101	-0.395	-0.0509	0.0664	-0.170
	(2.33)	(-0.90)	(-1.60)	(-0.49)	(0.67)	(-1.36)
Dummy for risky region	-0.00751	-0.0419	0.394	0.0693	0.240*	0.0964
	(-0.07)	(-0.37)	(1.60)	(0.67)	(2.48)	(0.75)
Log median rice yield (vill)	1.512***	0.969***	0.265	-0.0847	1.346***	0.812***
	(7.78)	(8.45)	(1.14)	(-0.90)	(13.64)	(7.05)
Dummy for ag. Implements	0.0479	0.0166	-0.244	-0.0066	-0.0158	-0.243
	(0.42)	(0.13)	(-0.82)	(-0.05)	(-0.14)	(-1.57)
Dummy for ethnicity	0.387	-0.0247	-2.299*	0.425	-0.648	0.333
	(1.20)	(-0.07)	(-2.40)	(1.13)	(-1.92)	(0.96)
Dummy for transport equipments	0.0352	0.288*	0.194	0.0721	0.109	0.327*
	(0.29)	(2.26)	(0.68)	(0.62)	(1.01)	(2.28)
Log distance to provincial capital	-0.0981*	-0.0456	0.203*	-0.0082	-0.0508	-0.101
	(-2.19)	(-0.52)	(1.97)	(-0.10)	(-1.22)	(-1.00)
Log distance to bus stop	0.00786	0.0221	-0.327	-0.181**	-0.150*	-0.141
	(0.11)	(0.29)	(-1.93)	(-2.58)	(-2.22)	(-1.64)
Log distance to market	0.00261	-0.0933	0.247	0.0708	0.0573	0.0445
	(0.03)	(-1.87)	(1.28)	(1.55)	(0.78)	(0.80)
Dummy for radio, TV, or telephone		0.218		-0.102		0.00289
		(1.40)		(-0.93)		(0.02)
Log village population density		-0.120**		0.098***		-0.0433
		(-2.78)		(3.63)		(-0.95)
Educational level of HH		0.00625		0.0110		0.0129
		(0.35)		(0.78)		(0.63)
Constant	12.93	0.175	18.15	-1.366	14.27	0.471
	(19.26)	(0.27)	(13.00)	(-2.31)	(27.08)	(0.68)
Number of Observations	781		781		781	

