Grower Heterogeneity and the Gains from Contract Farming: The Case of Indian Poultry

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Abstract

This paper offers an empirical analysis of contract farming for poultry in the southern state of Andhra Pradesh in India. The literature contains comprehensive discussions about the pros and cons of contract farming as a mechanism of vertical coordination in the supply chain relative to other organizational forms. But quantiative analyses are few. This paper does three things. First, it adds to the small and growing body of work that estimates the income gains to contract growers. Second and going beyond existing work on developing countries, this paper also addresses the risk benefits from contracting. We are able to do this because our data set contains observations from repeated production cycles of poultry growers. Thirdly, the paper estimates the income gains from contracting to the processing firms as well. The paper shows that the poultry integrators in Andhra Pradesh are able to appropriate almost the entire efficiency gains from contracting. Yet, the contract growers are better off with the contract. This outcome is because of grower heterogeneity and the way it is employed in the selection of contract growers.

Keywords: Contract Farming, Contracting, Poultry, Vertical Integration

JEL Codes: L230, L240, Q130

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1. Introduction

Contract farming has been described by Glover (1987) as an institutional arrangement that combines the advantages of plantations (quality control, coordination of production and marketing) and of smallholder production (superior incentives, equity considerations). These theoretical benefits, notwithstanding, contract farming has been controversial and has been criticized for being exploitative (Little and Watts, 1994, Singh, 2002).

Between the giant corporation and the small grower, bargaining power surely lies with the former. So why would not processors offer contracts that push growers to their reservation utility? Also, in practice, growers have encountered problems with respect to manipulation of quality standards, poor technical assistance, and sometimes plain cheating and deliberate default (Glover, 1987). As a result, Glover (1987) concluded that research must "systematically examine successes and failures and from then draw generalizations about the conditions under which CF (contract farming) can operate profitably and to the benefit of small farmers" (p 447).

This paper offers an empirical analysis of contract farming for poultry in the southern state of Andhra Pradesh in India. The contract growers undertake production for the so-called integrators. These are firms that raise grandparent and parent flocks, and supply day-old-chicks, feed and veterinary services to contract producers. The fully-grown broilers are bought back by the integrators and sold in wholesale markets. India's poultry industry also has partially integrated enterprises that do not undertake contract production and specialize in supplying feed or day-old-chicks to independent non-contract growers.

Integrator firms have the option of buying birds from independent growers, and similarly, contract growers have the option of being independent growers. Therefore, relative to this alternative, both parties in the contract relationship must benefit from it. When does this happen? Does it require contract production to produce a surplus relative to non-contract production? Is this observed in contract poultry production and if so, how is it distributed between the integrator and the growers? These are the questions to which the paper seeks answers.

The literature contains comprehensive discussions about the pros and cons of contract farming as a mechanism of vertical coordination in the supply chain relative to other organizational forms.[1] The basic message is that in some circumstances, spot markets may not offer sufficient vertical coordination. On the other hand, full vertical integration can be very costly. For processors, contract farming offers a way out – it provides for vertical coordination without all the costs of vertical integration. However, if contract farming is to be observed, growers must gain too. The sources of their gains may lie in price insurance, access to cheaper credit and higher incomes. Previous work has also discussed what kinds of growers are more likely to be under contract – in particular, whether the selection of contract growers is correlated with grower size and wealth.

[1] For contract farming experiences in different parts of the world, see Glover and Kusterer (1991), Key and Runsten (1999), Little and Watts (1994), Porter and Phillips-Howard (1997), and Singh (2002). Besides the above, papers that discuss the economic logic of these contracts include Glover (1984 and 1987), Grosh (1994), Simmons, Winters and Patrick (2005) and Winters, Simmons and Patrick (2005).

While the literature on contract farming is extensive, it does not, with few exceptions, offer estimates of what growers gain from contracting. This paper does three things. First, it adds to the small and growing body of work that estimates the income gains to contract growers (for instance, Miyata, Minot and Hu (2007), Simmons, Winters and Patrick (2005), Warning and Key (2002), and Winters, Simmons and Patrick (2005)). Second and going beyond the above cited work, this paper also addresses the risk benefits from contracting. We are able to do this because our data set contains observations from repeated production cycles of poultry growers. Thirdly, the paper estimates the income gains from contracting to the processing firms as well. The paper shows that the poultry integrators in Andhra Pradesh are able to appropriate almost the entire efficiency gains from contracting. Yet, the contract growers are better off with the contract. This outcome is because of grower heterogeneity and the way it is employed in the selection of contract growers.

The next section describes the analytical methods used to estimate income gains for processors and growers. Section 3 explains the poultry contract in Andhra Pradesh. This is followed in section 4 by a discussion of the data and descriptive statistics. The income gains to poultry integrators from contracting are estimated in Section 5. The focus of section 6 is to estimate the expected income gains to contract growers. Through a probit equation, we first evaluate the factors that matter to their participation in contracting. Having established the non-random selection of contract growers, the estimation of income gains is considered within a treatment effects model. The risk benefits from contracting are estimated in section 8. Concluding remarks are gathered together in section 9.

2. Estimating Income Gains: Analytical Methods

Using data from poultry contract production in Andhra Pradesh, this paper estimates the gains from contracting to integrators or wholesalers and to contract growers. This section describes the methods used for this purpose.

The gains to integrators can come from either (a) higher quality and hence price premiums and/or (b) lower costs of procuring birds. In our case study, we did not find evidence of price premiums. Integrators lack a presence in the retail market and branding is still at a preliminary stage. The principal gains therefore lie in lower costs than the alternative – which is to procure birds from independent growers.

Let P_c be a wholesaler's cost of procuring a bird from a contract grower. Then it can be written as

(1) $$P_c = F_c + C_c + M_c$$

where *F* is the grower's production cost (principally feed and medicines), *C* is the credit costs for financing the inputs during the production cycle and *M* is the grower's income margin on each bird. Note that if the integrator advances all or most of the production inputs to the grower, *C* is the credit cost to the integrator rather than the grower.

Alternatively, a wholesaler can obtain birds from non-contract growers. Letting *n* subscript non-contract grower, the cost of procuring from non-contract growers is

(2) $$P_n = F_n + C_n + M_n$$

As the non-contract grower finances the working capital, *C* is the credit cost to the grower here.

Comparing (1) and (2), we obtain the gains from contracting for an integrator.

(3) $$P_n - P_c = (F_n - F_c) + (C_n - C_c) + (M_n - M_c)$$

($P_n - P_c$) are the cost savings from contract production. Although straightforward, the literature does not contain estimates of contracting gains to processors.

