WP-2012-019

The Heterogeneous Welfare Impacts of Participation in Contract Farming Schemes: Evidence from Southern India

Sudha Narayanan

Indira Gandhi Institute of Development Research, Mumbai
September 2012
http://www.igidr.ac.in/pdf/publication/WP-2012-019.pdf

The Heterogeneous Welfare Impacts of Participation in Contract Farming Schemes: Evidence from Southern India *

Sudha Narayanan †

Abstract

Assessing the extent of welfare gains from participation in contract farming arrangements is important to be able to make a case for promoting contract farming as a way for smallholders to capitalize on the opportunities offered by modern supply chains. At the same time, empirical accounts of contract farming schemes in developing countries not only suggest high mortality rates but also show that many schemes have high farmer exit or attrition rates, indicating that farmer experiences might be variable. This paper demonstrates the heterogeneity of welfare impacts of contract farming participation by estimating an endogenous switching model using survey data for 474 farmers in four commodity sectors, gherkins, papaya marigold and broiler. The study shows that net welfare gains vary widely both across contract commodities and across farmers within a commodity sector. While contracting in papaya and broiler are associated with improvements in net profit per month for those participating and potential improvements of 47% and 123% for current non-participants, the impacts for gherkins and marigold are more ambiguous. The standard deviation of point estimates of treatment effects is quite large indicating variability in welfare gains from contracting to different farmers even within the same commodity sectors. It is therefore important to recognize that notwithstanding the sign of average treatment effects, contract farming arrangements have diverse impacts on income for individual farmers.

1 Introduction

The issue of welfare gains to small farmers from participation in modern agro-food supply chains, specifically in contract farming arrangements, in developing countries has acquired much significance in recent times (Minot, 2008; Swinnen, 2007; Reardon and Gulati, 2008; Barrett et al., 2012). Should participation in these chains lead to clear net welfare gains, it offers credible opportunities for farmers in these countries to transform their livelihoods.

*This study was completed when I was a Visiting Postdoctoral Fellow at the Centre for Development Economics, Delhi School of Economics during 2011. The fieldwork on which this study is based was supported financially by the American Institute of Indian Studies's Junior Research Fellowship (2006), IFPRI-New Delhi Office, the Borlaug-Leadership Enhancement in Agriculture Program (LEAP) Fellowship (2008), AAEA Foundation's Chester McCorkle Scholarship (2008) and the Ithaca First Presbyterian International Student Fellowship (2007). I thank Uma Mageswari, Anbarassan, Geetha Krishnamurthy and S.Vannamalar, graduate students of the Department of Agricultural Economics, Tamil Nadu Agricultural University (TNAU), Coimbatore, for field support and M.Chandrasekaran (TNAU), Bart Minten (IFPRI-NDO) and Christopher Barrett (Cornell University) for providing valuable advice and guidance in shaping the project. The current version has benefitted from inputs from Chris Barrett, William Lesser, Stefan Klonner and seminar participants at Cornell University.

†Indira Gandhi Institute of Development Research (IGIDR), Mumbai, INDIA. e-mail: sudha@igidr.ac.in.

While existing work has been largely successful in addressing methodological issues to measure welfare impacts of participation in modern supply chains, a majority of works confine themeselves assessing whether or not participant farmers benefits on *average*. An aspect that has faced relative neglect has been the heterogeneity of farmer experiences, especially welfare impacts associated with contract participation, both within and across schemes. This assumes importance in the context of high mortality of contract farming schemes in developing countries and widespread prevalence of disadoption or exit from contract participation. In India, for example, the study on which this article is based recorded high attrition rates in the sample villages surveyed. Further, among attrition farmers who were interviewed as many as 20 per cent of them stated absence of net profits or economic losses from contracting as the reason for exiting the system, the single most important reason, underlining that while on average participating farmers benefit, average effects mask the heterogeneity of farmer experiences that bear the ingredients of churning and attrition.

This study uses unique survey data of farmers in multiple schemes to answer the following questions: Do contracting farmers do better, on average? How much do they stand to gain relative to their counterparts who do not participate? What is the extent of heterogeneity in welfare outcomes for participating farmers within a commodity group? Do these patterns differ across contract commodities?

In the context of the four commodities I study, the decision to contract often coincides with a decision to grow the contract commodity, which poses difficulties for separating the welfare gains from contracting versus that from growing a different crop. I adopt an endogenous switching model where farmers sort themselves into two regimes, contracting and not contracting, based, in part, by the perceived differential welfare gains between the two regimes. While this enables me to estimate welfare implications of participation in the two regimes, it also allows me to comment on the differential returns to factors across these regimes and see if different regimes reward key factors of production differently. I then explore the variation in estimated treatment effects across schemes and across farmers, the treatment here referring to contract participation.

Following this introduction is a description of different empirical approaches to assessing welfare gains of contract garming. This section also describes the survey data, its empirical context and the estimation strategy adopted. The next section describes the variables used and presents key results from the estimation of the endogenous switching model, focussing on incremental net profit associated with contracting. I then discuss the structure of costs and returns to highlight the sources of gains and comment on the returns to key factors of production under contracting and not contracting, before concluding the paper.

2 Empirical Approaches

The attempt to assess empirically if participation in contract farming schemes (and more generally, modern supply chains) is associated with higher welfare is fraught with several methodological and epistemological problems and much attention has been devoted assessing welfare gains from contract farming has focused on tackling the problem of selection (Barrett et al., 2012). A direct comparison of welfare metrics based on contract participation could potentially lead one to conclude, for instance, that contract farmers do better, without acknowledging the possibility that it might be the higher ability farmers who participate.[1] An important challenge is therefore to account for factors that might implicitly influence both participation and the welfare outcomes; without these, welfare gains might be wrongly attributed to participation, when in fact, they are due to competing factors that have been omitted from the model specification.

Whenever selection of farmers into contract schemes is transparent or there is adequate understanding of the process, a model based on selection on observables could credibly and fully account for the selection effect. A common approach has been the use of Heckman's selection model to control for selection bias. Propensity score matching methods represent another similar approach (Maertens and Swinnen, 2009). Minten, Randrianarison, and Swinnen (2009) only observe households who participate in contract farming, and so they resort to comparing households who participate in contract farming with households who do not participate in contract farming by constructing a control group from a different data set. In general, these approaches rest on the assumption that selection into treatment, i.e., participation in contract farming schemes, can be reliably based on observable characteristics (Dehejia and Wahba, 2002; Angrist and Pischke, 2009).

In many situations, this requires a leap of faith. A firm's selection of farmers to contract with and farmers' own choices on whether to contract or not are driven by their attitudes to risk, perceptions of the alternatives, and in the context of weak contract enforcement, on trustworthiness, reliability or reputation, referred to sometimes as 'social collateral'. These are typically unobserved by the researcher, while firms and farmers tend to have relevant information or proxies in their information sets. While this problem is redressed somewhat by obtaining more and better information from surveys, alternate approaches provide ways to overcome this constraint.

In the Instrumental Variable (IV) approach, participation is instrumented for by a variable that is

[1] Many studies present simple comparisons, admittedly, without making claims of causal effects. Kumar (2007),Swain (2008),Rangi and Sidhu (2000),Haque and Birthal (1998) provide examples of contract farming in India. To the extent that these studies unpack the structure of costs and returns and the sources of welfare gains to contracting, they provide useful starting points for analysis.

correlated with participation but not with the welfare outcome of interest. However, IV identification is still achieved only through the observable instruments, and hence this method inherits the same problems of Propensity Score methods or Heckman models. None of the approaches can be singled out as the best across contexts. The selection on observables design, for instance, enables richer treatment of the selection process, often a question of considerable importance in its own right. On the other hand, where the survey data do not contain enough detailed information on drivers of selection, this can jeopardize the credibility of the results. In such cases, a selection on unobservables design is probably preferable.

The efficacy of these approaches invariably depends on the choice of an instrument that enables identification of the parameters of the model. As Bellemare (2010) elucidates, many instruments that have been used can be faulted for possibly being endogenous to the outcomes studied. Miyata, Minot, and Hu (2009) treat the distance between a respondents farm and the farm of the village chief as an instrument.Rao and Qaim (2011) use farmer group membership to serve as an instrument and Simmons, Winters, and Patrick (2005) choose number of organizations farmers are members of as an instrument. Other instruments include the number of female laborers in the respondents household as well as a dummy for whether a female in the household is a member of a womens organization (Maertens and Swinnen, 2009). Bellemare (2010) makes innovative use of an experiment, deriving farmer willingness to pay (WTP) for a certain return from a randomly drawn level of investment. Across methods, the central challenge is to find an appropriate instrument that can break any correlation between selection and the unexplained variation in welfare outcomes.

2.1 Data and its Empirical Context

The data come from a survey of 474 farmers covering four commodity sectors, gherkins, marigold, papaya, and broiler chickens, in the southern state of Tamil Nadu and was conducted between 2009 and 2010.The list of contracting farmers for the year of the survey was obtained from one contracting firm in each of the commodities studied.[2] Based on this list, all the hamlets in the sample area were divided into contracting and non-contracting hamlets and their corresponding villages into contracting villages or non-contracting villages. A similar exercise was carried out for the larger administrative units called blocks and then districts. Starting from the largest administrative unit for the study area, contracting districts were sampled, within which contract and non-contract blocks were randomly sampled and then further on, within sampled blocks,

[2]All firms were approached, who were contracting for the particular commodity in the study area. The firms selected as the subject or sample firms were those that were contracting that year and were willing to share the complete list of contract farmers. The study firms were the first to share these lists.

contract and non-contract villages were sampled and so too with hamlets. In the hamlets sampled, a census of all households identified four key types of farmers: those currently contracting; those who were growing the contract crop but for the open market or contracting for other firms; those who had given up contracting with the subject firm; and those who had never contracted. The sample respondents were randomly selected from each type. If a farmer grew the contract crop for some other firm and quit, they were not sampled at all.

All the contract farming schemes studied operate in rainfed agricultural areas and have diverse arrangements with farmers. Gherkins are a non-traditional export crop with no domestic market. The crop is procured from farmers and processed at small-scale plants by washing, rinsing and preserving in brine, acetic acid or vinegar. These are either bottled and labeled for international clients or shipped out in barrels for bottling. Papaya was introduced in the region in the 1990s for extracting papain, which has wideranging industrial uses. The variety is appropriate, but not ideal, for table consumption, and the fruit is a by-product that is used to make candied fruit or for pureeing. Marigold contracting was initiated by firms for oleoresin extraction for export, mainly as coloring agent for poultry feed. Marigold has a thriving local market, however, for fresh cut flowers that are used for a number of occasions, religious and otherwise. The broiler industry in the study region is almost completely vertically coordinated, a process that began in the mid-1990s. Day-old chicks are provided by the firm and bought back by the contracting firm. The firm acts as an aggregrator-intermediary, but also has its own brand of chicken in various processed forms.

In many ways, the four schemes are fairly typical of contract production arrangements elsewhere in the developing world. All contract commodities are cash crops and involve production processes that require farmers to respond continuously to the need to maintain quality. Firms engaged in contract farming thus engage actively in the production process, not only providing critical inputs but also maintaining close supervision from sowing through to harvest and post-harvest handling.

The commodities and firms selected for study represent varying degrees of involvement by the firm in the production process or intensity of contractual relationship. Broiler represents high relationship intensity, with the firm's officials visiting contract growers every day to monitor health and status of the birds. These firms provide day old chicks to the farm and have detailed protocols for the feed mix and vaccination schedules. For papaya, the involvement of the firm varies over the life cycle of the crop. In the nursery stage, field officials monitor the crop closely with daily visits and once the plant matures into the flowering stage, there is limited oversight, unless the situation demands it. In papaya, an interesting feature is that labor for latex extraction is organized and trained by the firm, with the wages being borne by the farmer. Latex extraction requires great skill and the firm believes it can ensure quality and supply of latex for the plant by maintaining a pool of trained workers, who extract latex on contract farms. Marigold represents the least participation of the firm in the production process, related partly to fewer quality requirements that need only modest supervision. In fact, the marigold firm suggests that monitoring is required more for contract enforcement rather than for production under contract. The marigold firm thus restricts itself to providing high quality seeds at subsidized prices and training new contract farmers in the cultivation practice for marigold. Its field officials advise farmers periodically on pest and disease control. Across the schemes there is heterogeneity in the way risks are distributed between firm and farmers, although they do share many features, such as provision of some critical inputs, technical advice and an agreement to buy back at the end of the season.

2.2 Estimation strategy

Given the specific context of the study, it is imperative to elaborate the nature of welfare comparisons between contract and non-contract farmers. In general, it is hard in the case of cotton, papaya and gherkins to separate the contracting effect from the cropping pattern effect. Farmers who participate and are selected are committing to both a mode of production and/or transaction and simultaneously to growing a new crop. Gherkin has no alternate spot market. The same is true for papaya, where, if farmers were not contracting, they would opt for other crops or other table varieties of papaya.

Even when there is an alternate domestic market, as in the case of marigold and broiler, the definition of the counterfactual can be challenging. If the identity of firms matter, then the treatment is not contract participation per se but contracting with one firm rather than another. Given that contractual practice, or what is contractual and what is not, is fuzzy on many aspects, if one admits the possibility that there is considerable diversity in the manner firms operate, even with similar terms of contract, crop or destination, it no longer makes sense to speak of a generalized notion of contracting.