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

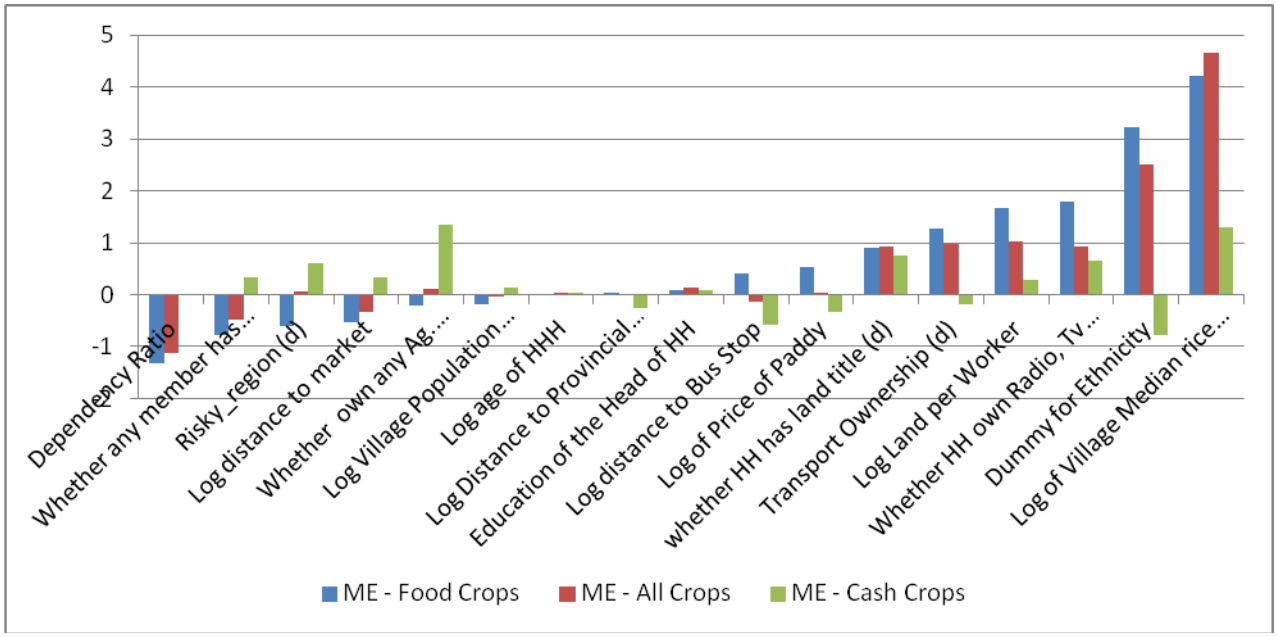

Figure 6 Marginal Effects - Small Holders (CSES - 2007)

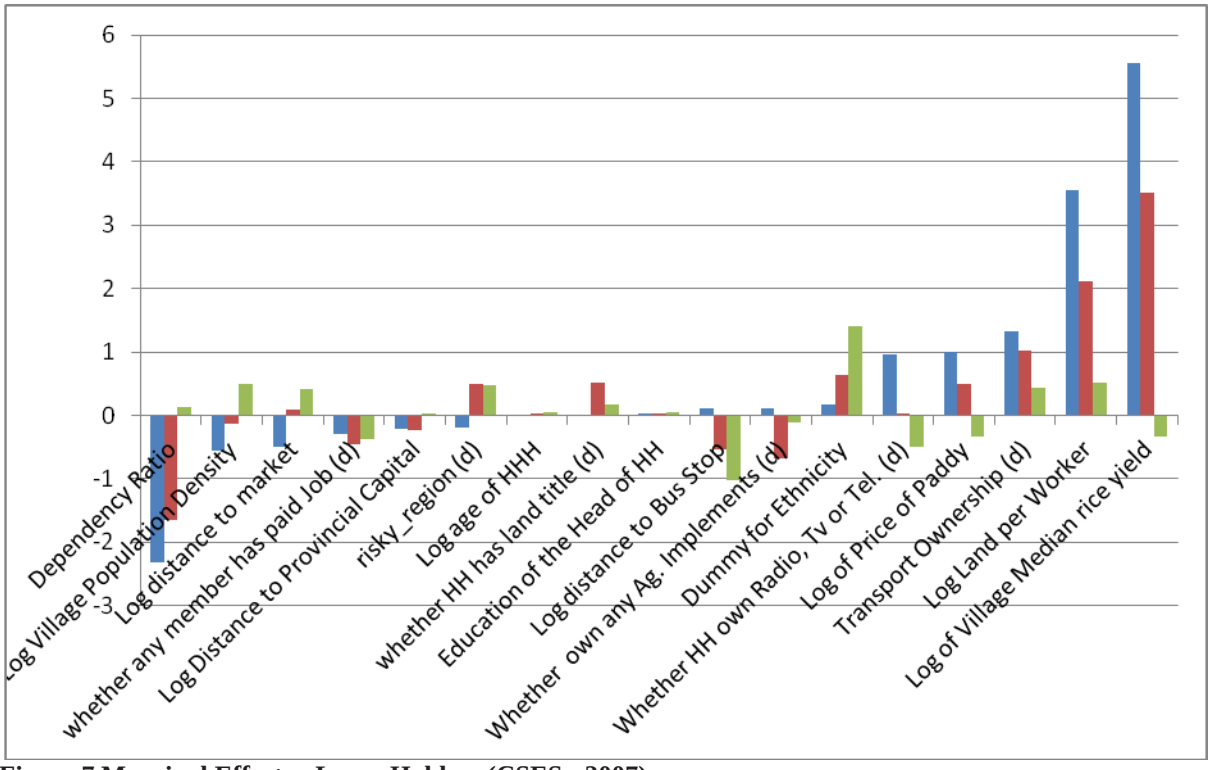

Figure 7 Marginal Effects - Large Holders (CSES - 2007)

6. Conclusion

Using household survey data of Cambodia (CSES – 2004 and CSES – 2007), this study assessed the effects of transactions costs as well as price and non-price factors on market participation and marketed surplus. A switching regression model was used that accounts not only for the effects of fixed and variable transactions costs but also for the role of heterogeneous endowments, technology, and other institutional factors in promoting market participation and generating marketable surpluses. In doing so, we estimated the model for three crop types and the same regressions for smallholders - who are most likely to be among the poorest and the most vulnerable – as well as large holders. We estimated the unconditional marginal effects, that is, the total change in quantities transacted unconditional on market participation, for the full sample and for the samples of small and large holders. Some of our findings we believe could be very useful for future policy design for poverty alleviation and small/subsistence holder's welfare.

