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

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Bharat Ramaswami*
Indian Statistical Institute, New Delhi, India

Pratap Singh Birthal
National Centre for Agricultural Economics
and Policy Research, New Delhi, India

P. K. Joshi
National Centre for Agricultural Economics
and Policy Research, New Delhi, India

Abstract

This paper offers an empirical analysis of contract farming for poultry in the southern
state of Andhra Pradesh in India. In particular, it estimates and evaluates the gains from
the contract relationship to both parties. Previous literature has paid greater attention to
grower benefits from contracting but even here quantitative estimates are scarce. In
poultry, integrators gain from lower production costs and possibly interest arbitrage. But
grower margins are not significantly different between contract and non-contract
production. Despite this, contract growers gain appreciably from contracting in terms of
lower risk and higher expected returns. In terms of observed and unobserved
characteristics, contract growers have relatively poor prospects as independent growers.
With contract production, these growers achieve incomes comparable to that of
independent growers. Efficiency wage type arguments might be responsible for this
outcome.

Keywords: Contract Farming, Contracting, Poultry, Vertical Integration

JEL Codes: L230, L240, Q130

*Corresponding author: Bharat Ramaswami, Indian Statistical Institute, 7, S.J.S.
Sansanwal Marg, New Delhi 110016, India; Phone: 91-11-51493947; Email:
bharat@isid.ac.in

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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).

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? While the literature on contract farming is extensive, it does not, with

the exception of Warning and Key (2000), offer estimates of what growers gain from

contracting.

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,

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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 has paid greater attention to grower benefits from contracting but even here quantitative estimates are scarce.[1] As mentioned earlier, Warning and Key (2002) is one paper that considers the grower gains from contracting in a formal empirical framework. However, they do not deal with the sources of gains to the processing firms and therefore leave open the question of how grower rewards are sustained.

2. 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.

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[1] For contract farming experiences in different parts of the world, see Glover and Kusterer (1991), Key and Runsten (1999), and Porter and Phillips-Howard (1997)

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.

3. 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. A sample of 25 contract producers and an equal number of non-contract producers were randomly selected from 10 villages of Rangareddy, Mehboobnagar and Nalagonda districts in Andhra Pradesh. A majority of the contract growers were associated with a leading poultry integrator. Survey data was based on recall memory of the households but it was also supplemented with the records maintained by both contract and non-contract producers. Besides information about the

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[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.

growers, data was collected about the inputs, output and prices for the last six production cycles. 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.

The survey instrument consisted of four parts. In the first part, information about village level infrastructure was collected. This consisted of distance from various infrastructure facilities such as roads, railways, telephone, post office, regional rural bank, animal feed shop among others. Table 1 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.

The second part of the survey elicited information about the grower including age, schooling, experience in broiler farming and previous occupation. 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.

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The third part of 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 costs (lower half of Table 3). The cost structure is comparable across contract and non-contract growers. 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 4 compares the outputs and revenues (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 average gross revenues per kg of bird are much lower for contract growers reflecting the netting out of input costs by the integrator.

The final section of the survey is relevant only to contract growers and it obtained information about the contract between the producer and the integrator. In particular, this section contains information about the nature of input sharing between the producer and the integrator. As noted in the earlier section, integrators supply chicks, medicine, feed and veterinary services. Growers supply land, buildings, labor, and other variable inputs

such as electricity and disinfectants. Using the information on input sharing, Table 5 computes the total value of variable inputs and the value of inputs supplied by the grower. For the growers not on contract, the two figures are the same. But this is not so for contract growers. For them, the integrator supplies most of the inputs measured in value terms. 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.

4. 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. For a wholesaler, the cost of procuring a bird whether through a contract or from independent growers consists of three terms: production costs (principally feed and medicines), credit costs and the grower's margin. Contract production would not be observed unless the integrator is 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.

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.[3] Contrary to

expectation, it is contract production that is more efficient. 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 2.15. Independent growers differ from contract growers in

various observable 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. Recall 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. [4] 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.

The marginal cost of producing a kg of bird under contract production is 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

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[3] 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.
[4] 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.

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. 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 growers.

The third way in which integrators can gain from contract production is through lower grower margins. Even with the constraint that the contract has to be acceptable to growers, margins can be lower relative to independent growers because of grower heterogeneity. The relative lack of experience of contract growers in poultry and in agriculture generally, suggests that, with the same technology, non-contract growers are likely to more productive. Therefore, if independent, contract growers would not earn the same incomes as earned by the sample of independent growers. Tables 1 and 2 suggest that integrators prefer to offer contracts to growers who are credit deprived and inexperienced in poultry production and thus likely to have lower bargaining power than the experienced independent growers with access to credit.[5] While inexperience can increase production costs, integrators would prefer contracting if it were more than compensated by lower grower margins (relative to independent growers).