Clearly, wholesalers would want to integrate only if the cost of procuring birds from contract growers is lower than the alternative – that of purchasing birds from independent growers. In particular, the integrator must be able to reduce one or all of the cost components. Note that it is possible that integrators contract out production even if there is no gain in production efficiency as long as the other two cost components are lower. Credit costs would be lower in contract production if the integrator can access funds cheaper than independent growers, which could happen if credit markets are imperfect. Grower margins can be lower in contract production only if growers are heterogenous and if, for some reason, contract growers are willing to accept lower margins. If all growers are identical, then grower margins in contract production cannot be lower than in non-contract production.

The second part of our analysis is to estimate the income gains to contract growers from contracting. $(M_c - M_n)$ is the difference in average income (on unit bird) between contract and independent growers. However, in general, this is not the correct measure of the gains to contract growers because they may be systematically different in terms of characteristics such as education, experience and ability from independent growers.

To take this into account, we adopt the treatment effects models from the program evaluation literature. In a regression framework, the treatment effects model is given by

(4) $$R_i = a + bC_i + \mathbf{c}'\mathbf{X}_i + \varepsilon_i$$

where R_i is the net returns of the *i*th producer, C_i is a dummy variable that takes the value 1 if grower *i* is in contracting and takes the value 0 otherwise. $\mathbf{X}_i$ is a vector of control variables and ε 's are zero mean random variables. b measures the impact of contracting on mean returns.

Ordinary least squares estimates of (4) are typically biased because the contract dummy is likely to be correlated with unobserved omitted variables, such as ability, captured in the disturbance term. To obtain consistent estimates, we present regressions where the contract dummy is instrumented. The alternative is to augment (4) by a selectivity correction term and to estimate the equation by ordinary least squares.

The selectivity correction approach was used by Warning and Key (2002) to estimate the gains in income among peanut farmers in Senegal who opted for contracting. Based on village surveys of reputations of individuals, they constructed an honesty variable for each contracting and non-contracting farmer in their sample. This served as an identifying variable in their sample selection model as it might be expected to matter in the participation equation but not in the income equation. Their findings recorded a sizeable increase in income from contracting. However, their selectivity correction term was not significant suggesting that either the farmers were not purposively selected or that their instrument was not good in explaining the variation in participation.

Miyata, Minot and Hu (2007) also use selectivity correction to estimate income gains for contract growers of apples and green onions in Shandong Province of China. The identifying variable in their model is the distance between the farm of a household and the farm of the village leader as the latter plays a role in selecting farmers for participation in contract farming. They find that contracting is associated with higher incomes. However, like in the Warning and Key paper, the selectivity correction is not significant in their sample either.

Simmons, Winters and Patrick (2005) estimate the income gains for contract growers of seed corn in East Java, seed rice in Bali and broilers in Lombok, Indonesia. Because of the difficulty of finding noncontract growers of these products, their approach is to collect information on all agricultural household activities and to compute and compare the returns to all agricultural activities (and not just to the contracted activity) across contract growers and noncontract growers. The predicted probability from a contract participation equation is used to instrument the contract participation dummy in a gross income regression. The coefficient of this dummy was positive and significant in the case of seed corn and broilers and insignificant for seed rice. Using the Hausman test, the endogeneity of the contract dummy was confirmed for seed corn but was rejected for seed rice and broilers. Winters, Simmons and Patrick (2005) use a similar approach to estimate income gains for contract farmers growing hybrid seed corn in East Java, Indonesia.

3. Contracting in Poultry Production

In a poultry contract, integrators provide day-old chicks, feed and medicines to contract growers. The contract growers supply land, labor and other variable inputs (like electricity). At the end of the production cycle, the grower receives a net price (by weight) that is pegged to an industry price set by a group of integrators (not the retail price). The industry price fluctuates within a narrow range and is a lot more stable than the retail price. Thus, the grower, it would seem, receives considerable price insurance.

For sharp upward deviations of the retail price from the industry price, growers receive an incentive. This practice presumably lessens the incentives to default on the part of growers and reflects the competition from the non-contract sector.

The grower is insured for mortality rates upto 5%. Beyond that the grower bears the risk of loss. This controls moral hazard and provides incentives for growers to supply their best effort. A company representative who sorts out problems especially regarding disease visits the grower daily. According to company accounts, the integrators spend time and resources in screening producers for reputation and prior experience.

The broiler contract is an instance of a “production management” contract where the integrator supplies inputs and extension, advances credit (in kind), provides price insurance and monitors grower effort through frequent inspections.[2] The detailed monitoring is because of the considerable credit advanced by the integrator that provides more than 90% of the cost of production in terms of the value of inputs. Because the frequent monitoring controls for moral hazard, it is also conducive to insurance. The frequency of contact would also mean that the integrator incurs transaction costs.

4. Data and Descriptive Statistics

The data was collected from a primary field survey of contract and non-contract producers. The survey was undertaken in the year 2002-03 to collect the required information for the year 2001-02. The sample was stratified into contract and non-contract growers and within each of these strata, 25 growers were randomly picked. Thus, a total sample of 50 growers was randomly selected. As poultry growers are

[2] The terminology is taken from Minot (1986) who classified contracts according to the intensity of contact between the integrator and the grower. The production management contract involves the most contact.

widely dispersed with often not more than couple of growers in a village, the sampling strategy was to randomly pick villages from a census list and then to choose all poultry growers within a village. The census list of villages was restricted to Rangareddy, Mehboobnagar and Nalagonda districts in Andhra Pradesh.[3]

A majority of the contract growers were associated with a leading poultry integrator.[4] Survey data was based on recall memory of the households but it was also supplemented with records maintained by both contract and non-contract producers. Besides information about the growers, data was collected about the inputs, output and prices for the last six production cycles of each grower. Due to some missing data, we have, in all, data from 285 production cycles from our sample of 50 growers. As we will discuss later, a production cycle is about six to seven weeks. Allowing for gaps between cycles when facilities are cleaned and renewed, the data correspond to about one year's production.

Table 1 contains information about village infrastructure measured by distance to various facilities such as urban centres, railways, regional rural bank, animal feed shop among others. It shows that contract and non-contract growers are different with respect to access to infrastructure. The big difference lies in the better access of non-contract growers to credit facilities whether it is the cooperative credit society or the regional rural bank or the primary dairy cooperative society.

[3] Contract growers were picked from 16 villages and non-contract growers were chosen from 8 villages.
[4] Twenty growers were associated with Venkateshwara Hatcheries and remainder with two other firms. At the time of the survey, Venkateshwara Hatcheries were dominant and other integrators were not important in the region. So a larger sample would not have thrown up producers contracting with different integrator firms. Today, the competition is much greater and it is unlikely a single integrator will dominate a representative sample of growers.