Comparison between the marginal effects of the small and large holders reveals substantial qualitative and quantitative differences between these two groups. By providing technical support/ extension services and resolving land issues and land redistribution, targeted support in the form of basic agricultural assets can have high payoffs in terms of poverty alleviation, reduced vulnerability and increased food security. Furthermore, targeted support helps the poor to participate in the growth process and to reap benefit out of the opportunities opened up by the exchange economy. Having secure land title is important for poverty alleviation and reducing vulnerability through increased participation of smallholders and subsistence farmers in markets and commercial sales.

Integrating non-ethnic Khmers into the mainstream of economic activities is also likely to payoff in terms of poverty alleviation and a vibrant rural economy. Another important finding is the transaction cost barrier for smallholders' market participation. Easier access of smallholders to better rural infrastructure (e.g. road networks and other physical facilities) is important for producing outputs to meet market demand. Evidence points to geographic poverty traps that are exacerbated by risk aversion and low-return crops, causing poverty to persist for generations. High yielding varieties, extension services along with insurance would help in breaking out of the shackles of subsistence farming.

Overall, the findings suggest that policy options other than price policies are available to promote commercialization and generate agricultural surpluses, particularly by the smallholders. This is important because, in the short run, higher prices are likely to benefit sellers (mostly large holders who are already in the market) only, impose costs on buying households unable to respond to price incentives, and bypass those failing to participate in markets because of high transactions costs and other barriers to market entry. Therefore, price policies will have very different behavioural and welfare implications for different segments of the farming population. In the face of the food price dilemma facing many countries recently, policies that reduce transactions costs and induce smallholders to commercialize could thus be important alternatives to price policies to promote marketed surplus and commercialization of agriculture by smallholders and thereby reduce poverty and vulnerability of this particular community of farmers.

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Appendix 1

Marginal Effects

There are four different responses of marketing behaviour to changes in explanatory variables in selectivity models (Huang et al. 1991). These are: i) the change in probability of marketing participation; ii) the change in desired quantities traded; iii) the change in actual quantities traded conditional on market participation; and iv) the total change in quantities transacted unconditional on market participation. The unconditional marginal effect, which is of particular interest for this study, on actual quantities transacted (Q_i^m) per unit change in the $i-th$ variable (X_{ki}) can be calculated as (Huang et al. 1991) follows:

$$\left(\frac{\partial E(Q_i^m)}{\partial X_{ki}}\right) = \beta^x \Phi(\theta X_i + \kappa T_i) + \theta^x \phi(\theta X_i + \kappa T_i)[(\beta X_i) + (\theta X_i + \kappa T_i)\rho] \quad (15)$$

where, β^x and θ^x correspond to the estimated parameters for variable X in the quantity and selection equation of the model respectively; while, $\Phi(.)$ and $\phi(.)$ stand for cumulative and probability density functions of standard normal distribution respectively. The above equation shows that the total unconditional marginal effect on quantities transacted equals the sum of (1) the marginal effect on quantities transacted by participants weighted by the probability of participation, and (2) the marginal effect on the probability of participation weighted by the expected quantities transacted by participants. While the changes in the quantities transacted by participants weighted by probability of participation represent the total effects due to current participants, the changes in probability of participation weighted by expected quantities transacted by participants represents total effects due to new participants.