Similarly, the counterfactual to contracting should ideally refer to farmers who supply to precisely the same markets and for the same purpose. In the case of marigold for instance, the firm contracts for extraction and the non-contract farmers sell in the fresh flower market, conflating these two implies that it is no longer clear if the welfare gains record the gains from distinguishing use or destination or whether it measures incremental benefits from contracting versus not contracting. It is essential therefore to distinguish between concluding that contracting benefits small farmers and concluding that supplying to export markets is more lucrative than to domestic markets. The recent literature on supermarket participation makes this distinction clear by framing the question differently, asking if farmers benefit from participating in modern supply chains rather than traditional channels (Minten, Randrianarison, and Swinnen, 2009; Maertens and Swinnen, 2009).[3]

Furthermore, even with comparisons for the same crop between contracting and a traditional channel, given the crop has the same use across channels, the character of the local market can be transformed by the presence of contracting on a large scale and this leads to different kinds of empirical problems, so that the general equilibrium effect on the local market can alter the returns to non-participants as well.

Thus, whenever contracting appears jointly with some other distinguishing characteristic, either in terms of destination, end use or varietal difference, the challenge is to measure of welfare impact of contracting per se, delinked from other coincidental attributes. In general, it is extremely difficult to isolate these impacts in survey data. This problem permeates the four commodity sectors.

An endogenous switching regression (under known sample separation) offers a way to negotiate the difficulty in separating out a cropping pattern effect from the contracting effect.[4] The rationale for this is that selection into contracting puts farmers in different groups, associated with different profit streams. The survey data on net profits per acre collected for both contract and non-contract farmers implies that I observe sample outcomes, or draws, from both profit streams or both regimes, presumably coming from different distributions. This is analogous to sorting into different occupations or into public and private sector employment.

I assume that this sorting is potentially endogenous, driven at least in part by the difference in the net profits per acre when contracting and not contracting.[5] This separates the sample into two streams, those that contract and those that do not. While this separation into two streams does not help isolate the cropping pattern effect from the contracting effect, it is now possible to account for specific elements of the contractual relationship to assess its impacts on the welfare metric for those who are sorted into the 'treatment' group. For example, controlling for inputs or supervision provided by the firm, etc., for those that are in the contracting regime, allows identification of the impact of contractual elements, given that the farmer is participating in the growing of a contract commodity. This approach is not only essential to overcome the difficulties in separating the crop switching effect from the contracting effect but it also

[3]For India, there are several examples that suggest supplying for export markets yield higher returns than serving domestic markets. A study of Mahagrapes showed that profits earned per acre per annum by contract growers were nearly 38 percent higher than that for non-contract growers mainly because Mahagrapes serves global markets, and hence prices received are almost three times higher than in the local markets (Narrod et al., 2009). A similar case study of contract grape growers in Andhra Pradesh, also supplying the export market, showed that contract growers received 55 percent higher net returns than supplying to the domestic markets (Dev and Rao, 2005). For gherkins growers in Andhra Pradesh in 2004-05, returns over variable costs were 30 percent higher than for other vegetable crops (Dev and Rao, 2005).

[4]Maddala (1983) discusses the endogenous switching regression approach in detail.

[5]Exogenous factors drive participation too in terms of the selection process adopted by the firm that rations out farmers who might be willing to contract but are not offered contracts by the firm.

draws attention to an important aspect that is often neglected in empirical work in contract farming. In estimating welfare metrics as functions of farmer characteristics, it is possible to compare the returns to particular factors of production across the two regimes. In other approaches that account for selection, since regimes are pooled by construction, they mask the differential structure in returns to factors of production and other covariates. In contrast, the switching regression approach allows for structural differences in the relative determinants of profitability.

This approach has been used in a variety of contexts (Lee, 1978; Adamchik and Bedi, 2000; Fuglie and Bosch, 1995; Manrique and Ojah, 2003). In the context of agriculture, Cadot, Olarreaga, and Dutoit (2006) and Dutoit (2007) use this approach to assess the impact and ability of farmers to switch regimes, from subsistence farming to commercial agriculture in Madagascar, Cai et al. (2008) to evaluate contract farming in Thailand and Rao and Qaim (2011) supermarket participation on welfare of Kenyan farmers.

Suppose $\tilde{Y}_i$ represents a latent variable that marks the threshold that drives farmers to contract or not. While this is typically regarded as the expected utility from participation, here, it is treated as farmer i's net welfare gain from participation in contracting relative to the next best alternative. This latent subjective utility of a farmer i can be modeled as a function of covariates comprising individual farmer characteristics and perceptions and other hypothesized determinants of participation, denoted by W_i. This includes not merely farmer perceptions of contracting in terms of relative expected means, but also relative moments of a higher order along with risk scores that capture perceptions of contracting that are difficult to monetize. W_i also includes constraints imposed on participation by the firm, for example in the firm's choice of villages to work in. This then becomes the basis of sorting farmers into the regimes, defining contracting status. Let I_i be the indicator variable representing contracting status (at the time of survey) of farmer i. This is given by

$$\begin{aligned} I_i &= \begin{cases} 1 & \text{iff } \tilde{Y}_i > 0, \\ 0 & \text{iff } \tilde{Y}_i \leq 0 \end{cases} \\ \tilde{Y}_i &= W_i\alpha + v_i \end{aligned}$$

The endogenous switching regression model then suggests that farmers who are seen to contract face a welfare outcome Y_{1i} from one distribution and those who do not contract face a draw Y_{2i} from possibly another distribution. The net profit per acre, the welfare outcome of interest, is determined by a set of explanatory variables, X_{1i} and X_{2i} that could be different across regimes.

$$\begin{aligned} Y_i &= \begin{cases} Y_{1i} & \text{iff } I_i = 1, \\ Y_{i2} & \text{iff } I_i = 0 \end{cases} \\ Y_{1i} &= X_{1i}\beta_1 + u_{1i} \\ Y_{2i} &= X_{2i}\beta_2 + u_{2i} \end{aligned}$$

Y_{1i} and Y_{2i} are only partially observed, since the former is observed only for those belonging to regime 1 and the latter only for those belonging to regime 2. What is observed is, in fact, Y_i. This set of equations describes in detail the structure of the model I estimate. The indicator variable takes 1 or 0 for contracting status. This is driven by a latent variable, which is modeled as a function of a set, W_i, of farmer specific characteristics, farmer perceptions of contracting as well as the firm's choice of regions from which to procure.

If Σ is the variance-covariance matrix for the error terms u_{1i}, u_{2i} and v_i. The diagonal terms in the matrix are the variances of the error terms, denoted by σ_j^2 where $j = 1, 2, v$ and the covariance terms are given by σ_{jl} where $j, l = 1, 2, v$ and $j \neq l$.

$$\sum = \begin{pmatrix} \sigma_1^2 & . & . \\ \sigma_{12} & \sigma_2^2 & . \\ \sigma_{1v} & \sigma_{2v} & \sigma_v^2 \end{pmatrix}$$

In this model, I assume that the following properties hold

$$\begin{aligned} &(1) \quad u_{ji} \sim N(0, \sigma_j^2), j = 1, 2 \\ &(2) \quad v_i \sim N(0, \sigma_v^2) \\ &(3) \quad \sigma_{12} = 0 \\ &(4) \quad \sigma_v^2 = 1 \end{aligned}$$

Assumptions 1 and 2 are standard for Maximum Likelihood estimation methods, and the third assumption comes from the fact Y_{1i} and Y_{2i} are never observed together. In fact, this cannot usually be estimated since it does not explicitly appear in the likelihood function and is usually treated as being equal to 0. The last assumption is typically made since α can only ever be estimated up to proportional scale.

We need to make additional assumptions here that

$$\sigma_{2v} \neq 0$$

$$\sigma_{1v} \neq 0$$

If these are zero, then there is exogenous switching. Typically this is tested via the correlation coefficients.

$$\begin{aligned} \rho_{1v} &= \frac{\sigma_{1v}}{\sigma_1 \sigma_v} \\ \rho_{2v} &= \frac{\sigma_{2v}}{\sigma_2 \sigma_v} \end{aligned}$$

The efficient way to estimate this model is via Full Information Maximum Likelihood (FIML) that estimates the entire set of equations at once.Lokshin and Sajaia (2004) develop a module for implementation of this model in Stata.[6] Once the parameters are estimated, it is possible to calculate the following unconditional expectations,

$$\begin{aligned} E(Y_{1i}|X_{1i}) &= X_{1i}\beta_1 \\ E(Y_{2i}|X_{2i}) &= X_{2i}\beta_2 \end{aligned}$$

and conditional expectations,

$$\begin{aligned} E(Y_{1i}|I_i = 1, X_{1i}) &= X_{1i}\beta_1 + \sigma_1\rho_{1v}\lambda_1 \\ E(Y_{2i}|I_i = 1, X_{1i}) &= X_{1i}\beta_2 + \sigma_2\rho_{2v}\lambda_1 \\ E(Y_{1i}|I_i = 0, X_{2i}) &= X_{2i}\beta_1 - \sigma_1\rho_{1v}\lambda_2 \\ E(Y_{2i}|I_i = 0, X_{2i}) &= X_{2i}\beta_2 - \sigma_2\rho_{2v}\lambda_2 \end{aligned}$$

[6] For a discussion see Dutoit (2008) and Lokshin and Sajaia (2004).

where,

$$\lambda_1 = \frac{\phi(W_i \frac{\alpha}{\sigma_v})}{\Phi(W_i \frac{\alpha}{\sigma_v})}$$
$$\lambda_2 = \frac{\phi(W_i \frac{\alpha}{\sigma_v})}{1 - \Phi(W_i \frac{\alpha}{\sigma_v})}$$

and represent the Inverse Mills' Ratios. The functions ϕ and Φ represent normal distribution and the cumulative normal distributions, respectively, associated with probit models.

This model structure offers an opportunity to examine two phenomena. First, it is possible to compute treatment effects using the means. In particular, it is possible to compute the average treatment effect among the treated (TOT). In the following equation,

$$E(Y_{1i}|I_i = 1, X_{1i}) - E(Y_{2i}|I_i = 1, X_{1i}) \tag{1}$$

the mean of the left hand side variable is equal to the average difference between a sample contract farmer's average profitability under the contract and without the contract. A similar figure for the non-contract farmers gives the average treatment effect for those not treated. If non-contract farmers were able to contract, the average profitability premia is given by

$$E(Y_{1i}|I_i = 0, X_{2i}) - E(Y_{2i}|I_i = 0, X_{2i}) \tag{2}$$

Second, it is possible to investigate the pattern of sorting. Supposing the signs of the estimated correlation alternate across the coefficients, it implies that farmers are in regimes that offer them comparative advantage, so that, say, if $\rho_{1v} < 0$ and $\rho_{2v} > 0$, farmers with above average net income in regime 1 (contracting) are associated with a higher likelihood of being in regime 1 (contracting) and those earning a higher net profit not contracting are less likely to participate in contracting. Alternatively, if both coefficients are negative, i.e., $\rho_{1v} < 0$ and $\rho_{2v} < 0$, there is what Fuglie and Bosch (1995) refers to as hierarchical sorting, so that those in regime 1 have better than average net profits in both regimes, but are better off in regime 1. Those in regime 2 face below average profits in both regimes, but are better off in regime 1. If, on the other hand, $\rho_{1v} > 0$ and $\rho_{2v} < 0$ it represents a situation where, regime 1 farmers would actually have below average profitability with their status quo but would have above average gains in regime 2 and those in regime 2 have above average performance in regime 1 but below average performance in regime 2. The last possibility, when $\rho_{1v} > 0$ and $\rho_{2v} > 0$, implies that farmers in regime 1 have higher than average profitability whether they contract or not, whether they are in regime 1 or 2, and hence have absolute advantage.

The endogenous switching model comes with a few caveats. First, it assumes joint normality of errors. Second, the identification of the model comes through variables in the participation equation that influence participation but not the welfare outcome. The challenge is therefore to find a set of such variables. The next section discusses the nature of comparisons for each of the commodities and describes the variables used in the estimation of the model in detail.

3 The Nature of Comparisons and Variables Used

The welfare metric used in the analysis is net profit per acre. For contract farmers, whether or not it is the subject firm, this is the net profit per acre under the contract crop and for non-contract farmers, it is the net profit per acre either under the contract crop for an alternate market or under the crop they have chosen to be the closest substitute for the contract crop. This refers to the income earned from all main and byproducts of cultivation minus all paid out costs. This approach of accounting for costs is somewhat different from the cost concepts traditionally used in India (Table 1). I combine a subset of components from A1 and A2, while adding a few others. First, fixed costs were not apportioned and rent on own land, farm assets and costs of family owned labor were not imputed. Second, transactions costs, specifically those included in transport and marketing were accounted for, given that this is often an important source of gains for contract farmers. The constituents of net profit per acre for the contract commodities in this study are presented in Table 2.[7] Farmers were thus simply asked for the net income they were left with per unit area of production at the end of the season, after paying out all production and transactions costs for the entire season, including multiple harvests.[8]

The welfare metric is thus net profit per acre per month for the field crops and net profit per month per 5000 birds for broiler.[9] The treatment effect is computed as the change in this variable associated with a change in contracting status, conditional on covariates.

[7]For other crops, cited by farmers, as the next best alternative, the same components of costs are used and depending on the nature of the crop, the income is either from sale of flower, fruit or vegetable.

[8]An alternate welfare metric involves net profit per acre after accounting for imputed costs of family labor, depreciation of machinery and equipment, and fixed investments, including interest on working capital. Depreciation on fixed investment is set at 20% and on equipment at 10% following practice established by the Commission on Agricultural Costs and Prices (CACP) in India. This involves making a range of strong assumptions on parameters used to derive these and is hence not used as a welfare metric in this study.

[9]This is for a 5000 square feet shed space, that is considered a standard scale for broiler farmers in the region, by broiler contracting firms.