Table 2 summarizes the differences between contract and non-contract growers in terms of individual characteristics. Notice that the sample of non-contract growers are twice as experienced, slightly more educated and yet a little younger than contract growers. The sample of non-contract growers also contains a substantially higher proportion of growers who are specialized in poultry farming. On the other hand, poultry production is a subsidiary activity for majority of the contract growers. The table also shows that only 58% of contract growers (as opposed to 75% of independent growers) had a background in agriculture related activities in terms of their previous occupation. Examples of previous non-agricultural background for a contract grower includes occupations in sectors such as pharmaceuticals, electrical hardware, cement, police, clothes and wine retailing. Consistent with their previous occupational background, contract growers own less land than non-contract growers.

The survey collected information about the inputs, outputs and revenues from the last 6 production cycles of each grower. The production process in poultry consists of transforming baby chicks into fully-grown birds. Besides chicks, the inputs into this process are feed, medicine, labor and time. Table 3 presents information about input use and costs per production cycle for contract and non-contract growers. Note that the numbers are averaged twice – first over production cycles for each grower and then across all growers. Non-contract growers have longer production cycles and lower flock sizes and correspondingly lower total variable costs. They also use less hired labor (possibly because of their lower flock size) and capital.

The most striking difference between contract and non-contract growers comes about in the provision of inputs. In the case of contract growers, integrators supply chicks, medicine, feed and veterinary services. Growers supply land, buildings, labor, and other variable inputs such as electricity and disinfectants. As a result, the integrator supplies most of the inputs measured in value terms (last row of Table 3). On average, the out of pocket expenses for inputs for contract growers is less than 3% of total input costs. Thus, in kind provision of credit is an important feature of contract production. For the growers not on contract, the value of inputs supplied by them is the same as their total cost of their variable inputs.

The variable cost structure is, however, comparable across contract and non-contract growers. As can be seen in Table 4, feed, medicine and veterinary services accounts for about 75% of total variable cost. The expenditure on chicks is about 20-22% of cost while other variable costs such as labor and electricity constitute only 3% of total costs.

Table 5 compares the outputs and income (from bird sales) of contract and non-contract producers across all production cycles. As contract producers have larger flock sizes, their output is also larger whether measured by the number of birds or the total weight of birds sold. However, the average weight of a bird is pretty much the same across contract and non-contract growers.

The income from a production cycle is calculated as the difference between revenues and variable input costs. Revenues are from the sale of grown chicks, litter and bags. The value of home consumption, if any, is also imputed to revenues. Inputs consist of chicks, feed, medicine, vaccine, litter, veterinary fees, labor, electricity and disinfectants. For contact growers, however, the processor advances most of the value of inputs. Compared to the non-contract grower, the contract grower needs very little working capital and therefore incurs negligible interest costs. However, this is not so for the independent growers and interest costs must be netted out from their income. Table 5 reports the average income per production cycle on the assumption that growers face an interest cost of 15% per annum. Contract growers have higher incomes. To see whether this is due to larger flock sizes, the last row also reports the average income per kilogram of bird. Although contract growers report higher returns per kilogram, the difference is not statistically significant. The sensitivity of these results to the interest rate and the justification of using a 15% interest rate are discussed in the next section.

5. The Relative Efficiency of Contract Production: Gains to Integrators

In this section, we investigate the possible ways in which the integrator gains from contracting out poultry production. As noted in section 2, the gains to the integrator must stem from lower costs (relative to independent growers) on production, credit and grower's margin.

As feed is the major input in growing birds, the poultry industry evaluates the technical efficiency of production process by the feed-conversion ratio, i.e., the number of kilograms of feed required to produce a kilogram of bird. The relation between feed and output is approximately linear. Regressing feed quantity on output, the feed-conversion ratios as 1.88 and 2.15 for contract and non-contract growers, i.e., it is contract production that is more efficient.[5] It is important to note that this does not mean that by switching to a contract, the independent grower will achieve a feed-conversion ratio of 1.88. Independent growers differ from contract growers in various observable

[5] The R^2 in the regressions were 0.98 and 0.89 respectively for non-contract and contract growers. The intercept terms were positive but small. As a result, the average feed-conversion ratios are slightly larger than the marginal feed conversion ratios and this difference declines as output increases.

characteristics and possibly unobserved characteristics as well, which would have to be taken into account in predicting their performance in contract production.

For a more general analysis, we can compare cost functions. As the cost of poultry production is primarily the cost of chicks and feed, the technology is characterized by constant costs. Hence the cost function can be captured by a linear regression of total costs on bird output (measured in kilograms). Recall that the data set consists of observations from upto 6 production cycles for 25 contract and 25 non-contract growers. Thus, the error term will contain a producer-specific component. To take that into account, all standard errors are corrected for heteroskedasticity as well as dependence stemming from the correlation of errors from the production cycle of a particular producer. [6] The regression is done separately for contract and non-contract producers. The predicted value from these regressions is graphed against the dependent variable in Figures 1 and 2. As can be seen, the fit is very good.

From these regressions, we find the marginal cost of producing a kg of bird under contract production to be Rs. 30 while it is Rs. 26.22 under non-contract production. Thus, it is non-contract production that is efficient - which is the opposite of what was concluded from comparing feed-conversion ratios. However, as contracting is a form of joint production, it should be remembered that it is the integrators who determine the feed, medicine and chick costs of contract growers. Therefore, these numbers are not necessarily indicative of competitive prices but may well be a sign of transfer pricing.

To have cost figures that reflect competitive prices for feed and medicine, we recalculate contract production costs using the prices paid by non-contract growers.

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[6] These are simply the Huber-White standard errors corrected for correlation within clusters (Rogers, 1993, Wooldridge, 2002). Here a cluster consists of observations from different production cycles for a particular producer.

When this is done, we obtain the marginal (and average) costs for the contract grower as Rs. 24.8. Compared to the marginal costs for the non-contract grower of Rs. 26.2 per kg, contract production involves a saving (relative to procurement from non-contract growers) of Rs 1.4 for every kg of bird. This result is consistent with and is indeed driven by the lower feed-conversion ratio of contract production. Thus, even though integrators employ growers who are relatively inexperienced, production costs are lower because of better technology (e.g., breeding stock) and management practices.