Appendix 2

Table 10 Marginal Effects: All Households (CSES-2004)

Variables	ME - Food Crops	ME - Cash Crops	ME - All Crops
Log median price of paddy (vill)	3.486***	1.246***	3.726***
	(10.68)	(4.90)	(10.79)
Log land per worker	3.113***	0.497***	3.034***
	(35.48)	(7.97)	(33.15)
Log age of HH	0.0912	1.199***	1.123***
	(0.31)	(5.03)	(3.56)
Dependency ratio	-0.0159***	-0.000693	-0.0130***
	(-12.85)	(-0.74)	(-10.19)
Dummy for land title	-0.0832	0.216	0.154
	(-0.53)	(1.76)	(0.93)
Dummy for paid job	-0.290	-0.0181	-0.342
	(-1.40)	(-0.11)	(-1.54)
Dummy for risky region	-2.004***	1.272***	-0.723*
	(-8.68)	(4.84)	(-2.43)
Log median rice yield (vill)	3.748***	0.385***	3.528***
	(25.06)	(3.52)	(22.59)
Dummy for ownership of ag. Implements	1.052***	0.805***	1.390***
	(6.41)	(6.33)	(7.86)
Dummy for ethnicity	0.207	0.514	0.514
	(0.43)	(1.51)	(1.00)
Dummy for ownership of transport equipments	0.293	-0.0188	0.210
	(1.54)	(-0.12)	(1.04)
Log distance to market	-0.218**	0.213***	-0.0349
	(-2.94)	(3.62)	(-0.44)
Log distance to bus stop	0.270***	-0.342***	0.00955
	(4.85)	(-8.09)	(0.16)
Log distance to provincial capital	-0.0385	0.290***	0.0838
	(-0.34)	(3.41)	(0.71)
Dummy for ownership of radio, TV, or telephone	0.291	0.290*	0.464**
	(1.79)	(2.26)	(2.68)
Log village population density	0.0109	0.637***	0.445**
	(0.08)	(6.14)	(3.19)
Educational level of HH	0.0475*	0.0295	0.0630**
	(2.31)	(1.79)	(2.90)
Number of Observations	6913	6913	

Marginal effects; *t* statistics in parentheses (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11 Marginal Effects: Small Holders (CSES-2004)

	ME - Food Crops	ME - Cash Crops	ME - All crops
Log median price of paddy (vill)	2.596***	0.614*	2.832***
	(7.71)	(2.18)	(7.01)
Log land per worker	1.619***	0.139	1.594***
	(17.15)	(1.96)	(14.51)
Log age of HH	-0.417	0.539*	0.213
	(-1.41)	(2.10)	(0.60)
Dependency ratio	-0.00943***	-0.000958	-0.00912***
	(-7.58)	(-0.95)	(-6.30)
Dummy for land title	-0.107	0.389**	0.280
	(-0.66)	(2.88)	(1.44)
Dummy for paid job	-0.339	-0.0629	-0.382
	(-1.67)	(-0.37)	(-1.55)
Dummy for risky region	-1.080***	0.985**	-0.176
	(-4.50)	(3.28)	(-0.51)
Log median rice yield (vill)	2.554***	0.769***	3.066***
	(17.47)	(6.58)	(17.26)
Dummy for ownership of ag. Implements	0.575***	0.609***	0.932***
	(3.52)	(4.49)	(4.79)
Dummy for ethnicity	0.178	0.609	0.920
	(0.36)	(1.82)	(1.67)
Dummy for ownership of transport equipments	0.151	-0.0746	0.0651
	(0.80)	(-0.46)	(0.29)
Log distance to market	-0.282***	0.0368	-0.251**
	(-3.58)	(0.56)	(-2.67)
Log distance to bus stop	0.244***	-0.182***	0.0514
	(4.15)	(-3.91)	(0.75)
Log distance to provincial capital	-0.179	0.0229	-0.174
	(-1.56)	(0.25)	(-1.30)
Dummy for ownership of radio, TV, or telephone	-0.00907	0.214	0.170
	(-0.05)	(1.55)	(0.82)
Log village population density	-0.117	0.457***	0.221
	(-0.86)	(4.06)	(1.36)
Educational level of HH	0.00149	-0.00646	-0.00360
	(0.17)	(-0.84)	(-0.34)
Number of Observations	3982	3982	

Marginal effects; *t* statistics in parentheses (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12 Marginal Effects: Large Holders (CSES – 2004)