Table 1: Cost Concepts

Cost Concept	Includes
A1	All actual expenses in cash and kind incurred in production by the producer. The items covered in cost A1 are costs on: (i) hired human labor, (ii) hired bullock labor, (iii) owned bullock labor, (iv) home produced/purchased seed, (v) plant protection chemicals, (vi) home produced/purchased manure, (vii) fertilizers, (viii) insecticides and pesticides, (ix) depreciation on farm machinery, equipment and farm building, (x) irrigation, (xi) land revenue, land development tax and other taxes, (xii) interest on working capital, (xiii) interest on crop loan, and (xiv) miscellaneous expenses.
A2	Cost A1 + Rent paid for leased-in land
B	Cost A1 + Interest on value of owned capital assets (excluding land)
B2	Cost B1 + Rental value of owned land (net of land revenue) and rent paid for leased-in land
C1	Cost B1 + Imputed value of family labor
C2	Cost B2 + Imputed value of family labor
C2	Cost C2 estimated by taking into account statutory or actual wage rate which ever is higher
C3	Cost C2+ 10 per cent of Cost C2 to (on account of managerial functions performed by farmer)

These concepts are defined by the Commission of Agricultural Costs and Prices (CACP), Government of India.

Table 2: Computation of Net Profit per acre for Contract Commodities

Cost Concept	Income	Costs
Gherkins	Income from sale of fruit	Farm yard manure + Seeds + Micronutrients +Plant protection+ Fertilizer application + Weeding + Land preparation + Seedbed preparation + Seed treatment + Intercropping expenses (if any) + Transport Costs + Commission + Female hired labor + Male hired labor
Marigold	Income from sale of flower	Same as above
Cotton	Income from sale of kapas	Same as above
Papaya	Income from latex and fruit	Same as above
Broiler	Income from sale of bird, poultry manure	Medicines + Electricity + Water charges + Charcoal + Cleaning Costs + Supplementary feed + Hired labor + Transport + Commission

[1] For broiler the chick and feed are provided by the firm across the industry, and hence does not constitute a cost incurred by the firm.

An exclusive focus on net profit per acre as a welfare measure, i.e. the assumption of separability, can be faulted for not taking the entire context of household decisions, the particular place of the contract commodity in a portfolio of crops or of its impact on other aspects of welfare. However, given that eliciting reliable data on incomes from households is notoriously difficult in the context of the study area, this was not pursued. Further, it is typical for farmers to treat the contract commodity as a cash crop substitute so that they allocate acreage either to the contract commodity or to an alternate cash crop. The assumption that the contracting crop does not alter the essential nature of the entire portfolio of crops is therefore reasonable in this case.

For all the commodities, the net profit per acre was obtained for the entire cropping season. The aggregation over the season would account for multiple pickings or harvests and smoothen biases introduced by price volatility over the season. While this contributes to aggregation bias, it also makes inter-farmer comparisons more reliable. For perennials like papaya, data was obtained for the most recent month and for broiler, for the most recent completed cycle (comprising six weeks from chick to broiler). While farmers were typically encouraged to refer to any written accounts they had, in most cases, farmers relied on recall. The detailed costs and returns was obtained according to established protocols for collecting such data. [10]

The other caveat, which holds for most studies of this nature, is that the net profit per acre recorded in the year of survey is one draw from a distribution. It is therefore natural that these can be very different in different years, depending on a host of exogenous conditions such as weather, pest pressure and external market conditions. There is also a large variation across farmers. The results on welfare outcomes are therefore to be interpreted with caution. In the context of the larger work, this is in fact illustrative of heterogeneity of farmer experiences across time, contributing to the dynamics or life cycle of contracting schemes.

For each scheme, the treatment group constitutes all contract farmers for that particular commodity, implying that they contract with either the subject firm or for any other firm. The Farmer Survey sampled non-contract farmers specifically for each of the four contracting schemes studied. I am able to pool all the commodity or scheme-specific non-contract farmers across the schemes to form a larger control group, given that the welfare metric and the explanatory variables collected were common across schemes. In other words, the relevant comparison group for gherkins, for instance, is not only the control group sampled specifically within the gherkins contracting scheme (or commodity /scheme-specific controls) but includes the non-contracting farmers sampled in the marigold, papaya and broiler as well (pooled controls). This is

[10] I also had access to cost of cultivation studies that provided benchmarks as crosschecks.

possible because there are no overlapping identities, i.e., there is no case where a farmer who is not a contract farmer with respect to one commodity is a contract farmer for another commodity. The control group for the treatment for each commodity is therefore the pooled sample of farmers who do not contract with either the subject firm(s) or any other firm. Non-contract growers of poultry are however excluded from the control group, since these include broiler producers, would alter the composition of the control groups substantially.

Figures 1, 2, 3 and 4 map the distributions of monthly net profits for contract farmers for each commodity. The figures also graph the distributions of monthly net profits for two comparison or control groups : (1) a scheme or commodity-specific control group and (2) the pooled control group that pools control groups from all the contracting schemes studied, including the scheme-specific control group. This latter group represents all farmers not contracting at all from across schemes. For example, Figures 1 portrays the distribution of net profits for gherkins contract farmers (first, for the subject firm alone, and the second, for any firm), the net profits for the gherkins-control and also the distribution of net profits for pooled control that includes the gherkin, marigold, papaya and broiler control group. From the broiler control group, only those farmers are included, who do not grow poultry and grow a field crop. For each of these commodities, it is apparent that these unconditional distributions of net profits per month are different for contract farmers (the treatment group) and non-contract farmers (the control group). This is valid for both the commodity specific control group as well as the pooled group.

In the case of papaya and broiler, the net profit distribution for contract farmers is starkly different from that for the non-contract farmers. Comparisons for broiler deserve special attention. The broiler control group includes farmers who do not grow poultry. Since growing a field crop and growing poultry are quite different, the control group turns out to be heterogeneous, although the monthly net profits for those who do not grow poultry has been scaled down to an area area of 5000 square feet.[11] As a result of this, when the control groups from other commodities are pooled, there is a marked difference in distributions. Despite the fact that including non poultry growers in the control group implies comparisons across very different categories, in the context of a regime switching model, this yields special insight. Broiler farmers often require heavy investment in fixed assets (sheds to house the birds, feeders, drinkers, etc.) that work as barriers to entry. Most farmers convert farmland to broiler sheds. Those who are unable to do this are invariably resigned to continuing cultivation of field crops. In this context, the particular nature of comparison makes sense.

For a pooled control group to be a valid basis for comparing welfare gains, there needs to be an instrument

[11] The underlying assumption is that farmers who do not grow poultry would use the farmland to grow other field crops.

Figure 1: Distribution of Net Profit per month for Gherkins Contract and Non-contract farmers

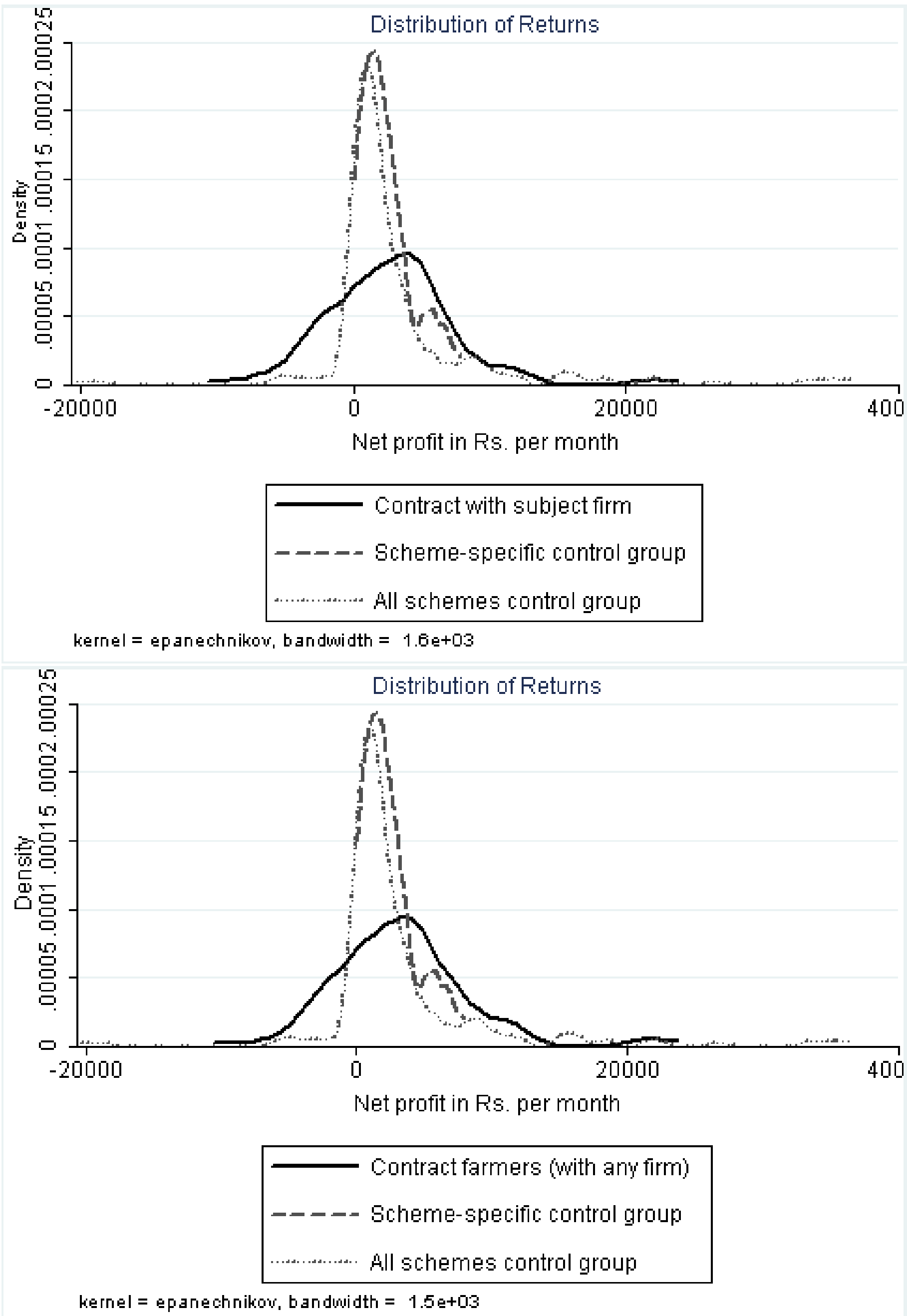


Figure 2: Distribution of Net Profit per month for Marigold Contract and Non-contract farmers

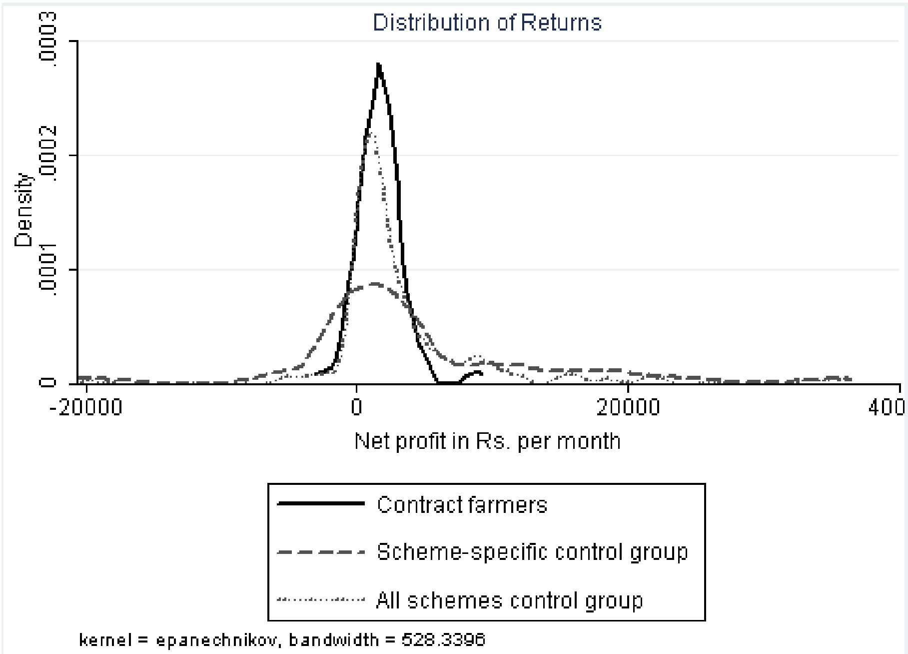


Figure 3: Distribution of Net Profit per month for Papaya Contract and Non-contract farmers