The second way in which contract production could be cheaper than non-contract production is if the integrator can access credit at lower cost than the independent growers. Unfortunately, however, our analysis cannot say much about this at all since our data set lacks information on credit costs of independent growers and that of integrators. However, it is unlikely integrators face a credit cost disadvantage relative to the independent growers since the latter are more likely to be dependent on informal finance. From studies of rural finance, we know that informal credit is widely prevalent and that it is more costly than credit from institutional sources. According to the all India rural credit survey, formal sector accounted for 53% of all rural credit in 1991. Moneylenders and friends or relatives account for the rest. More recent data from the World Bank indicates that access to formal sector credit is very limited for poorer households. According to the same survey, the median interest from banks (the primary institutional source) in 2003 was 12.5% per annum while the average interest rate from informal sources was 48%. For credit from institutional sources, transaction costs are also significant. These arise because of distance to financial institutions, cumbersome procedures and bribes ranging from 10% to 20% of loan amount (Srivastava and Basu, 2004). As a result, the effective cost of credit from formal sources is likely to be greater than the median interest rate. A survey in 2001 of the poultry sector reports that interest rates on commercial loans were typically around 15% per annum (USDA, 2004). As informal credit is more costly than this, an interest cost of 15% per annum can be taken to be a lower bound to the cost of credit for non-contract growers.

The third way in which integrators can gain from contract production is through lower grower margins. As noted in section 2, margins cannot be lower for contract growers if they are drawn from the same population as non-contract growers. However, we saw in section 3, contract growers are relatively inexperienced suggesting that with the same technology, they are likely to be less productive than non-contract growers. Therefore, if independent, contract growers may not earn the same incomes as earned by the sample of independent growers. Tables 1 and 2 suggest that contract growers are more likely to be credit deprived and inexperienced in poultry production and thus more likely to have lower bargaining power than the experienced independent growers with access to credit.[7] While inexperience can increase production costs, integrators might still prefer contracting if it were more than compensated by lower grower margins (relative to independent growers).

In Table 5, however, we have already seen that the average income per kilogram of output from a production cycle of a contract grower is not statistically different from that of a non-contract grower. That computation assumed an interest rate of 15% per annum. At higher interest rates, the return to non-contract growers declines while

[7] Such a possibility was also noted by Key and Runsten (1999). The data in Tables 1 and 2 could be equally interpreted to say that it is the inexperienced and credit-deprived growers who find contracts appealing.

contract growers are almost completely insulated from credit costs.[8] This can be seen in Table 6. The standard errors of the difference in returns between contract and non-contract growers are corrected for heteroskedasticity and within cluster correlation (a cluster here consists of production cycles from a particular producer). Thus, lower grower margin is not a source of income gain to the integrator.

In sum, production efficiency seems to be the way in which integrators gain from contract production. It is likely they also enjoy some advantage in terms of interest arbitrage. However, there is no substantial saving in grower margins despite using inexperienced growers. Against these gains, integrators incur costs in repeated dealings with growers. Birthal, Joshi and Gulati (2007) have shown that these costs are of the order of Rs. 0.1 to Rs. 0.15 per kg. Therefore, the net gains from contracting remain substantial.

6. Gains to Growers: Income

In the previous section, we compared the average returns of contract growers with the average returns of non-contract growers. While this is useful to demonstrate the gains to integrators, it is a biased measure of the gains that accrue to contract growers because it does not take account of the fact that contract growers are not a random selection from the population of poultry growers. In fact, as we have seen, the non-contract growers in the sample are more experienced, slightly more educated and less likely to have non-agricultural backgrounds. Controlling for these factors is therefore important.

[8] Income margins of contract growers are lower only if interest rates are below 10%. As discussed in the text, borrowing rates even from the low-cost formal banking system are higher than this level.

Table 7 reports the estimates of probit participation equations (in contracting). From column (1), it can be seen that years of schooling, experience, adults in the household and ownership of land (unirrigated and irrigated) positively affect the probability of being an independent non-contract grower. In addition, growers who are at more distance from credit facilities, and with previous occupational backgrounds in non-agriculture are more likely to be contract growers.

Previous work on crop contracts has also found that age and education are positively correlated with being a non-contract grower (Miyata et.al, 2005; Simmons et.al, 2005; Winters et.al, 2005).[9] These results are consistent with anecdotal accounts in poultry of processors wishing to contract with growers with weak bargaining power. In addition, Simmons et.al (2005) find in their analysis of broiler contracts in Lombok, Indonesia that participation was negatively influenced by ownership of irrigated land. They interpret this finding as indicating that the contract "may be more attractive to smaller farmers who have limited potential for crop production". In our results, we too find that land ownership (especially unirrigated land) negatively affects participation in the contract. Furthermore, participation is more likely if the previous occupational background was in non-agriculture. This lends additional support to the interpretation advanced by Simmons et.al (2005).

In their review of contract farming, Key and Runsten (1999) pointed out that the factors that disadvantage small growers (such as lack of access to formal credit and insurance) also provide incentives for processors to contract with them. This observation was empirically supported by Simmons et.al (2005) who found selection as contract

[9] In these papers, experience is not separately included and therefore age and experience effects are not separated. In this paper, age is not significant (and not reported) given experience. Therefore, it is the experience effect that matters.

farmer to be positively correlated with credit constraints. In our results, the distance to rural banks is a measure of access to credit. This measure is positively associated with selection as a contract grower.

One possibility is that this result is driven by a correlation between the distance to rural banks and the distance to other infrastructure facilities in which case we could not interpret the distance to rural banks variable as a measure of access to credit. However, this is ruled out by the estimates of column (2) where we find that the magnitude and significance of the distance to rural banks variables is robust to inclusion of a variable proxying for access to other infrastructure – namely distance to urban centres.

As discussed in section 2, our estimates of income gains to contract growers control for the non-random selection of contract growers by a treatment effects model as in (4). Estimates of (4) are presented in Table 8 (assuming an interest rate of 15%). In all estimates, standard errors are corrected for heteroskedasticity and within cluster correlation. Column 1 presents ordinary least squares estimates when no controls are included. Column 2 contains estimates from ordinary least squares (OLS) regressions with controls. The estimate of the impact of contracting does not change much. It is not significant in either specification. [10]

The control variables consist of years of schooling, experience, land endowments, labor endowments (number of adults in household), distance to urban centres (to measure access to infrastructure) and seasonal impacts. Season is a variable that takes values from 1 to 12 and identifies the month in which production begins. Thus a production cycle with a season code of 1 begins production in early January and the output enters the

[10] We also ran these regressions assuming interest costs to growers are 20%, 25% and 30%. As one would expect, the average treatment effect is greater and statistically more significant, higher is the interest rate.

market after mid-February. The season variable is meant to take account of the seasonality in prices and production. As the seasonal trend is quadratic, we have also included the squared term of season. Neither land nor labor endowments are significant indicating that their advantages are fully captured in costs and net income. The distance to urban centres is also insignificant suggesting a similar interpretation. Experience and the seasonal trend are the strongly significant variables.