	ME - Food Crops	ME - Cash Crops	ME - All Crops
Log median price of paddy (vill)	4.697***	2.362***	4.683***
	(8.58)	(5.18)	(9.78)
Log land per worker	3.623***	-0.541**	2.103***
	(16.09)	(-2.96)	(10.43)
Log age of HH	0.0716	1.033*	0.397
	(0.14)	(2.36)	(0.86)
Dependency ratio	-0.0192***	0.00456*	-0.00910***
	(-8.94)	(2.53)	(-4.79)
Dummy for land title	0.0137	0.0786	0.0456
	(0.05)	(0.36)	(0.20)
Dummy for paid job	0.107	0.0341	0.0109
	(0.31)	(0.12)	(0.03)
Dummy for risky region	-2.854***	1.852***	-1.126*
	(-6.27)	(4.04)	(-2.54)
Log median rice yield (vill)	4.552***	0.00944	3.270***
	(17.52)	(0.05)	(14.37)
Dummy for ownership of ag. Implements	0.875**	0.373	0.591*
	(2.75)	(1.38)	(2.00)
Dummy for ethnicity	1.039	0.604	0.505
	(1.28)	(0.96)	(0.67)
Dummy for ownership of transport equipments	-0.0906	-0.262	-0.405
	(-0.27)	(-0.90)	(-1.42)
Log distance to market	-0.107	0.328**	0.135
	(-0.89)	(3.17)	(1.25)
Log distance to bus stop	0.192*	-0.561***	-0.0212
	(2.12)	(-7.36)	(-0.26)
Log distance to provincial capital	0.0874	0.578***	0.115
	(0.46)	(3.66)	(0.69)
Dummy for ownership of radio, TV, or telephone	0.983***	0.353	1.179***
	(4.07)	(1.54)	(4.90)
Log village population density	0.366	0.789***	0.969***
	(1.82)	(4.14)	(4.96)
Educational level of HH	0.0259*	0.0130	0.0160
	(2.06)	(1.34)	(1.41)
Number of Observations	2996	2996	

Marginal effects; *t* statistics in parentheses (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13 Marginal Effects: All Households (CSES-2007)

Variables	ME - Food Crops	ME- Cash Crops	ME- All Crops
Log median price of paddy (vill)	0.911***	-0.371***	0.249*
	(8.03)	(-4.73)	(2.55)
Log land per worker	3.356***	0.223	2.484***
	(17.58)	(1.77)	(16.07)
Log age of HH	0.00257	0.0322**	0.0139
	(0.19)	(3.07)	(1.11)
Dependency ratio	-2.427***	-0.209	-1.972***
	(-8.86)	(-0.99)	(-8.07)
Dummy for land title	0.492	0.496	0.757*
	(1.30)	(1.69)	(2.17)
Dummy for paid job	-0.672	0.206	-0.502
	(-1.76)	(0.69)	(-1.42)
Dummy for risky region	-0.553	0.627*	0.353
	(-1.38)	(2.05)	(0.96)
Log median rice yield (vill)	5.762***	0.319	4.616***
	(13.70)	(1.08)	(12.88)
Dummy for ownership of ag. Implements	-0.0691	0.667	-0.0819
	(-0.15)	(1.90)	(-0.20)
Dummy for ethnicity	2.014	0.345	2.331
	(1.72)	(0.33)	(1.80)
Dummy for ownership of transport equipments	1.686***	0.607	1.644***
	(3.57)	(1.59)	(3.92)
Log distance to provincial capital	-0.0995	-0.210	-0.349
	(-0.34)	(-0.97)	(-1.33)
Log distance to bus stop	0.390	-0.673**	-0.144
	(1.38)	(-3.09)	(-0.56)
Log distance to market	-0.635***	0.298*	-0.157
	(-3.47)	(2.11)	(-0.93)
Dummy for ownership of radio, TV, or telephone	1.403*	-0.305	0.710
	(2.48)	(-0.83)	(1.43)
Log village population density	-0.494***	0.268**	-0.145
	(-3.75)	(3.14)	(-1.24)
Educational level of HH	0.122*	0.0582	0.117*
	(2.07)	(1.39)	(2.20)
Number of Observations	1698	1698	1698

Marginal effects; *t* statistics in parentheses (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14 Marginal Effects: Small Holders (CSES-2007)