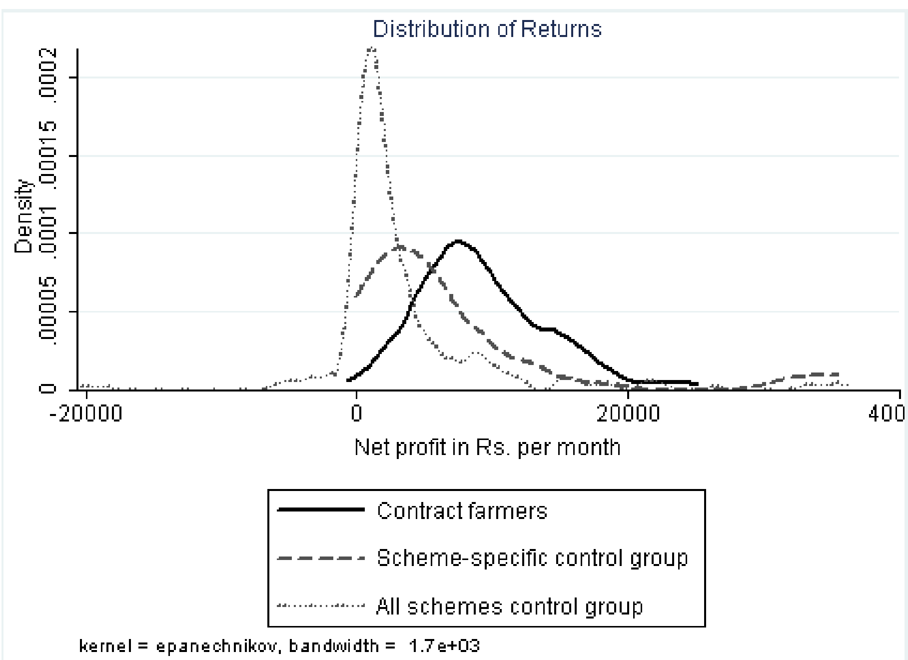
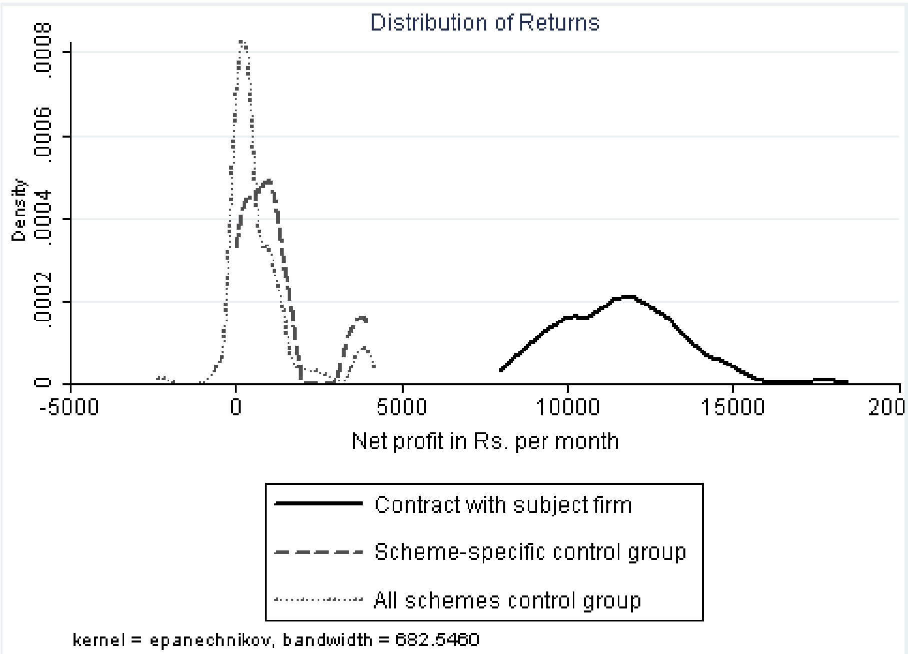
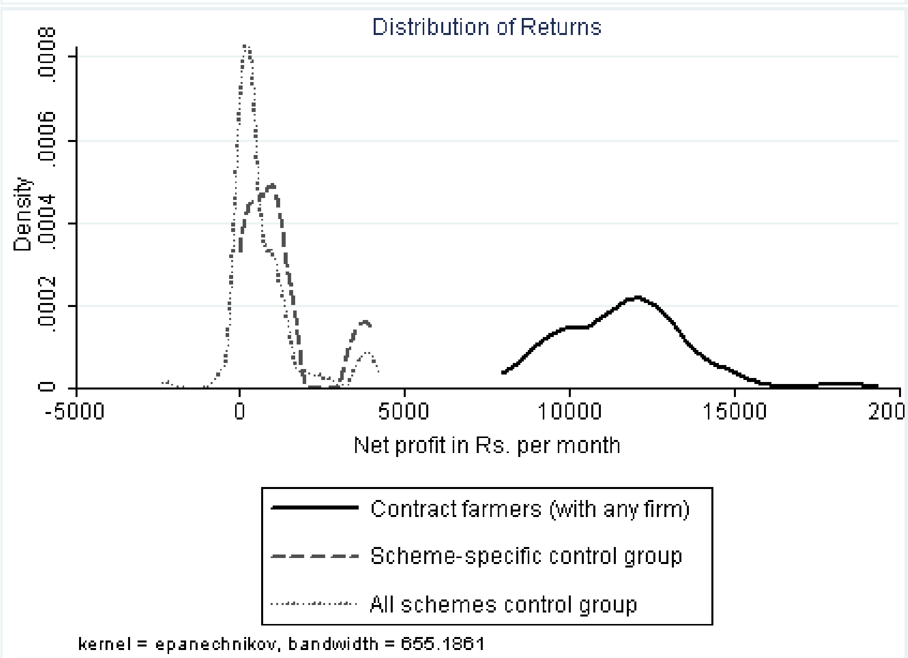


Figure 4: Distribution of Net Profit per month for Broiler Contract and Non-contract farmers





or a set of instruments that is/are correlated with non-participation for both the commodity-specific control group as well as for the pooled control group, but not with the welfare metric of interest.

The instrument I use is a variable that is constructed by an interaction of an individual farmer's coefficient of absolute risk aversion elicited though experiments recording the bid price of a risky, fair bet[12] with the coefficient of variation of the spot or alternate market price of the contract commodity for which the model is estimated.[13] The higher the farmer's risk aversion or the coefficient of variation of spot market price for a commodity, the greater would be the propensity of the farmer to opt to contract. There is no strong argument to suggest that the coefficient of variation in the price of a commodity influences net profit per acre. While it is possible that absolute risk aversion coefficients might indicate a farmer's preference for risk that might impact farming practice and hence net profits, the fact that it is interacted with price variability that is set in the regional markets breaks this relationship. Further, it is an absolute number that allows for pooling farmers who might grow different crops. I also control for the possibility that farmers are not afforded the opportunity to contract with the contracting firm by using the number of contract hamlets in the block where the respondent is located. If, firms select spatially, as they often do, this would control for the sample contracting firm's locational preference for sourcing supplies. Region fixed effects were ineffective since often the choice of contract regions coincides with schemes, or social group. Hence the number of hamlets was chosen over region dummy variables. In fact, this scores over the use of region dummy variable, since it captures the variation in the intensity of a firm's presence within a particular region. This cannot serve as an instrument since firms would choose regions that are more suitable for growing the contract commodity and hence does influence the welfare metric, but it is important to control for spatial selection in order to admit the validity of the pooled control group as a basis for comparison.

In addition, I use a set of instruments for the commodity specific control group that reflect farmer perceptions of contracting relative to the next best alternative. In the Farmer Survey, I elicit subjective distributions of net profits per acre that farmers associate with contracting versus the next best alternative that they have nominated. Relative moments of these subjective distributions and stochastic dominance between them presumably influence whether they want to contract or not. In addition, risk scores from psychometric mapping of risks that include those that influence subjective perceptions of returns and those that are harder to express in monetary terms (for example, impact on health, the notion of self-respect,

[12]This was obtained from maximum price farmers would be willing to pay for a lottery that would fetch them, with equal probability, an amount equivalent to two days of wages for a male unskilled agricultural laborer (Rs.300)or one day's wage for an unskilled male worker (Rs.150).

[13]The prices for marigold and papaya were collected from secondary data and for gherkins and broiler, the distribution of actual realized prices obtained by the non-subject firm growers in the survey season was used.

etc.) indicate the net incremental risk farmers associate with contracting with the firm in question.[14] These variables are summary measures that incorporate risk attitudes, assessments of farmers' abilities and expectations with regard to uncertainties of nature, among other things. In particular, it represents the net incremental risk a farmer associates with contracting (net, because it factors in both the risk and benefits to contracting, incremental, because the net risk from not contracting is subtracted from the score) and hence indicates a farmer's inclination towards contracting. Clearly, these perceptions of relative benefits and risks of contracting over alternatives potentially drives selection, but cannot determine net returns per acre, and can be used as instruments for identification.

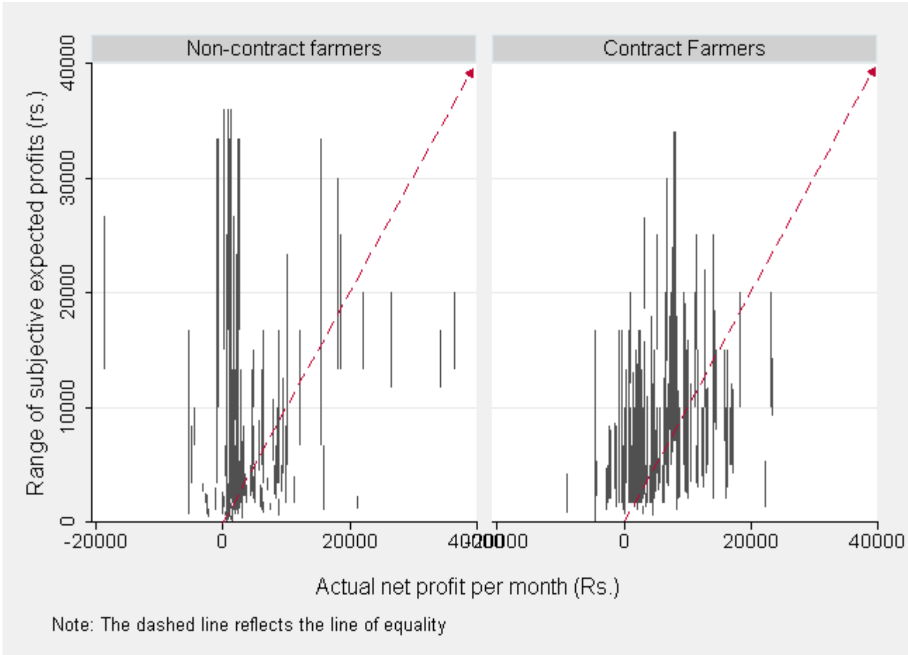
There is a case to be made however of potential endogeneity, that the current outcome influences perceptions, given that the survey collects information for these after realization of net profits that season. I would argue that this endogeneity is weak at best. First, subjective distributions of profits were elicited for a twenty season time frame, and for a typical year, so that while the most recent experience is surely incorporated, it is unlikely to drive the responses overwhelmingly. Also, the measures used in the selection equation are relative measures, of contracting and not contracting, so that the influence of the most recent experience is further muted.

Figure 5 plots the range of subjective net profits per acre per month elicited in the survey alongside the actual net returns, for contract and non-contract farmers. Whenever the range bar straddles the line of equality, the actual or realized net profit that season falls within the range of subjective expectations. It is evident that in a number of cases, observations lie outside the 'typical' range expected by farmers, indicating that the most recent actual outcome has not overwhelmingly influenced the range of typical subjective returns. Had that been the case, one would expect the actual outcomes to fall within the range for most farmers. In other words, if the season of the survey happened to be an extraordinarily good or bad year for the farmer, the figure suggests that farmers have not incorporated this in their assessments of subjective distributions of typical returns, suggesting that the instruments for identification are reliable.

In the case of poultry, I use, additionally, fixed costs on infrastructure as a driver of selection. As mentioned, the sunk cost in often an entry barrier and hence impacts selection. Also, total investment in shed only sets the scale of operations, while there are no scale economies associated with the range of shed space farmers in the region can possibly achieve, implying that scale of investment cannot contribute to net

[14] A Combined Risk Score is computed where a complete listing of all risk reducing and risk enhancing attributes the farmer associates with contracting and the next best alternative is used. The farmer assigns values between one and ten to each relevant attribute denoting the stated frequency of occurrence and another value to represent the criticality of the attribute to the farmer's sense of well-being. The score uses these two values as weights to compute a summary number that denotes the net incremental risk of the farmer from choosing contracting over his or her self-declared next best alternative. Details are available in (Narayanan, 2010).

Figure 5: Comparing expectations and outcome



profit per area operated. Furthermore, there is not much difference in the quality of these fixed investments that might affect net profits. It is difficult too to argue that it might be endogenous since the investment has already taken place, and is influenced by perceptions of incremental risk at the time of the investment and not influenced by current welfare outcomes. By the same logic, I use investment in irrigation facility in the selection equation for papaya, controlling for land owned that influences the ability to make such investments.[15] Together, the instruments capture essential elements for a specific non-contract farmer to serve as a control group for any of the contract commodities.

In the selection equation that sorts farmers into different regimes, apart from these instruments, I include specific farm and household characteristics, when it is of particular relevance to the contract commodity. Implicitly, these capture variables that are associated with attributes firms might be concerned about when choosing farmers and those that represent farmer willingness to contract. The attempt in this paper is not to model the selection process but rather to account for its correlates.

For the outcome equation, I use a hybrid of a traditional production/profit function approach with those more commonly used in studies in contract farming. This is in part to judge the relative strength of association between inputs and profits across the two regimes, and to account fully for the fact that in the commodities studied contract growing almost always involves higher intensity of input use, be it family labor

[15] Farmers were asked if they undertook any investment specifically to be enable to contract for papaya, so that this is not a generic investment but can be regarded as sunk cost for initiating contract farming in papaya.

or fertilizers and pesticides. The outcome, net profit per acre, is treated as a function of the total area under contract cultivation, application of human labor, use of fertilizers (both chemical and farm yard manure), plant protection chemicals. It is also a function of farmer and farm characteristics that might be associated with entrepreneurial abilities, experience and so on.

The estimated model varies across commodities in terms of the set of explanatory variables used. This was driven, in part, by what seemed relevant to the particular commodity. Farmer characteristics include age, social group, some indicator of education, either of the farmer or of the most educated member of the household, land owned, and distance from the nearest road. The availability of irrigation is represented by either the proportion of land irrigated or by an indicator variable for whether the farmer is dependent on rain. In the equation for outcomes, depending on the crop, input use, labor days over the season, of both hired and family labor is invariably included. Supervision enters in some cases as a binary variable. This is derived from the number of visits over the entire cropping season or growing cycle, since the use of the latter yielded unstable coefficients. If there has been any supervision at all in the past season, the variable carries a value of one and zero otherwise. Not all the variables are used in all the equations. Tables 4, 5, 6 and 7 present the summary statistics of the variables used in the models.