A variable that is omitted in the above specification is ability, whether as a poultry grower or as a business manager. If this variable is correlated with the contract dummy, ordinary least squares estimates are inconsistent. Individual specific fixed effects cannot be used to control for ability as the contracting status does not vary over the production cycles for which we have data. Instead, as discussed in section 2, we use instruments to correct the bias from the omitted variable.

Instrument variable (IV) estimates of (4) are presented in the third and fourth columns of Table 8. In the third column, the contract dummy is instrumented by grower's distance from a regional rural bank. From the probit estimates in Table 7, this variable is correlated with the contract dummy (as will be seen in Table 9 below). Furthermore, conditional on the variables in the **X** matrix (especially experience, schooling and access to infrastructure), ability whether in poultry or in business management, should not depend on location. Hence the distance from rural bank is a valid instrument.

Column 4 of Table 8 uses an additional instrument as well – a dummy for whether the previous occupation was in non-agriculture. This variable is correlated with contract status but would it be uncorrelated with ability? If those with low ability choose non-agricultural occupations, then previous occupation dummy is likely to be correlated with poultry growing ability. However, such an argument supposes that those with initial careers in non-agriculture had the choice of pursuing a career in poultry production. This is unlikely to be generally true because family background (especially father's occupation in the Indian context) and information (technical and business expertise in poultry production) are important determinants of the set of initial job alternatives that an individual would consider. Furthermore, there is no compelling reason for management ability to be correlated with the previous occupation dummy. The estimates in column 4 easily pass the Hansen statistic for overidentification.

The instrument variable estimates of the average treatment effect are larger and statistically more significant than the OLS estimates. The IV estimates are significant at the 5% level. Comparison with the OLS estimates shows that correction for unobservables is important. The OLS estimates underestimate the gain from contracting because the unobserved factors that matter for selection as contract grower negatively impact incomes from poultry farming. While the OLS estimates suggest modest impacts of between Rs. 0.15 – Rs. 0.2, the IV estimates are substantial at around Rs. 1.10. Considering average returns to a contract grower are Rs 2.2 per kg, contracting raises returns by around 50%.

7. Gains to Growers: Risk Shifting

Calculating the mean income gains from contracting provides only a partial picture of the change in utility for contracting producers. As mentioned before, a fundamental feature of contract farming is the shifting of risk from producers to processors. In this section, we exploit the data on production histories to estimate the extent of risk transfer from contract growers to integrators.

The most straightforward way to estimate risk shifting would be to compare the variability of net returns of contract growers with that of non-contract growers. But this comparison would once again be subject to bias because of the use of incorrect counter-factual. Knoeber and Thurman (1995) propose that the variability of net returns of contract growers be compared to the hypothetical or simulated returns that they would have received as "independent growers" i.e., if they had purchased inputs and sold their output at market prices and not contracted with the integrator. The counterfactual is one where the behavior of contract growers is held constant in terms of input decisions, labor and capital allocation. Given this behaviour, what would revenues and costs look if inputs and outputs were valued at market prices?

Let σ_i denote the standard deviation for the *i*th producer. This is calculated for each grower from the data on 6 production cycles. Also let σ_c and σ_n denote mean standard deviation for the group of contract growers and non-contract growers respectively. They are estimated as the sample means of the σ_i's and v_i's and are reported in the first two columns of Table 9. The computations assume the lowest possible interest rate of 15% per annum. The table also reports the standard errors of these estimates. The figures show that the variability of returns of non-contract growers exceed that of contract growers by a factor of 8 or 10 depending on the measure of variability (standard deviation or coefficient of variation). However the estimate of average variability for the non-contract growers is not very precise because of the large differences in variability within the non-contract group. The coefficient of variation ranges between 0.23 and 4.3 for non-contract growers while it ranges between 0.023 and 0.26 for contract growers.

Following the Knoeber and Thurman methodology, we simulate the returns that would have been received by contract growers if they had not been on contract. There are two components of the simulation. First, for the inputs advanced by the integrator (chicks, feed, medicine and vaccines), we value their cost using prices paid by non-contract growers. Second, we use the price received by non-contract growers for their birds, bags and litter to value the output of these items by contract growers. As the prices received (for output) and prices paid (for inputs) by non-contract growers are not identically the same, we use the median figure in all the cases. In all imputations, we use figures from comparable production cycles. For instance, the price used to value a contract grower's output from production starting in January would be the median price of non-contract growers in the same month.

From the simulated series, we construct once again the mean and standard deviation of returns. Let s_i denote the standard deviation of the simulated series for the ith producer. Also let s_c denote the mean standard deviation for the group of contract growers. This is reported in the last column of Table 9. As can be seen, the variability of the simulated series for contract growers is almost of the same order of magnitude as the variability of returns for non-contract growers, even though the "behaviour" of contract growers is held constant. Therefore, the difference in variability of returns between contract and non-contract growers is almost entirely due to differences in variability of input prices paid and output prices received. Differences in "behaviour" are unimportant.

On average, the standard deviation of the simulated series is more than 8 times greater than that of the actual series.

For each individual grower we compute the ratio of the standard deviation of the simulated series to the standard deviation of the observed series. For the 25 contract growers, the average of this ratio is 13.4. The median ratio is 8.25 and the distribution ranges from a minimum value of 2.7 to a maximum value of 91. At the median ratio, growers under contracting bear only 12% of the risk that would have been borne by them as non-contract growers. In other words, 88% of the risk in poultry farming is shifted from growers to processors as a result of contracting.

The statistical significance of the reduction in variability can be assessed for each grower by testing the hypothesis that the simulated variance for the *i*th contract grower equals the variance of the observed series. As the simulated and observed series are correlated, Knoeber and Thurman derive a Wald statistic that takes this correlation into account. The statistic is

$$T_i = (s_i^2 - \sigma_i^2)/[(2/n)(s_i^4 + \sigma_i^4 - 2\rho_i^2)]^{1/2}$$

where for the *i*th producer, s_i^2 and σ_i^2 are the sample variances of the simulated and actual series, ρ_i^2 is the covariance between the two series and n is the number of production cycles. Under the null hypothesis that the variances of the two series are identical, the Wald statistic is asymptotically standard normal.

The median value of the Wald ratio is 1.69, which means that for 50% of contract growers the null of no difference in variability is rejected in favor of the one-sided alternative that the variability is greater in the simulated series at the 5% significance level. The smallest Wald ratio is 1.41. Hence the null is rejected in favor of the alternative for all growers at the 10% significant level. The reason that the differences are not statistically valid at the 5% level for some growers is because of the small number of production cycles as a result of which the differences in variability are estimated imprecisely.