Variables	ME - Food Crops	ME- Cash Crops	ME - All Crops
Log median price of paddy (vill)	0.535***	-0.345***	0.0112
	(4.50)	(-4.00)	(0.09)
Log land per worker	1.669***	-0.280	1.016***
	(7.63)	(-1.68)	(4.62)
Log age of HH	-0.00207	0.0156	0.0156
	(-0.15)	(1.23)	(0.97)
Dependency ratio	-1.313***	-0.00534	-1.126***
	(-4.32)	(-0.02)	(-3.43)
Dummy for land title	0.907*	0.754*	0.938*
	(2.16)	(2.06)	(2.02)
Dummy for paid job	-0.768	0.326	-0.490
	(-1.88)	(0.90)	(-1.07)
Dummy for risky region	-0.607	0.596	0.0645
	(-1.33)	(1.53)	(0.13)
Log median rice yield (vill)	4.223***	1.288**	4.657***
	(8.20)	(3.03)	(8.54)
Dummy for ownership of ag. Implements	-0.216	1.343**	0.110
	(-0.42)	(2.78)	(0.19)
Dummy for ethnicity	3.219***	-0.790	2.503
	(4.99)	(-0.51)	(1.47)
Dummy for ownership of transport equipments	1.266*	-0.192	0.982
	(2.03)	(-0.38)	(1.52)
Log distance to provincial capital	0.0238	-0.271	-0.0112
	(0.08)	(-1.06)	(-0.03)
Log distance to bus stop	0.396	-0.588*	-0.140
	(1.19)	(-2.00)	(-0.38)
Log distance to market	-0.525*	0.333	-0.333
	(-2.35)	(1.69)	(-1.38)
Dummy for ownership of radio, TV, or telephone	1.795**	-0.660	0.931
	(2.66)	(-1.33)	(1.39)
Log village population density	-0.186	0.142	-0.0471
	(-1.39)	(1.20)	(-0.34)
Educational level of HH	0.0962	0.0935	0.145*
	(1.79)	(1.80)	(2.46)
Number of Observations	917	917	917

Marginal effects; *t* statistics in parentheses (d) for discrete change of dummy variable from 0 to 1 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15 Marginal Effects: Large Holders (CSES-2007)

Variables	ME - Food Crops	ME - Cash Crops	ME- All Crops
Log median price of paddy (vill)	0.999***	-0.344*	0.487***
	(6.40)	(-2.40)	(4.45)
Log land per worker	3.547***	-0.521	2.110***
	(8.58)	(-1.40)	(7.30)
Log age of HH	-0.00834	0.0509**	0.00152
	(-0.42)	(2.87)	(0.11)
Dependency ratio	-2.310***	0.134	-1.647***
	(-6.09)	(0.38)	(-6.10)
Dummy for land title	-0.00792	0.170	0.520
	(-0.02)	(0.36)	(1.41)
Dummy for paid job	-0.299	-0.376	-0.451
	(-0.56)	(-0.80)	(-1.12)
Dummy for risky region	-0.198	0.472	0.486
	(-0.38)	(0.99)	(1.26)
Log median rice yield (vill)	5.548***	-0.343	3.512***
	(10.87)	(-0.78)	(10.53)
Dummy for ownership of ag. Implements	0.111	-0.110	-0.687
	(0.18)	(-0.19)	(-1.60)
Dummy for ethnicity	0.171	1.412	0.627
	(0.11)	(0.97)	(0.42)
Dummy for ownership of transport equipments	1.334*	0.425	1.025*
	(2.33)	(0.79)	(2.44)
Log distance to provincial capital	-0.208	0.0360	-0.242
	(-0.51)	(0.10)	(-0.80)
Log distance to bus stop	0.107	-1.015**	-0.538*
	(0.30)	(-3.15)	(-2.07)
Log distance to market	-0.499*	0.420*	0.0842
	(-2.16)	(2.00)	(0.51)
Dummy for ownership of radio, TV, or telephone	0.956	-0.501	0.00832
	(1.47)	(-0.95)	(0.02)
Log village population density	-0.553**	0.493***	-0.125
	(-2.66)	(3.71)	(-0.96)
Educational level of HH	0.0287	0.0556	0.0374
	(0.35)	(0.78)	(0.63)
Number of Observations	781	781	781

Marginal effects; *t* statistics in parentheses (d) for discrete change of dummy variable from 0 to 1
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$