Table 3 presents the Kolomogorov-Smirnov tests for comparing distributions. Consistently, the distributions of returns for contract farmers (whether they contract exclusively for the subject firm or for any firm) is statistically significantly different from those of the control groups, irrespective of whether the comparison is restricted to a commodity specific control group of non-contract farmers or to the entire pool of non-contract farmers.

The models correct for heteroscedasticity. The standard errors are clustered at the village level to account for correlation in the errors. This model is run to gauge treatment effects and not to study the correlates of selection. Hence, the inclusion of variables, other than the instruments, to account for selection have broad relevance but are not meant to to be rigorous specifications of covariates of selection. The results of the estimation are presented for each commodity in Tables 8, 9,10 and 11. For gherkins and broiler, the relevant treatment group includes all farmers who contract, and not restricted to just the subject firm.

4 Estimated Treatment Effects

Table 12 shows the average treatment effect for both the treated (contract farmers) as well as for the untreated (non-contract farmers). The treatment effect is measured as the incremental net profit per month in rupees

Table 3: Two-sample Kolmogorov-Smirnov test for equality of net profit distribution functions

Commodity	**D**	**p-value**
Gherkins		
Subject contracting firm		
Contract with subject gherkin firm versus commodity-specific control farmers	0.315	0.02***
Contract with subject gherkin firm versus all control farmers	0.266	0.01***
Any contracting firm		
Contract with any gherkins firm versus commodity-specific control farmers	0.275	0.04**
Contract with any gherkins firm versus all control farmers	0.222	0.01***
Marigold		
Contract with subject marigold firm versus commodity-specific control farmers	0.273	0.01***
Contract with subject marigold firm versus all control farmers	0.209	0.03 ***
Papaya		
Contract with subject papaya firm versus commodity-specific control farmers	0.491	0 ***
Contract with subject papaya firm versus all control farmers	0.662	0***
Broiler		
Subject contracting firm		
Contract with subject broiler firm versus other commodity-specific control farmers	1.000	0.00***
Contract with subject broiler firm versus all control farmers	1.000	0.00 ***
Any contracting firm		
Contract with any broiler firm versus commodity-specific control farmers	1.000	0.00***
Contract with any broiler firm versus all control farmers	1.000	0.00***

Significance levels : * : 10% ** : 5% * * * : 1%

[1] Farmer Survey. 2009-10.
[2] The distribution for which the tests are conducted refer to net profit per acre in Rs./month for gherkins, papaya and marigold.
[3] The distribution for which the tests are conducted refer to net profit in Rs./month for 5000 birds or 5000 square feet of space.

(Rs.). For the former, it represents the average difference between the expected net profit for contract farmers and what they would have earned had they not contracted. For the latter, it represents the average difference in expected net profit for non-contract farmers had they been contracting and the expected net profit when not contracting.[16] These are computed for the commodity-specific sample to ensure tighter comparisons and for the pooled sample to enable a broader comparison. The table also shows the standard deviation of the distribution of the estimated treatment effects to emphasize that notwithstanding the sign of the average, particular farmers might gain significantly from contracting whereas others might be significantly worse off with contracting. The variation is in part reflective of the large variations in the predicted net profits earned in the season surveyed and partly from similar variations in the estimated counterfactuals as in Equations 1 and 2.

The findings differ across schemes. In the case of gherkins and marigold, the treatment effect on both the treated and untreated is negative, implying that contracting leaves both contract and non-contract farmers worse off in terms of net profit per acre per month. Gherkins contract farmers have earned, on average, a lower net profit per month by virtue of choosing to contract. Had they not, they would have, on average,

[16] As mentioned, for gherkins and broiler, the treatment group represents contract farmers who contract with either the subject firm or any other firm.

Table 4: Summary Statistics for Endogenous Switching Model : Gherkins

	Non-contract farmers (n=184)				Contract farmers (n=77)			
	Mean	**Standard Deviation**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Dependent Variable								
Net profit per acre per month (Rs.)	3453.5	6945.7	-20687	36422	3282.8	5058.3	-8982	22173
Explanatory variable								
Fertilizer application	172.8	231.6	0	2013	535.4	166.7	100	1100
Plant protection	157.3	496.9	0	3333	600.9	257.9	100	1500
Total hired labor (days)	75.2	81.8	0	374	46.4	19.6	0	100
Total family labor (days)	40.9	46.2	0	208	155.4	48.6	46	266
Land owned (acres)	6.7	11.4	0	106	2.2	4.6	0	40
Distance from surfaced road (kms.)	1.5	7.1	0	50	0.4	0.5	0	3
Age (years)	46.9	11.1	23	79	38.5	9.3	22	70
(D) Most educated family member is illiterate	36.2	N.A	0	1	5.2	N.A	0	1
Combined risk score for commodity-specific control farmers	14.3	61.8	-200	338	-33.8	167.9	-400	350
Risk aversion to open market prices	1.1	0.3	1	2	1.3	0.1	1	1
(D)Contracting first order stochastic dominates next best alternative	27.6	N.A	0	1	56	N.A	0	1
(D)Contracting second order stochastic dominates next best alternative	29.7	N.A	0	1	59	N.A	0	1
Ratio of mean returns from contracting over next best alternative	0.7	2.440677	0	27	3.2	4.5	0	25
The number of hamlets sample firm procures from in the block	2.1	4.2	0	11	8.1	3.9	2	11

[1] Farmer Survey, 2009-10.
[2] Contract farmers refer to only those who contract with either the subject firm or any other firm. Non contract farmers refers to those who do not contract at all and are the pooled controls

Table 5: Summary Statistics for Endogenous Switching Model : Marigold

	Non-contract farmers (n=208)				Contract farmers (n=59)			
	Mean	**Standard Deviation**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Dependent Variable								
Net profit per acre per month (Rs.)	3565.1	6783.6	-20687	36422	1705.1	1701.7	-2600	8750
Explanatory variable								
Fertilizer application	217	260	0	2013	201.2	50.71	125	350
Plant protection	212	503	0	3333	0.0	0	0	0
Total hired labor (days)	73	78	0	374	142.7	63.06	68	417
Total family labor (days)	55	62	0	266	14.5	4.52	8	35
Number of visits by field official	2	2	0	6	2.4	1.17	1	6
Land owned (acres)	6	11	0	106	5.2	3.84	1	25
(D) Rainfed farm	0		0	1	0	N.A.	0	0
Percentage of land owned that is irrigated	76	30	0	100	90.2	23.17	0	100
Distance from surfaced road (kms.)	1	7	0	50	1.6	1.76	0.1	10
Age (years)	46	11	23	79	45.3	12.33	25	80
(D) Education	16	N.A.	0	1	53	N.A.	0	1
Combined risk score for commodity-specific control farmers	-117	193	-668	0	-601.7	169.10	-1297	0
Risk aversion to open market prices	9	2	4	13	6.4	1.29	2	13
Difference in Skewness in returns from contracting and next best alternative'	0	0.6	-2.7	3	0.3	1.02	-2	3
(D)Contracting first order stochastic dominates next best alternative	8	N.A.	0.0	1	25	N.A.	0	1
(D)Contracting second order stochastic dominates next best alternative	7	N.A.	0.0	1	14	N.A.	0	1
Ratio of mean returns from contracting over next best alternative	0.35	0.9	0.0	7	0.8	0.74	0	3
The number of hamlets sample firm procures from in the block	1	1.6	0.0	5	4	0.95	3	5

[1] Farmer Survey,2009-10.
[2] Contract farmers refer to only those who contract with the subject firm, since there are no other firms contracting in the region. Non contract farmers refers to those who do not contract at all and are the pooled controls

Table 6: Summary Statistics for Endogenous Switching Model : Papaya

	Non-contract farmers (n=196)				**Contract farmers (n=72)**			
	Mean	**Standard Deviation**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Dependent Variable								
Net profit per acre per month (Rs.)	3565.1	6783.6	-20687	36422	9289.0	4724.8	973	23382
Explanatory variable								
Plant protection	212.3	502.9	0	3333	962.2	1072.8	0	4333
Total hired labor (days)	72.7	77.7	0	374	63.2	82.4	5	454
Total family labor (days)	55.4	62.2	0	266	96.2	44.8	0	164
(D)Supervision	3.8	N.A	0	1	2.8	N.A	0	1
Land owned (acres)	6.2	10.8	0	106	5.7	5.0	0	25
Percentage of land owned that is irrigated	76.2	30.3	0	100	88.3	20.1	30	100
Distance from surfaced road (kms.)	1.4	6.7	0	50	0.8	1.4	0	6
Age (years)	46.3	11.1	23	79	45.1	9.5	27	70
(D) Scheduled Caste or Tribe	0.5	N.A	0	1	5.6	N.A	0	1
(D) Highest educated family member is illiterate	4.8	N.A	0	1	43.1	N.A	0	1
Combined risk score for commodity-specific control farmers	-13.9	63.2	-490	130	-96.1	186.2	-610	455
Risk aversion to open market prices	4.7	1.0	2	6	4.1	1.3	0	6
Difference in Skewness in returns from contracting and next best alternative'	0.0	0.3	-1.9	2	0	1.1	-2.96	2
Contracting first order stochastic dominates next best alternative	7	N.A	0.0	1	7	N.A	0	1
Contracting second order stochastic dominates next best alternative	7	N.A	0.0	1	36	N.A	0	1
Ratio of mean returns from contracting over next best alternative	1.8	2.7	0.1	27	1	1.0	0.16	4
The number of hamlets sample firm procures from in the block	0.8	1.3	0.0	7	3	2.6	1	7

[1] Farmer Survey, 2009-10.
[2] Contract farmers refer to only those who contract with the subject firm, since there are no other firms contracting in the region. Non contract farmers refers to those who do not contract at all and are the pooled controls

Table 7: Summary Statistics for Endogenous Switching Model :Broiler

	Non-contract farmers (n=208)				Contract farmers (n=81)			
	Mean	**Standard Deviation**	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
Dependent Variable								
Net profit per month (Rs.)	689.8	1032.0	-2379	4188	11729.4	1958.4	8625	18698
Explanatory variable								
Total hired labor (days)	72.7	77.7	0	374	107.5	87.4	12	430
Total family labor (days)	55.4	62.2	0	266	111.6	66.7	0	280
Land owned (acres)	6.2	10.8	0	106	6.9	6.3	0	45
Percentage of land owned that is irrigated	76.2	30.3	0	100	59.5	34.7	0	100
Distance from surfaced road (kms.)	1.4	6.7	0	50	0.3	0.7	0	5
Age (years)	46.3	11.1	23	79	46.1	11.0	29	75
Combined risk score for commodity-specific control farmers	-7.5	50.2	-300	175	-194.6	97.3	-379	85
Risk aversion to open market prices	1.5	0.3	1	2	1.5	0.4	0	2
The number of hamlets sample firm procures from in the block	2.1	3.6	0	12	6.8	4.0	0	12

[1] Farmer Survey,2009-10.
[2] Contract farmers refer to only those who contract with either the subject firm or any other firm. Non contract farmers refers to those who do not contract at all and are the pooled controls.
[3] The net profit per month figures pertain to net profit for a standard area denoted by the shed space that can hold 5000 birds to enable comparison across groups.

Table 8: Gherkins: Endogenous Switching Model

Dependent variable: Net profit per acre per month (Rs.)			
Variable	**Coefficient**	**Robust Standard Error**	**z-statistic**
Regime 1: Contracting with any firm			
Percentage of cultivated land that is irrigated			
Land owned (acres)	79.12	44.26	1.79 *
Distance from surfaced road (kms.)	1431.78	626.44	2.29 **
Total hired labor (days)	34.26	38.13	0.90
Total family labor (days)	56.59	24.58	2.30 **
Age (years)	32.88	83.74	0.39
Plant protection (liters)	-1.64	3.26	-0.50
Fertilizer application (kgs.)	-2.85	4.85	-0.59
(D) Family member has post-secondary education	-819.09	1269.06	-0.65
Constant	-7272.07	2665.34	-2.73 ***
Regime 2: Not contracting with any firm			
Land owned (acres)	-24.52	23.61	-1.04
Distance from surfaced road (kms.)	51.14	134.46	0.38
Total hired labor (days)	10.17	11.59	0.88
Total family labor (days)	8.02	16.7	0.48
Plant protection (liters)	2.04	0.89	2.29 **
Fertilizer application (kgs.)	1.78	1.85	0.96
(D) Family member finished schooling	-908.66	1217.62	-0.75
Age (years)	-41.6	44.31	-0.94
Constant	4515.43	2018.73	2.24 **
Regime selection			
Land owned (acres)	-0.02	0.02	-1.00
Distance from surfaced road (kms.)	0.03	0.04	0.75
Total hired labor (days)	0.01	0.004	2.96 ***
Total family labor (days)	0.02	0.004	4.98 ***
Age (years)	-0.04	0.02	-2.00 **
Plant protection (liters)	-0.0002	0.0005	-0.37
Fertilizer application (kgs.)	0.001	0.0005	2.21 **
(D) Family member finished schooling	-1.24	0.54	-2.30 **
Combined risk score X Dummy for Gherkins	0.001	0.001	0.78
Risk aversion to open market prices	4.87	1.32	3.69 ***
Ratio of mean returns from contracting over next best alternative	-0.06	0.04	-1.50 *
Number of contract hamlets in block	0.12	0.03	4.00 ***
Constant	-8.52	2.26	-3.77 ***
Mills' Ratio Regime 1 (mean)	2.9		
Mill's Ratio Regime 2 (mean)	0.46		
N	261		
Wald chi2(8)	71.02		
Prob > chi2	0.00 ***		
Log pseudolikelihood	-2682.57		

Significance levels : * : 10% ** : 5% * * * : 1%

[1] (D) means dummy variable taking on the value 1 when the variable is true and 0 otherwise.
[2] FOSD means contracting first order stochastic dominates next best alternative.
[3] SOSD means contracting second order stochastic dominates next best alternative.