The risk reduction from contracting can also be assessed by testing the null hypothesis that the median value of σ_i and s_i are equal. This can be done by making use of nonparametric tests for difference in medians using paired data. The paired data in this instance involves the observed and simulated standard deviations for each grower. The sign test considers the number of times the difference between the simulated and observed standard deviations is positive. The null is rejected if the number of differences of one sign is too large or too small (Gibbons and Chakraborti, 1992). In our case, the difference between the simulated and observed standard deviations is positive for each grower. Hence the null is rejected in favor of the alternative hypothesis that the median difference is positive.

If the distributions can be regarded as symmetric, one can also use the Wilcoxon signed-rank test. Here the absolute differences between the paired values are ranked and the test statistic is the sum of the positive signed ranks that is then compared to the tabulated critical values (Gibbons and Chakraborti, 1992). Here too the null is resoundingly rejected in favor of the alternative of positive differences at the 0% significance level.

9. Concluding Remarks

This paper has examined the gains to both integrators and growers from contracting in poultry production. As poultry is produced by contract and independent growers, the latter becomes the benchmark to assess the gains for both parties.

For integrators, contract production is more efficient. While they possibly also gain from interest arbitrage (not established in this paper), the surprising finding is that grower margins do not vary much between contract and non-contract growers. Therefore, a lower grower margin is not the strategy by which integrators sustain contract production. It also follows, that neither do integrators share the efficiency surplus with growers through higher grower margins.

However, contract growers do gain substantially in terms of risk reduction and even in terms of expected income. The key to the latter impact is that poultry integrators choose or growers self-select such that contract growers are those whose skills, experience and access to credit make them relatively poor prospects as independent growers. The provision of credit is the vital component of a poultry contract. With contract production, these disadvantaged growers achieve incomes comparable to that of independent growers. As a result, the integrator is able to receive the surplus from contract production (relative to procurement from independent growers) while offering at the same time significant gains to contract growers in terms of a reduction in risk as well as higher expected returns.

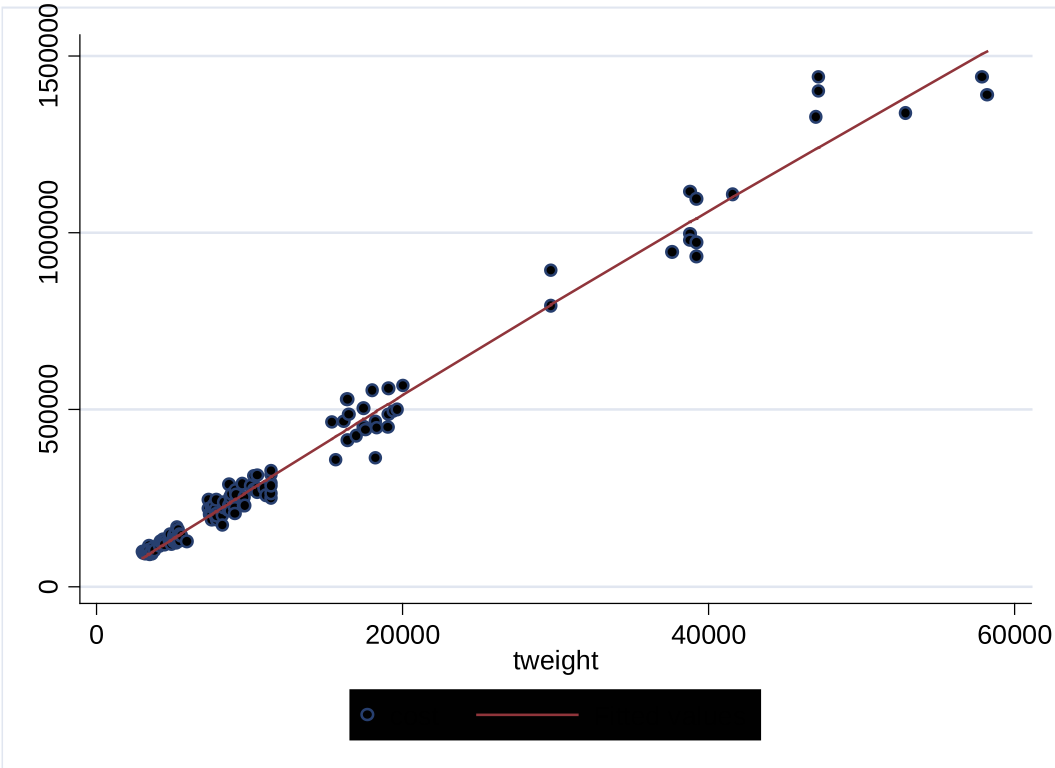
Crucial to this outcome are the improved technology and management practices that are employed in contract production. This results in lower feed-conversion ratio and is achieved by producers whose endowments are not as suited to poultry production as the independent growers. This is possibly due to standardization of production practices in contract production as contract growers exhibit a striking homogeneity in feed-conversion ratios and expected returns relative to independent growers. As this is achieved by close supervision on the part of the processor, contract farming in poultry can be seen as a response to double-sided moral hazard, which was put forward, by Eswaran and Kotwal (1985) to explain sharecropping.

The fact that contract production in poultry has benefited growers substantially suggests that these growers are not bereft of bargaining power. But what is the source of this bargaining strength? Why does not the processor offer growers a contract that is only slightly better than their reservation utility in their alternative enterprise (say as subsistence growers)? Poultry contracting involves the use of improved and standardised technology and production practices. This involves supply of inputs, close contact and training of the contract grower. Protecting this investment (in inputs and training) requires that default by growers and turnover in their ranks should be minimum. This in turn is achieved by processors offering above reservation utility contracts akin to efficiency wages. In its absence, the threat of denial of future contracts is not a major deterrent to default and defection by contract growers. Such threats are the primary means by which processors enforce contracts (Key and Runsten, 1999). A leading processor in India commented “Our rule is very clear – we will never work with you once you violate our contract” (interview with Executive Director, Pepsico Holdings Pvt. Ltd, Agriculture Today, September 2004).

The literature has recognized that the bargaining power of growers depends on the value of the alternatives at their disposal. For this reason, Glover and Kusteter (1990), for instance, suggest that the contract crop should not be the main one but one that is a second or third crop. Porter and Phillips-Howard (1997) recommend that contract farming should be allowed only in those areas where growers have alternatives. But as the poultry case shows, the processors might in fact want to choose farmers whose exit option is low. Their exit option is low not because they are locked into a contract or because their entire income is dependent only on contracting but because they cannot compete as independent growers. Even so, the growers possess some bargaining power as long as turnover in their ranks is costly for the company. The alternatives for the processor also need to be considered.