Table 9: Marigold: Endogenous Switching Model

Dependent variable: Net profit per acre per month (Rs.) **Variable**	**Coefficient**	**Robust Standard Error**	**z-statistic**
Regime 1: Contracting with sample firm			
(D) Rainfed farm	160.53	381.13	0.42
Fertilizer application (kgs.)	15.16	5.07	2.99 ***
Land owned (acres)	45.97	42.43	1.08
Distance from surfaced road (kms.)	-53.33	106.89	-0.50
Total hired labor (days)	-0.44	3.25	-0.14
Total family labor (days)	122.96	52.25	2.35 **
Age (years)	19	17.95	1.06
(D) Family Education (1=Illiterate)	-32.46	350.2	-0.09
Constant	-4274.66	1741.75	-2.45 **
Regime 2: Not contracting with sample firm			
Land owned (acres)	-17.32	17.04	-1.02
(D) Rainfed	1544.48	1040.3	1.48
Fertilizer application (kgs.)	0.6	1.09	0.55
Distance from surfaced road (kms.)	71.52	139.22	0.51
Total hired labor (days)	10.63	10.28	1.03
Total family labor (days)	7.32	7.28	1.01
(D) Family illiterate	-750.48	2689.73	-0.28
Age (years)	-28.89	35.39	-0.82
Constant	2562.74	2144.39	1.20
Regime selection			
(D) Rainfed	1.38	0.77	1.79 *
Fertilizer application	-0.003	0.001	-1.93 *
Land owned (acres)	0.05	0.02	2.50 ***
Distance from surfaced road (kms.)	-0.02	0.01	-2.00 *
Total hired labor (days)	0.00	0.00	1.07
Total family labor (days)	0.03	0.01	3.00 ***
Age (years)	0.01	0.01	1.00
(D) Family illiterate	0.02	0.33	0.06
Combined risk score X Marigold Scheme dummy	-0.01	0.00	-3.31 ***
Risk aversion to open market prices	-0.1	0.16	-0.63
Difference in skewness	-0.06	0.19	-0.32
(D) FOSD	-1.13	0.66	-1.71 *
(D) SOSD	1.19	0.59	2.02 **
Ratio of mean returns	-0.15	0.16	-0.94
Number of contract hamlets in block	1.21	0.36	3.36 ***
Constant	-7.89	2.75	-2.87 ***
Mills' Ratio Regime 1 (mean)	3.83		
Mill's Ratio Regime 2 (mean)	0.31		
N	267		
Log pseudo-likelihood	-2675.51		
Wald chi2(8)	23.51		
Prob > chi2	0.003***		

Significance levels : ∗ : 10% ∗∗ : 5% ∗ ∗ ∗ : 1%

[1] (D) means dummy variable taking on the value 1 when the variable is true and 0 otherwise.
[2] FOSD means contracting first order stochastic dominates next best alternative.
[3] SOSD means contracting second order stochastic dominates next best alternative.

Table 10: Papaya: Endogenous Switching Model

Dependent variable: Net profit per acre per month (Rs.) Variable	Coefficient	Robust Standard Error	z-statistic
Regime 1: Contracting with sample firm			
Percentage of cultivated land that is irrigated	7.95	22.63	0.35
Land owned (acres)	-210.92	107.13	-1.97 **
Distance from surfaced road (kms.)	914.22	404.54	2.26 **
(D) Supervision	-656.35	1343.36	-0.49
Total hired labor (days)	-1.2	5.65	-0.21
Total family labor (days)	-8.5	14.9	-0.57
Age (years)	-22.78	48.92	-0.47
Plant protection (liters)	1.87	0.58	3.22 ***
(D) Family illiterate	-5441.89	2242.54	-2.43 **
(D) Scheduled Caste/Tribe	1904.13	1501.49	1.27
Number of crops grown annually per acre	455.33	952.15	0.48
Constant	9405.84	3986.8	2.36 **
Regime 2: Not contracting with sample firm			
Land owned (acres)	-16.6	13.36	-1.24
Percentage of cultivated land that is irrigated	55.28	15.77	3.51 ***
Distance from surfaced road (kms.)	47.65	110.31	0.43
Total hired labor (days)	-2.92	14.03	-0.21
Plant protection (liters)	1.43	0.83	1.72 *
Total family labor (days)	20.31	10.49	1.94 *
(D) Scheduled Caste/Tribe	-6141.49	1342.13	-4.58 ***
(D) Family member finished primary school	-1625.52	1001.63	-1.62
Age (years)	13.14	40.15	0.33
(D) District 2	5259.96	1726.09	3.05 ***
(D) District 1	1810.08	1258.55	1.44
Number of crops grown annually per acre	-313.28	287.79	-1.09
Constant	-4038.88	2458.45	-1.64
Regime selection			
Percentage of cultivated land that is irrigated	0.01	0.01	1.00 *
Distance from surfaced road (kms.)	0.01	0.03	0.33
(D) Supervision	-2.35	0.49	-4.80 ***
Total hired labor (days)	0.00	0.00	-0.32
Total family labor (days)	0.01	0.00	2.94 ***
Age (years)	0.005	0.02	0.23
Plant protection	0.0004	0.00	1.90 *
(D) Family illiterate	-0.99	0.44	-2.25 **
(D) Scheduled Caste/Tribe	0.38	0.42	0.90
Number of crops grown annually per acre	-0.94	0.31	-3.03 ***
Land owned (acres)	0.06	0.05	1.20
(D) Family member finished primary school	-0.79	0.48	-1.65 *
(D) District 2	8.68	5.27	1.65 *
(D) District 1	9.91	5.31	1.87 *
Combined risk score X Papaya dummy	-0.001	0.002	-0.56
Risk aversion to open market prices	-0.57	0.23	-2.48 **
Ratio of coefficient of variation in returns	2.52	1.82	1.38
Difference in Skewness	0.06	0.23	0.26
(D) FOSD	-0.48	0.71	-0.68
(D) SOSD	0.52	0.76	0.68
Ratio of mean returns	-0.51	0.23	-2.22 **
Sunk Cost (Rs.'0000)	0.22	0.12	1.93 *
Number of contract hamlets in block	0.18	0.13	1.38
Constant	-7.54	6.23	-1.21
Mills' Ratio Regime 1 (mean)	4.44		
Mill's Ratio Regime 2 (mean)	0.48		
Number of observations	267		
Log pseudolikelihood	-2712.45		
Wald chi2(11) =	438		
Prob >chi2 =	0.00***		

Significance levels : $*$: 10% $**$: 5% $***$: 1%

[1] (D) means dummy variable taking on the value 1 when the variable is true and 0 otherwise.

[2] FOSD means contracting first order stochastic dominates next best alternative.

[3] SOSD means contracting second order stochastic dominates next best alternative.

Table 11: Broiler: Endogenous Switching Model

Dependent variable: Net profit per acre per month (Rs.) **Variable**	**Coefficient**	**Robust Standard Error**	**z-statistic**
Regime 1: Contracting with any firm			
Land owned (acres)	-48.87	25.49	-1.92 *
Percentage of cultivated land that is irrigated	10.38	5.65	1.84 *
Distance from surfaced road (kms.)	153.95	129.87	1.19
Age (years)	13.15	14.86	0.88
Total hired labor (days)	4.38	2.15	2.04 **
Total family labor (days)	21.41	3.57	6.00 ***
Constant	7935.9	981.34	8.09 ***
Regime 2: Not contracting with any firm			
Age (years)	5.02	5.87	0.86
Land owned (acres)	10.57	3.5	3.02 ***
Percentage of cultivated land that is irrigated	9.7	2.04	4.75 ***
Total hired labor (days)	1.56	1.29	1.21
Total family labor (days)	0.77	0.89	0.87
Distance from surfaced road (kms.)	3.83	13.05	0.29
Constant	-507.39	299.88	-1.69 *
Regime selection			
Land owned (acres)	0.04	0.65	0.06
Percentage of cultivated land that is irrigated	-0.03	0.14	-0.21
Distance from surfaced road (kms.)	-0.75	2.58	-0.29
Age (years)	-0.01	0.25	-0.04
Total hired labor (days)	0	0.08	0.00
Total family labor (days)	0.01	0.12	0.08
Combined risk score X Broiler dummy	-0.01	0.005	-2.17 **
Risk aversion to open market prices	0.68	3.97	0.17
Sunk cost (Rs. '0000)	0.89	9.68	0.09
Number of contract hamlets	0	11.26	0.00
Constant	-2.9	102.16	-0.03
Mills' Ratio Regime 1 (mean)	3.99		
Mill's Ratio Regime 2 (mean)	0.69		
N	289		
Log likelihood	-2431.53		
Wald chi2(6)	55.76		
Prob > chi2	0 ***		

Significance levels : * : 10% ** : 5% * * * : 1%

[1] (D) means dummy variable taking on the value 1 when the variable is true and 0 otherwise.

earned, close to one and a half times their net profit from contracting. Marigold farmers could have earned a return that was fifty percent higher than their net profit from contracting had they not grown for the sample firm.

For the commodity-specific control group of non-contract farmers, the results suggest that non-participating farmers are better off that way, and contracting either for gherkins or marigold would leave them worse off. To put these results in perspective, those who did not grow gherkins often grew tomato or other horticultural crops, which fetched the farmers particularly good returns this season. As for marigold, the price in the fresh flower market often shoots up and is typically higher than the contract price. The negative treatment effect reflects, in all likelihood, this effect. It is important to note that this is an average across farmers and also picks data for just one season, so that it only represents a snapshot view, that is not necessarily robust.

For broiler and papaya, contracting increases net profits on average, for both contract farmers and those not currently contracting. Papaya contract farmers would have foregone 37% of their current net profits had they chosen not to contract for papaya, broiler growers would have lost one and a half times their average net earnings had they not opted to contract. For those not participating, entering papaya contracting would enhance a non-participating farmer's net profit by 47% and if non-contract farmers were to take up contracting with the sample firm for broiler, they would earn net profits that are more 123% higher.

In the gherkins contracting scheme, ρ_{1v} is positive and statistically significant. This indicates that farmers who contract for gherkins have a absolute advantage in participating. They tend to have a higher than average net profit whether or not they are contracting. In the broiler contracting scheme, there is clear evidence of hierarchical sorting. Both ρ_{1v} and ρ_{2v} are negative and statistically significant. This indicates that those who contract have better than average profits, irrespective of whether they contract or not, but are better off when contracting. Those who do not contract face below average profits in both regimes, and would be better off contracting. This is indicative of exclusion of 'low ability' farmers. Papaya is similar to broiler in that both ρ_{1v} and ρ_{2v} are negative but neither is statistically significant indicating that selection is potentially exogenous. The coefficient of correlation is not statistically significant for marigold and hence, here too selection is possibly exogenous. This is broadly consistent with the current operational status of the schemes, as evident from interviews with agribusinesses. For example, for the marigold scheme, the contracting arrangements are not tight in the sense that sidesale to the spot market is very high. This

Table 12: Treatment Effects and Regime Sorting

Variable	**Mean incremental income (Rs.)**	**Standard Deviation of distribution of point estimates**	**Average Treatment effect as a proportion of average actual net profit**	**Number of observations**
Treatment Effect on the Treated				
Gherkin	-4407	1989	-1.46	77
Marigold	-1577	1334	-0.49	59
Papaya	3175	3594	0.37	71
Broiler	11082	1236	1.51	81
Treatment Effect on the Untreated(Commodity-specific controls)				
Gherkin	-174	3009	-1.02	38
Marigold	-4167	2557	-1.29	62
Papaya	4030	2112	0.47	27
Broiler	9040	1331	1.23	57
Treatment Effect on the Untreated(All controls)				
Gherkin	1172	4162	0.28	180
Marigold	3377	9699	0.79	208
Papaya	4844	492	1.14	196
Broiler	10066	1682	2.66	208
Correlation Coefficients in the Switching Models	**Regime 1 :** ρ_{1v}		**Regime 2 :** ρ_{2v}	
	Estimate	Standard Error	Estimate	Standard Error
Gherkins	0.51	0.20 **	0.45	0.46
Marigold	0.22	0.21	-0.14	0.11
Papaya	-0.17	0.58	-0.05	0.37
Broiler	-0.97	0.54 **	-0.99	0.60**

Significance levels : $*$: 10% $**$: 5% $***$: 1%

[1] For gherkins and marigold all costs are for the most recent season completed, for one acre, which spans three months.
[2] For papaya, this is an annual figure that has been converted to an equivalent per month per acre.
[3] For broiler, this is a monthly figure per 5000 birds or 5000 square feet of shed space.
[4] All treatment effects are computed and averaged over the sample within commodities.

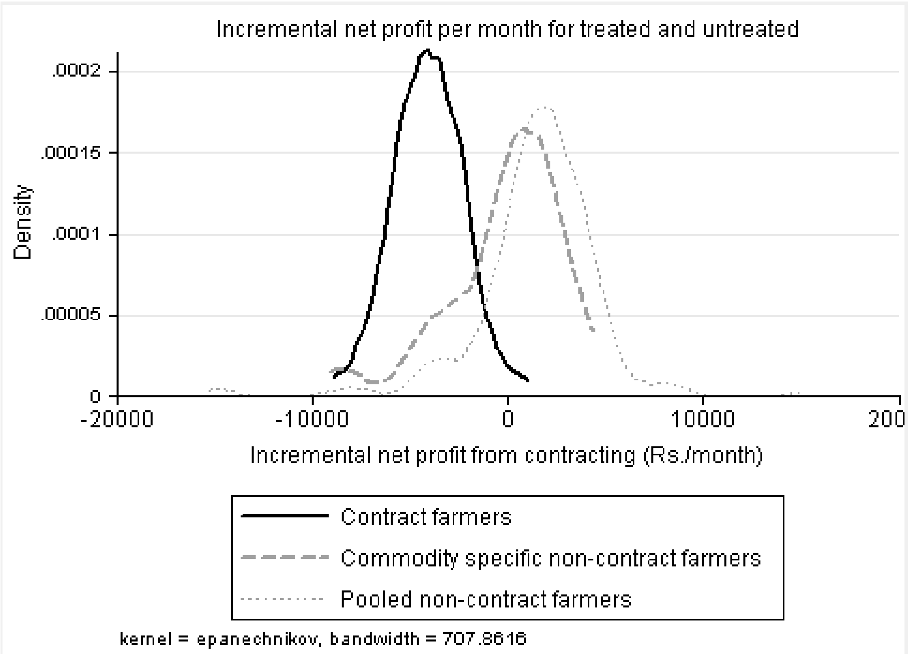
muddies any evidence of sorting. Again for papaya, this year saw a catastrophic loss of the papaya crop to mealybug infestation, again rendering inferences regarding sorting murky.[17]

When treatment effects on the untreated are computed for all controls, participation in contract farming in each of the commodities studied is associated with positive net gains on an average (Table 12). Should these farmers be able to contract for gherkins, they could increase their incomes by about 28% in gherkins and for marigold, by 79% and substantially more for papaya (114%) and broiler (206%).

Treatment effects that measure an average impact on the set of farmers can potentially mask the heterogeneity of farmer experiences. To unravel these farmer level differences, it is useful to graph the

[17]The coexistence of the beneficial treatment effect and the catastrophic loss is partly on account of the timing of the survey. The actual net profits recorded for papaya were for the preceding year, which was then converted to net profit per acre per year. At the time of the survey, the mealybug epidemic had been affecting crops for about three months. Since papaya latex extraction is a continuous process, the welfare metric captures a mixture of high yields and low yields. Without the mealybug attack, papaya contract farmers are likely to have benefited much more from papaya contracting, and there might have been stronger evidence on sorting.

Figure 6: Treatment Effect for Gherkins Contract and Non-contract farmers



distribution of treatment effects. Figures 6, 7, 8 and 9 show the range of treatment effects for different farmers, mapping the two distributions for contract and non-contract farmers separately. These distributions are key to understanding the origins of the dynamics of contract farming arrangements. In most cases, the distributions of treatment effects for both contract and non-contract farmers straddle the positive and negative axis. This suggests that some contract farmer might be better off opting out of the regime, while there are some non-contract farmers who might have an incentive to participate in contracting arrangements. This opens up the possibility of farmers reassessing their decisions to contract or taking specific actions to enter into transactional arrangements with firms.

There are only two cases in this sample where the treatment effect is unambiguously positive across treatment and different control groups. For papaya and broiler, non-contract farmers appear certain to benefit from contracting I suggest that for marigold and gherkins, the results require careful interpretation. Apart from the fact that this is evidence for one season and aggregates substantial heterogeneity across farmers, it might reflect the prices in the markets for the other crops that control group farmers grew, tomato, for instance. The treatment effect in this case can easily switch signs depending on market conditions. The key finding is however the heterogeneity of farmer experience. The large standard deviations in the point estimates of the average treatment effect reflect both the variation in the net profits accruing to the farmers in the survey season but also the range of potential impact of contracting for the various farmers.

Figure 7: Treatment Effect for Marigold Contract and Non-contract farmers

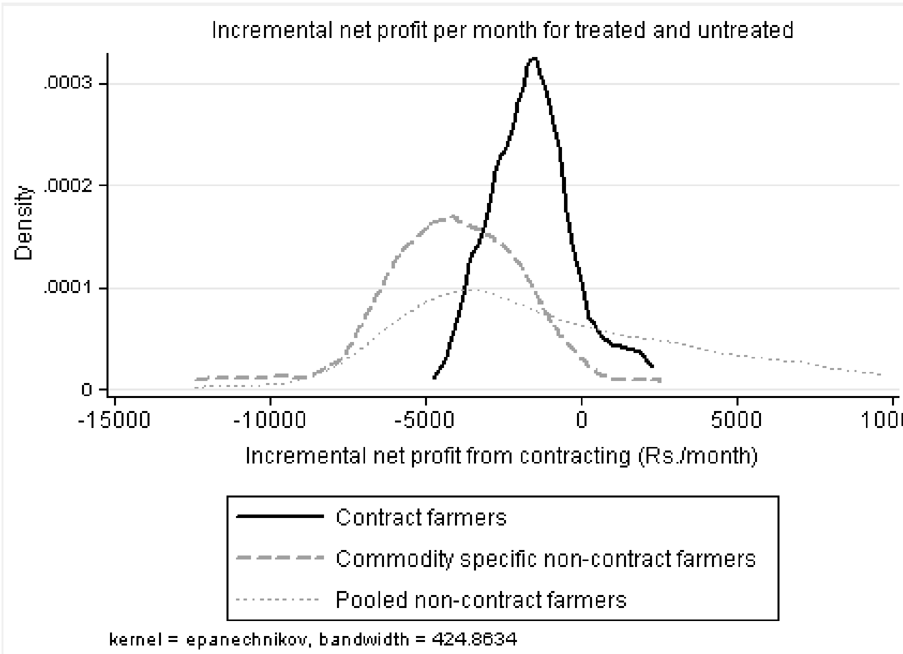


Figure 8: Treatment Effect for Papaya Contract and Non-contract farmers

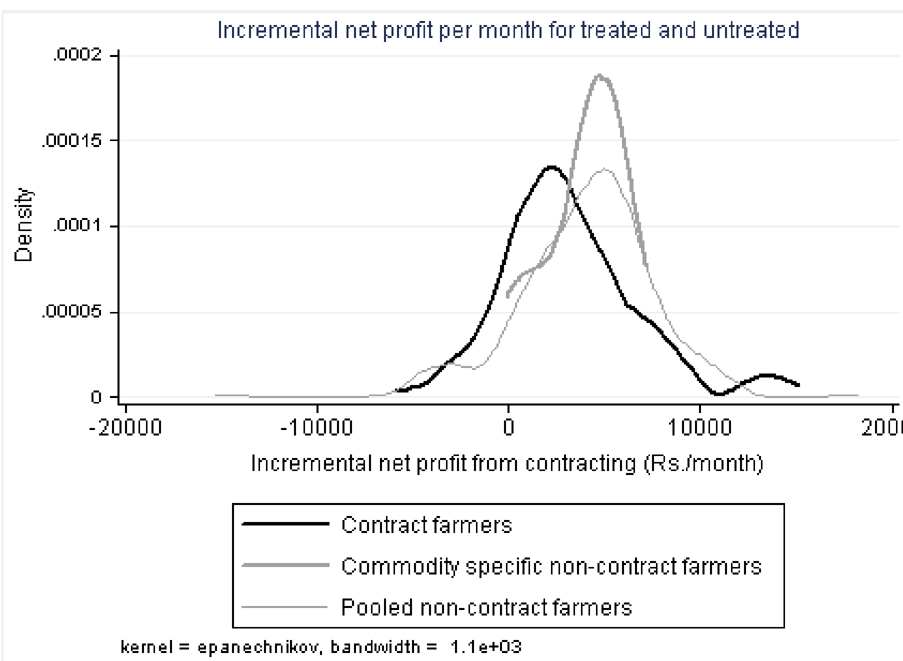
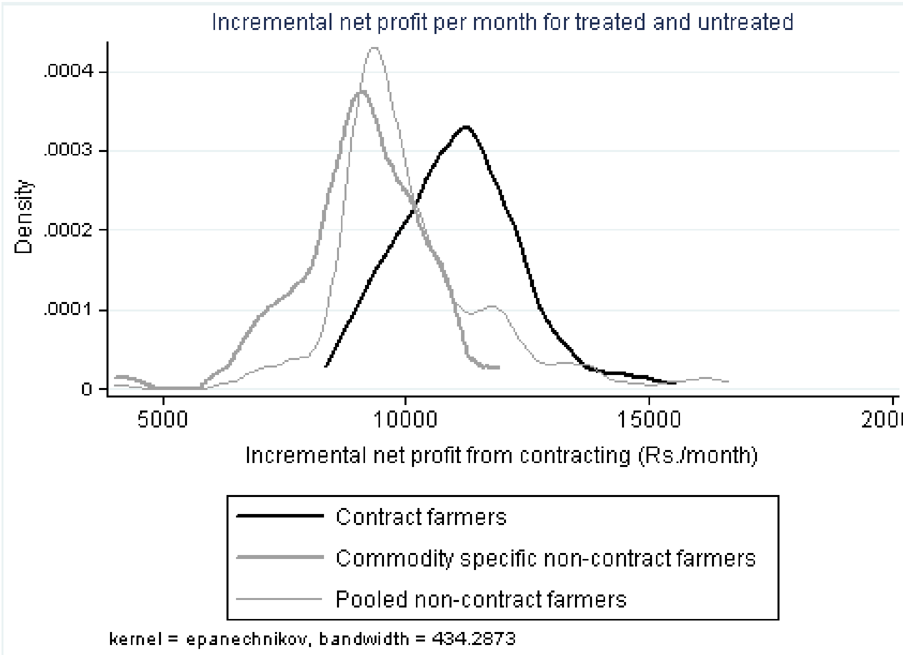


Figure 9: Treatment Effect for Broiler Contract and Non-contract farmers



5 Sources of Welfare Gains: The Structure of Costs and Returns

The heterogeneity of levels in treatment effects goes hand in hand with the sources of these gains (or losses) from contracting. This section first undertakes a simple decomposition of costs and returns to identify whether incremental incomes for contract farmers come from higher prices for the produce (being high-value crops as compared to the substitute) or via savings in transactions costs. It then assesses the returns to key factors of production across regimes that come from the estimation of the endogenous switching models.

Tables 13 and 14 indicate that other than for marigold, contract farmers, irrespective of whether they contract with the sample firm or any other firm, earn higher net returns on average. This is despite higher costs associated with contract growing.

This conforms with several previous studies that examine returns and cost structures in India. Singh (2007) and Gulati, Ganguly, and Landes (2008) review these in some detail. In general, findings suggest that the contract growing is associated with much higher costs of cultivation, 17-24 % in potato contract farming in Haryana (Tripathi and Singh, 2005) and for tomato in the Punjab (Kumar, 2007; Dileep, Grover, and Rai, 2002), but also higher gross and net returns driven in part by higher yields and in savings in transactions costs. Examples are gherkins (hybrid cucumber) in Andhra Pradesh (Haque, 2000; Dev and Rao, 2005), tomato in Punjab (Haque, 2000; Rangi and Sidhu, 2000) and Haryana (Dileep, Grover, and

Rai, 2002). Contract farming, when it involved a switch from traditional crops, gave much higher (almost three times) gross returns compared with that from the traditional crops of wheat, paddy in a study of tomato (Rangi and Sidhu, 2000). Studies show too that transactions costs were over 20% lower for contract milk and vegetable producers (Birthal, Joshi, and Gulati, 2005). In several cases, contract farmers emerged with larger net returns per unit area of contract crop relative to those who were not contracting or grew traditional crops.

As shown in Table 14, broiler contracting requires large fixed investments in sheds to house birds, drinkers and feeders and so on. The chicks and feed are provided by the firm. In the schemes studied, typically, the farmers procures medicines and takes care of the maintenance expenses. Typically, women are far less involved in broiler production than men.

The other commodities do not require much fixed investment, although for gherkins and papaya, most invested in either irrigation facilities or in spraying machines. Input costs of gherkins tends to be high, owing to heavy use of fertilizer, pesticides and micronutrients. This is not the case for marigold and papaya where contract farmers make do with farm yard manure and minimal fertilizers.

An interesting contrast is the use of labor (Table 13). Gherkins farmers rely heavily on family labor, and it is clear that relative to farmers who do not contract, they use far greater labor per three months, owing to the demands of harvesting in time and in the application of inputs, trellising and so on. In the case of marigold, there is much greater reliance on hired labor. Here too contracting implies a greater need for labor, mainly for harvesting. Papaya and broiler require very little labor in general. As is to be expected the costs associated with transactions, marketing, transport, commissions is typically zero for contracting farmers, while non-contracting farmers do incur these expenses.[18]

These differences point to the heterogeneity across crops and the need to acknowledge these differences in studying the instrumentality of contract farming in transforming smallholder livelihoods. The switching models offer a way to compare the above structural differences, in a limited way, between contract growers and non-contract growers in different schemes. Examining returns to factors of production for contract farmers also reflects key contractual elements. Given that all the contracting firms engage in offering technical advice, supervision and monitoring, and by supplying inputs, variables representing these aspects reflect the contribution of contractual inputs provided by the firm.

[18] In general, individual circumstances of a farmer and demands made by particular commodities drive selection.
Among those who grow poultry, it is also apparent that the higher the incremental risk associated with contracting, as indicated by higher combined risk scores, the lower the propensity to contract. For gherkins, younger farmers are more likely to contract. Further, the higher the variation associated with the realized prices paid by other contract firms for gherkins, the greater the likelihood of farmers wanting to contract with the sample firm in the study.