The poultry case study suggests that contract farming can be a useful institutional arrangement for the supply of credit, insurance and technology to growers – all of which are otherwise very demanding problems. The contract farming literature reminds us that these arrangements often fail because of opportunistic behaviour by either or both parties. In the poultry example, however, processor interests are closely aligned to that of the grower because of the massive provision of in-kind credit without collateral and grower compliance is purchased by efficiency wages. If either of these incentives are disturbed – for instance, if grower supervision were to become very expensive or if greater competition in the product market were to shrink grower benefits, then contract production may cease.

Figure 1: Cost Function for Non-contract Producers


0
500000
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1500000
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40000
60000
tweight

Figure 2: Cost Function for Contract Producers

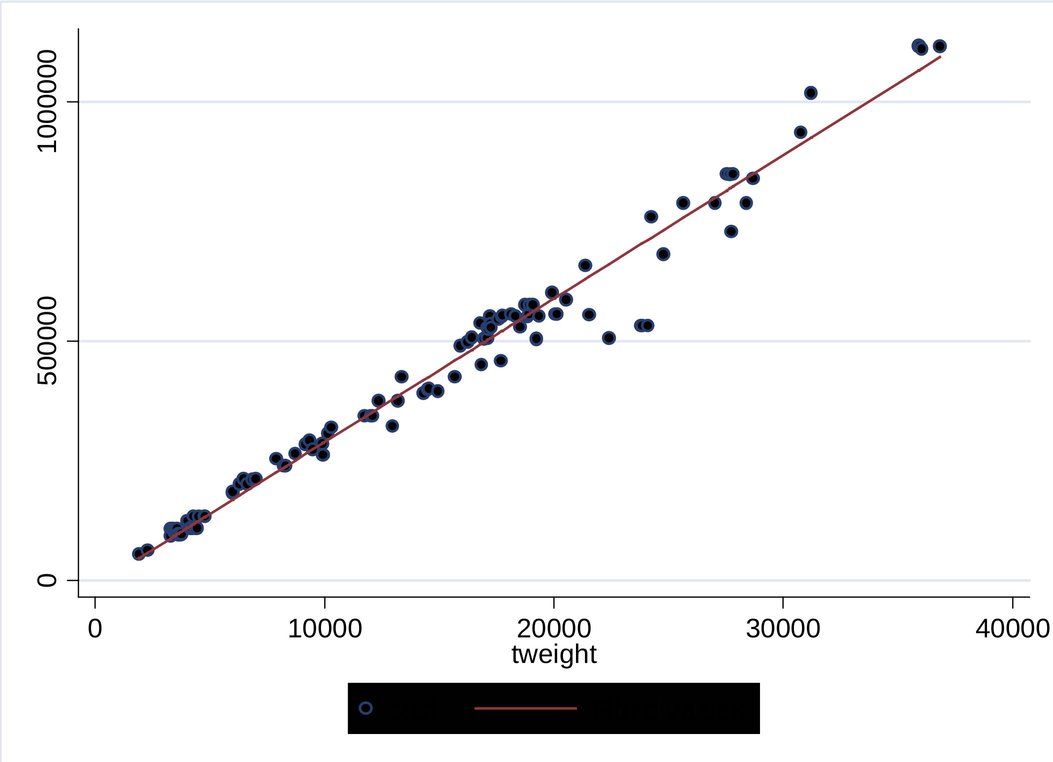

Table 1. Access to Infrastructure

			t-test of difference	
Item (distances in kilometres)	Non-contract	Contract	|t|	Prob > |t|
Distance to urban area	28.36	17.16	5.71	0.00
Distance to railway station	33.8	34.04	0.1	0.92
Distance to coop credit society	0.43	2.48	4.29	0.00
Distance to regional rural bank	1.2	6.84	7.64	0.00
Distance to commercial bank	1.28	6.28	8.69	0.00
Distance to primary dairy cooperative society	0.48	8.5	7.43	0.00
Distance to animal feed-shop	26.28	12.58	6.33	0.00
Distance to veterinary hospital	0.8	0.71	0.4	0.69

Table 2. Characteristics of Poultry Producers

			t-test of difference	
Item	Non-contract	Contract	|t|	Prob > |t|
Experience in poultry (years)	9.8	4.9	10.10	0.00
Age	36	39	3	0.003
Years of schooling	11.6	10.9	1.52	0.13
Number of adults in household	5.36	4.88	1.71	0.09
Proportion of farmers whose main occupation is poultry	72	36	6.7	0.00
Proportion of farmers whose earlier occupation was in agriculture/poultry/ dairy/ agricultural labor	75	58		
Land ownership (acres)	7.72	6.26	1.77	0.08

Table 3. Input Use by Poultry Producers
Averages Per Production Cycle

			t-test of difference	
Item	Non-contract	Contract	|t|	|t|
Flock size, # chicks	6,891	8,149	1.75	0.08
Time: Cycle length ,days	48.4	42.6	17	0.00
Feed quantity, quintals	276	277	0.06	0.95
Hired labor (days)	113	136	1.51	0.13
Family labor (days)	30	26	0.91	0.365
Proportion with borewells as water source	0.28	0.52	4.36	0.00
Number of Brooders	12	24	6.2	0.00
Number of Feeders	158	175	1.1	0.28
Total Variable Cost, Rupees	331,468	424,200	2.59	0.01
Value of inputs supplied by farmer, Rupees	331,468	12,249	11.93	0.00

Table 4: Cost Structure

Cost Structure		
Chicks, value, Rs. (% of total cost)	70,217 (20%)	96,558 (22.5%)
Feed & Medicines, Rs. (% of total cost)	251,058 (77%)	315,959 (74.5%)
Labor, electricity & other inputs, Rs. (% of total cost)	9,203 (3%)	10,344 (3%)

Table 5. Output and Revenues: Averages Per Production Cycle

			t-test of difference	
	Non-contract	Contract	|t|	|t|
Output: # of birds	6583	7808	1.78	0.08
Mortality: # of birds	302	388	2.48	0.014
Average total weight of birds sold (Kgs)	12105	13638	1.21	0.227
Average Weight per bird, Kgs	1.869	1.874	0.35	0.73
Average Income, Rupees	25,947	32,372	1.52	0.13
Average Income per kilogram of bird, Rupees per kg	2.05	2.2	0.73	0.47

Table 6. Returns to Poultry Producers:
Average Income Per Production Cycle (Rs/Kg)

Annual interest rate	Contract	Non-contract	Difference (t-value)
15%	2.20	2.05	0.15 (0.76)
20%	2.20	1.9	0.3 (1.49)
25%	2.19	1.66	0.44 (2.2)
30%	2.18	1.47	0.58 (2.84)

Standard errors corrected for heteroscedasticity and within cluster (producer) correlation.