Table 13: Cost of Cultivation for Broiler growers (Indian Rupees)

	Subject Contract Farmers	Other Contract Farmers	Attrition Farmers
Returns			
Net profit per month per 5000 birds	11602	12747	11487
Net Return (per cycle of six weeks)	23205	25494	22974
Gross Return (per cycle of six weeks)	34839	35565	33804
Recurring Costs (per cycle of six weeks			
Total costs	11635	10071	10830
Total labor cost	3189	1736	2386
(as % of total cost)	27	17	22
Total other costs	8446	8336	8444
(as % of total cost)	73	83	78
Fixed Costs			
Fixed Costs	82700	85692	85130
Labor per cycle of six weeks			
Male hired labor(days)	14	8	10
Male family labor(days)	16	20	14
Female hired labor (days)	6	1	3
Female family labor (days)	2	5	3

[1] All costs and returns are in Indian Rupees.
[2] Feed and chick costs are excluded from estimate of costs since the costs are borne by the contracting firm. The return is computed using grower charges, net of the costs of feed and chick for all farmer categories.
[3] The never contract farmers here grow other crops and are not presented in this table.

Returns to fertilizer use and family labor is statistically significant for marigold contract farmers, whereas these do not seem to matter to farmers who do not contract for marigold. For gherkins, farmers with larger landholding sizes are associated with greater net profit per acre as are farmers located farther from the road.

The presence of monitoring, denoted here as a dummy variable, does not seem to impact net profit per acre. Monitoring the production process is a very important aspect in the gherkins contracting scheme and is valued highly by the farmers. This result is somewhat surprising. However, it is possible that it is the intensity of supervision that matters rather than whether or not there is supervision.

In the case of papaya, contract and non-contract farmers earn higher profits per acres with plant protection, this is highly significant for contract farmers and is most likely owing to the mealybug infestation during the season surveyed. As with gherkins, farmers located farther away from the road tend to earn higher net profit per acre than those who are closer to a road. Larger size of farms tend to earn less net profit per acre from the contract farm. This is presumably due to the managerial demands made as the scale of operation increases. For those who do not contract for papaya, family labor inputs are associated with higher returns, and less educated and those belonging to marginalized communities fare worse. Plant protection for non-contract farmers is less significant than is the the case for papaya contract farmers.

Table 14: Cost of Cultivation: Comparisons across Schemes and Farmer Groups (Indian Rupees)

	Gherkin (per season when not specified)				**Marigold (per season when not specified)**				**Papaya (per month)**	
Farmer type	Subject Contract Farmers	Other Contract Farmers	Attrition Farmers	Never Contract farmers	Subject Contract Farmers	Other Marigold Farmers	Attrition farmers	Never Contract farmers	Subject Contract farmers	Never Contract Farmers
Returns										
Net profit per acre per month	2780	4463	2623	2308	1705	5168	5384	3243	9289	6934
Net profit per acre	8340	13388	7870	6924	5115	15504	16153	9729	9289	6934
Gross Return per acre	28919	34706	15296	12981	25495	44514	35190	31497	13215	10602
Recurring Costs										
Total Cost	20578	21317	7427	6057	20380	29010	18213	21768	3926	3668
Input Costs	10597	10704	3872	2584	8932	12462	5861	9270	1028	1596
(as % of total cost)	51	50	52	43	44	43	32	43	26	43
Operations Cost	9284	9781	2274	2193	1320	1822	5010	3486	147	265
(as % of total cost)	45	46	31	36	6	6	28	16	4	7
Marketing Costs	0	0	1228	1138	0	0	0	0	33	624
Total Labor Cost	696	833	53	142	10127	14726	7341	9011	2718	1134
(as % of total cost)	3	4	1	2	50	51	40	41	69	31
Fixed Costs										
Fixed cost	10491	6083	0	0	719	0	0	0	6708	0
Labor										
Female family labor (days)	64	76	38	43	4	7	0	0	8	4
Female hired labor (days)	1	1	2	2	72	73	51	47	32	28
Male family labor(days)	84	96	70	44	10	8	0	0	88	47
Male hired labor(days)	43	52	0	0	70	85	86	85	31	23

[1] For gherkins and marigold all costs are for the most recent season completed, for one acre, which spans three months.
[2] For papaya, this is an annual figure that has been converted to an equivalent per month per acre.
[3] All costs and returns are in Indian Rupees.

6 Concluding Remarks

The findings of the paper underscore the variability in the treatment effects not only across contract farming schemes but also across farmers within a particular scheme. The presence of contract farmers who in fact might be better off not contracting or of those not contracting but who have much to gain from contracting holds the possibility of attrition and expansion (or more broadly, churning) in a contracting firm's portfolio of supplier farmers. This is key to understanding the dynamics of farmer participation and selection in the broader context of modern agro-food chains.

The net gains or losses that are associated with the participation suggest a complex pattern of sorting into schemes. While in broiler, it seems clear that farmers who do better than the average are selected, for gherkins it is evident that farmers who opt out of contracting do not have a comparative advantage participating.

The diversity and heterogeneity in sorting is valuable from a public policy perspective. It is important to recognize that there are diverse groups of farmers. Only a subset of them fare well participating in modern supply chains, others are likely to fare poorly irrespective of whether they participate or not. It is when farmers can do better with contracting, but are rationed out by the firm, that exclusion of farmers from contracting arrangements becomes a policy concern. As long as farmers opt out voluntarily, on account of perceived risks or because they fare better when not participating, there is less cause for concern with regard to farmer capacity to participate in contract farming arrangements.

References

Adamchik, V.A., and A.S. Bedi. 2000. "Wage differentials between the public and the private sectors : Evidence from an economy in transition." *Labour economics* 7:203–224.

Angrist, J.D., and J.S. Pischke. 2009. *Mostly harmless econometrics : An empiricist's companion*. Princeton.: Princeton University Press.

Barrett, C., M.F. Bellemare, M. Bachke, H. Michelson, S. Narayanan, and T. Walker. 2012. "Smallholder market participation in evolving agricultural value chains: Comparative evidence fromfive countries." *World Development* 40(4):715–730.

Bellemare, M.F. 2010. *As you sow, so shall you reap: The welfare impacts of contract farming*. Working Paper,Duke University.

Birthal, P., P. Joshi, and A. Gulati. 2005. *Vertical coordination in high-value commodities*. International Food Policy Research Institute (IFPRI).

Cadot, O., M. Olarreaga, and L. Dutoit. 2006. *How costly is it for poor farmers to lift themselves out of subsistence?*. Washington, D.C.: World Bank, Development Research Group, Trade Team.

Cai, J., L. Ung, S. Setboonsarng, and P. Leung. 2008. "Rice Contract Farming in Cambodia: Empowering Farmers to Move Beyond the Contract towards Independence." *Asian Development Bank Institute, Discussion Paper No.109*, pp. .

Dehejia, R., and S. Wahba. 2002. "Propensity Score-Matching Methods for Nonexperimental Causal Studies." *The Review of Economics and Statistics* 84:151–161.

Dev, S.M., and C. Rao. 2005. "Food Processing and Contract Farming in Andhra Pradesh: A Small Farmer Perspective. Review of Agriculture." *Economic and Political Weekly* 40(26):2705–2713.

Dileep, B.K., R.K. Grover, and K.N. Rai. 2002. "Contract Farming in Tomato: An Economic Analysis." *Indian Journal of Agricultural Economics* 57:197–210.

Dutoit, L. 2008. *An analysis of agricultural development and the market : An econometric survey*.

Dutoit, L.C. 2007. *Heckman's Selection Model, Endogenous and Exogenous Switching Models: A survey*. The Selected Works of Laure C Dutoit. Available at: http://works.bepress.com/lauredutoit/3. Accessed December 12, 2010.

Fuglie, K.O., and D.J. Bosch. 1995. "Economic and Environmental Implications of Soil Nitrogen Testing: A Switching-Regression Analysis." 77:891–900.

Gulati, A., K. Ganguly, and M.R. Landes. 2008. "Toward Contract Farming in a Changing Agri-food System." In *Contract Farming in India :A Resource Book*. New Delhi: ICAR,IFPRI, USDA.

Haque, T. 2000. "Contractual Arrangements in Land and Labour Markets in Rural India." *Indian Journal of Agricultural Economics* 55(3):233–252.

Haque, T., and P. Birthal. 1998. *Future of farming in India: Contract or cooperative farming*. Papers presented at National Seminar on Cooperative Farming vs Contract Farming, Indian Social Institute in 1998.

Kumar, P. 2007. "Contract Farming through Agribusiness Firms and State Corporation: A Case Study in Punjab." *Economic and Political Weekly* 41:5367.

Lee, L.F. 1978. "Unionism and Wage Rates: A Simultaneous Equations Model with Qualitative and Limited Dependent Variables." *International Economic Review* 19:415–433.

Lokshin, M., and Z. Sajaia. 2004. “Maximum likelihood estimation of endogenous switching regression models.” *Stata Journal* 4:282–289.

Maddala, G.S. 1983. *Limited-dependent and qualitative variables in econometrics*. Cambridge, U.K. and New York: Cambridge University Press.

Maertens, M., and J.F.M. Swinnen. 2009. “Trade, Standards, and Poverty: Evidence from Senegal.” *World Development* 37:161–178.

Manrique, J., and K. Ojah. 2003. “The demand for housing in Spain: An endogenous switching regression analysis.” *Applied Economics* 35:323–336.

Minot, N. 2008. “Contract Farming in Developing Countries: Patterns, Impact, and Policy Implications.” In P. Pinstrup-Andersen and F. Cheng, eds. *Case studies in food policy for developing countries*. Ithaca, N.Y.: Cornell University Press, vol. 6-3.

Minten, B., L. Randrianarison, and J.F.M. Swinnen. 2009. “Global retail chains and poor farmers: Evidence from Madagascar.” *World Development* 37:1728–1741.

Miyata, S., N. Minot, and D. Hu. 2009. “Impact of Contract Farming on Income: Linking Small Farmers, Packers, and Supermarkets in China.” *World Development* 37:1781–1790.

Narayanan, S. 2010. “Contract farming as frictional equilibria: A Theoretical Perspective with Empirical Evidence from India.”

Narrod, C., D. Roy, J. Okello, B. Avendao, K. Rich, and A. Thorat. 2009. “Public-private partnerships and collective action in high value fruit and vegetable supply chains.” *Food Policy* 34:8–15.

Rangi, P.S., and M.S. Sidhu. 2000. “A Study on Contract Farming of Tomato in Punjab.” *Agricultural Marketing* 42(4):15–23.

Rao, E.J., and M. Qaim. 2011. “Supermarkets, farm household income, and poverty: Insights from Kenya.” *World Development* 39(5):784–796.

Reardon, T., and A. Gulati. 2008. “The supermarket revolution in developing countries.” *Policies for Competitiveness with Inclusiveness. IFPRI Policy Brief* 2.

Simmons, P., P. Winters, and I. Patrick. 2005. “An analysis of contract farming in East Java, Bali, and Lombok, Indonesia.” *Agricultural Economics* 33:513–25.

Singh, S. 2007. “Leveraging contract farming for improving supply chain efficiency in India: Some innovative and successful models.” pp. 317–324.

Swain, B.B. 2008. “The role of contract farming in agricultural development in a globalized world: An institutional economics analysis.”, pp. .

Swinnen, J.F.M. 2007. *Global supply chains, standards and the poor : How the globalization of food systems and standards affects rural development and poverty*. Wallingford, U.K. and Cambridge, MA: CABI.

Tripathi, R.S., R S, and S. Singh. 2005. “Contract Farming in Potato Production: An Alternative for Managing Risk and Uncertainty.” *Agricultural Economics Research Review* 18:47–60.

The Heterogeneous Welfare Impacts of Participation in Contract Farming Schemes: Evidence from Southern India

Sudha Narayanan

Indira Gandhi Institute of Development Research (IGIDR)

General Arun Kumar Vaidya Marg

Goregaon (E), Mumbai- 400065, INDIA

Email (corresponding author): sudha@igidr.ac.in

Abstract

Assessing the extent of welfare gains to participation from contract farming arrangements is important to be able to make a case for promoting contract farming as a way for smallholders to capitalize on the opportunities offered by modern supply chains. At the same time, empirical accounts of contract farming schemes in developing countries not only suggest high mortality rates but also show that many schemes have high farmer exit or attrition rates, indicating that farmer experiences might be variable.

This paper demonstrates the heterogeneity of welfare impacts of contract farming participation by estimating an endogenous switching model using survey data for 474 farmers in four commodity sectors, gherkins, papaya, marigold and broiler. The study shows that net welfare gains vary widely both across contract commodities and across farmers within a commodity sector. While contracting in papaya and broiler is associated with improvements in net profit per month for those participating and potential improvements of 47% and 123% for current non-participants, the impacts for gherkins and marigold are more ambiguous.

The standard deviation of point estimates of treatment effects is quite large indicating variability in welfare gains from contracting to different farmers even within the same commodity sectors. It is therefore important to recognize that notwithstanding the sign of average treatment effects, contract farming arrangements have diverse impacts on income for individual farmers that potentially trigger farmer attrition from these arrangements.

Keywords: contract farming, endogenous switching model, average treatment effects, India

JEL Code: Q12,Q13,Q18

Acknowledgements:

This study was completed when I was a Visiting Postdoctoral Fellow at the Centre for Development Economics, Delhi School of Economics during 2011. The fieldwork on which this study is based was supported financially by the American Institute of Indian Studies' Junior Research Fellowship (2006), IFPRI-New Delhi Office, the Borlaug-Leadership Enhancement in Agriculture Program (LEAP) Fellowship (2008), AAEA Foundation's Chester McCorkle Scholarship (2008) and the Ithaca First Presbyterian International Student Fellowship (2007). I thank Uma Mageswari, Anbarassan, Geetha Krishnamurthy and S.Vannamalar, graduate students of the Department of Agricultural Economics, Tamil Nadu Agricultural University (TNAU), Coimbatore, for field support and M.Chandrasekaran (TNAU), Bart Minten (IFPRI-NDO) and Christopher Barrett (Cornell University) for providing valuable advice and guidance in shaping the project. The current version has benefitted from inputs from Chris Barrett, William Lesser, Stefan Klonner and seminar participants at Cornell University.