Table 7: Probit Equation: Factors Influencing Participation in Contracting

	(1)	(2)	(3)
Explanatory Variables	Coefficients	Coefficients	Marginal Effects of (2)
Years of Schooling	-0.07***	-0.06**	-0.02**
	(0.02)	(0.02)	(0.010)
Experience	-0.7***	-0.9***	-0.3***
	(0.07)	(0.10)	(0.04)
Experience squared	0.03***	0.03***	0.01***
	(0.003)	(0.004)	(0.002)
# adults in household	-0.1**	-0.1***	-0.05***
	(0.04)	(0.05)	(0.02)
Whether previous occupation was in non-agricultural activity	0.8***	0.6***	0.2***
	(0.2)	(0.2)	(0.09)
Unirrigated land	-0.09***	-0.08***	-0.03***
	(0.02)	(0.02)	(0.008)
Irrigated land	-0.05*	-0.04	-0.02
	(0.03)	(0.03)	(0.01)
Distance from Regional Rural Bank	0.2***	0.2***	0.08***
	(0.03)	(0.02)	(0.009)
Distance from Urban Centre		-0.03***	-0.01***
		(0.005)	(0.002)
Constant	4.0***	5.3***	
	(0.5)	(0.8)	
Observations	50	50	50

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8. Income Equation

Dependent Variable: Income (Rupees) per kg per production cycle				
	(1)	(2)	(3)	(4)
Estimation Method	OLS	OLS	IV	IV
Contract dummy (Contract = 1)	0.15	0.16	1.09**	1.10**
	(0.20)	(0.21)	(0.52)	(0.55)
Years of Schooling		-0.00093	-0.0036	-0.0036
		(0.027)	(0.027)	(0.027)
Experience		0.17***	0.28***	0.28***
		(0.049)	(0.090)	(0.091)
Experience squared		-0.010***	-0.014***	-0.014***
		(0.0028)	(0.0042)	(0.0042)
# adults in household		0.035	0.063	0.063
		(0.044)	(0.055)	(0.056)
Unirrigated land		0.0060	0.021	0.021
		(0.026)	(0.032)	(0.032)
Irrigated land		0.018	0.026	0.026
		(0.017)	(0.019)	(0.020)
Distance from Urban Centre		-0.0079	-0.0017	-0.0017
		(0.0054)	(0.0051)	(0.0050)
Seasonal trend		-0.66***	-0.66***	-0.66***
		(0.13)	(0.13)	(0.13)
Seasonal trend squared		0.055***	0.055***	0.055***
		(0.010)	(0.010)	(0.010)
Constant	2.05***	2.85***	1.47	1.47
	(0.19)	(0.48)	(0.90)	(0.92)
Observations	285	285	285	285
R-squared	0.002	0.160		

Standard errors in parantheses corrected for heteroscedasticity and within cluster (producer) correlation.
*Significant at 10% level, **Significant at 5% level, ***Significant at 1% level

Table 9: Variability of Returns

	Non-contract	Contract (Observed)	Contract (Simulated)
Mean of Standard Deviations of Individual Growers (standard error)	$\sigma_n = 2.29$ (0.84)	$\sigma_c = 0.26$ (0.16)	$s_c = 2.17$ (1.29)

References

Birthal, P.S., P. K. Joshi and A. Gulati (2007), "Vertical Coordination in High-Value Food Commodities: Implications for Smallholders", in *Agricultural Diversification and Smallholders in South Asia*, Ed. P.K. Joshi, A. Gulati, and R. Cummings Jr, 405-440, New Delhi: Academic Foundation.

Gibbons, J. D. and S. Chakraborti, (1992), *Nonparametric Statistical Inference*, 3rd Edn., New York: Marcel Dekker.

Glover, D. (1987), "Increasing the Benefits to Smallholders from Contract Farming: Problems for Farmers Organizations and Policy Makers", *World Development*, 15(4): 441-448.

Glover D. and K. Kusterer, (1990), *Small Farmers, Big Business: Contract Farming and Rural Development*, London: Macmillan.

Eswaran, Mukesh and Ashok Kotwal, (1985), "A Theory of Contractual Structure in Agriculture", *American Economic Review*, pp 352-367.

Key, Nigel and David Runsten, (1999), "Contract Farming, Smallholders and Rural Development in Latin America: The Organization of Agroprocessing Firms and the Scale of Outgrower Production", *World Development*, 27 (2), 381-401.

Knoeber, C., and W. Thurman, (1995), "Don't count your chickens: Risk and risk shifting in the broiler industry," *American Journal of Agricultural Economics*, 77 (3), 486-496.

Little, P. D., and M. J. Watts, (1994), *Living Under Contract: Contract Farming and Agrarian Transformation in Sub-Saharan Africa*, Madison: University of Wisconsin Press.

Miyata S., N. Minot and D. Hu, (2007), "Impact of Contract Farming on Income", Discussion Paper 00742, Markets, Trade and Institutions Division, International Food Policy Research Institute, Washington D.C.

Minot, N. (1986), "Contract Farming and its effect on small farmers in less developed countries," Working Paper No. 31, Michigan State University International Development Papers.

Porter, G., and K. Phillips-Howard, (1997), "Comparing Contracts: An Evaluation of Contract Farming Schemes in Africa", *World Development*, 25 (2): 227-238.

Rogers, W. H. (1993), "Regression standard errors in clustered samples," *Stata Technical Bulletin*, 13: 19–23.

Simmons, P., P. Winters and I. Patrick (2005), "An Analysis of Contract Farming in East Java, Bali, and Lombok, Indonesia, *Agricultural Economics*, 33 supplement: 513-525.

Singh S., (2002), "Contracting out solutions: Political economy of contract farming in the Indian Punjab", *World Development* 30 (9): 1621-1638.

Srivastava, Pradeep and Priya Basu, (2004), "Scaling-Up Access to Finance for India's Rural Poor", Global Conference on Scaling Up Poverty Reduction, Shanghai, China

USDA, (2004), *India's Poultry Sector, Development and Prospects*, Agriculture and Trade Reports, Economics Research Service, WRS-04-03.

Warning, M., and Nigel Key, (2002), "The Social Performance and Distributional Consequences of Contract Farming: An Equilibrium Analysis of the *Arachide de Bouche* Program in Senegal," *World Development*, 30(2): 255-263.

Winters, P., P. Simmons and I. Patrick (2005), "Evaluation of a Hybrid Seed Contract between Smallholders and a Multinational Company in East Java, Indonesia", *Journal of Development Studies*, 41 (1): 62-89.

Wooldridge, Jeffrey M., (2002), *Econometric Analysis of Cross Section and Panel Data*, MIT Press, Cambridge, Massachusetts.