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[5] 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.

To examine this issue empirically, we calculate for contract and non-contract growers their average income per kg of output from a production cycle. This is the difference between revenues and 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 6 compares the incomes from poultry farming for interest rates ranging from 15% to 30% per annum. As one would expect, the return to non-contract growers declines significantly as interest rates rises while contract growers are almost completely insulated from credit costs. The returns are equal for both modes of production at a 10% rate of interest. For interest rates higher than 10%, the returns for contract growers are higher than that of contract growers. If we take 15% to be a representative borrowing rate for growers, contract growers earn on average Rs. 0.15 per kg more than non-contract growers, i.e., about 7% more than the per kg average earnings of a non-contract grower. While the gains to contract grower are not trivial in magnitude, they are not statistically significant when interest costs are 15% per annum (see last column of 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).

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.

5. 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.

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

$$(1) \qquad R_i = a + bC_i + \mathbf{c'X}_i + \varepsilon_i$$

where R_i is the net returns of the ith 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

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on mean returns. Under the assumption of homogenous treatment effects, *b* identifies the

average treatment effect as well as the treatment effect on the treated (Wooldridge, 2002).

The ordinary least squares estimates of (1) are displayed in Table 7 (assuming an

interest rate of 15%).   Standard errors are corrected for heteroskedasticity and within

cluster correlation. Column 1 presents the estimates when no controls are included.

Controls are included in column 2.   The estimate of the impact of contracting does not

change much. It is not significant in either specification. The other variables have the

expected signs and are significant. The other variables in the regression are experience,

experience squared, season, season squared and value of assets. 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 market after mid-February. The season variable is therefore 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. The third column of Table

7 extends the analysis to the case of heterogenous treatment impacts by including

additional controls in the form of interactions of the contract dummy with the demeaned

explanatory variables (Wooldridge, 2002). The coefficient on the contract dummy

continues to identify the average treatment effect. The magnitude and significance of the

average treatment effect improves but it is still not significant even at the 10% level.[6]

A variable that is omitted in the specification estimated in Table 7 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

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[6] 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.

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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 we use instruments to correct the bias from the omitted variable.

In Table 8, the first column presents estimates of (1) when the contract dummy is instrumented by grower's distance from a regional rural bank. It 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 and schooling), ability whether in poultry or in business management, should not depend on location. Hence the distance from rural bank is a valid instrument.

Column 2 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 (2) easily pass the Hansen statistic for overidentification. Additional controls for heterogenous treatment effects are included in the instrument variable estimates in column (3) (Woolridge, 2002).

The instrument variable estimates of the average treatment effect are larger and statistically more significant than the OLS estimates. The IV estimates from all the specifications 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 ranging from Rs. 0.77 to Rs. 0.86 per kg. Considering average returns to a contract grower are Rs 2.2 per kg, contracting raises returns by around 50%.

Table 9 reports the estimates of a probit participation equation (in contracting). As can be seen, both the instruments are significant correlates of the contract dummy. Growers who are at more distance from credit facilities, and with previous occupational backgrounds in non-agriculture are more likely to be contract growers. In addition, experience and schooling negatively affect the probability of being a contract grower. These results are consistent with anecdotal accounts in poultry of processors wishing to contract with growers with weak bargaining power. 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.

6. 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.

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.

Let σ_i denote the standard deviation for the ith producer. These are calculated from the data on 6 production cycles for each grower. Also let (σ_c, σ_n) and (v_c, v_n) denote mean standard deviation and mean coefficient of variation 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 rows (and second and third columns) of Table 10. 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 10. The variability of the simulated series is of the same order of magnitude as the variability of returns for non-contract growers. 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 ith 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 ith 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 very 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

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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.

7. Concluding Remarks

While most of the literature has considered gains to contracting for growers, 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,

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a lower grower margin is not the strategy by which integrators sustain contract production.

However, and despite this, contract growers do gain substantially even in terms of expected income. The key to this puzzle 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. With contract production, these 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

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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 is a useful institutional arrangement for the supply of credit, insurance and technology to growers – all of which are otherwise very demanding problems. For many commodities, however, contract farming in India is not legal because of the agricultural produce marketing acts that make it mandatory for commodities under the act to be wholesaled in regulated markets. Removing these prohibitions would be important to widen the scope of contract farming. Some observers believe that contract farming should be regulated to ensure that processors live up to the promises made in the contract regarding the quality of inputs, provision of credit and the buy-back arrangements. Note, however, that this is not an issue in the poultry example where the processor supplies 97% of the value of inputs. As a result, the interests of the processor and the grower are closely aligned.

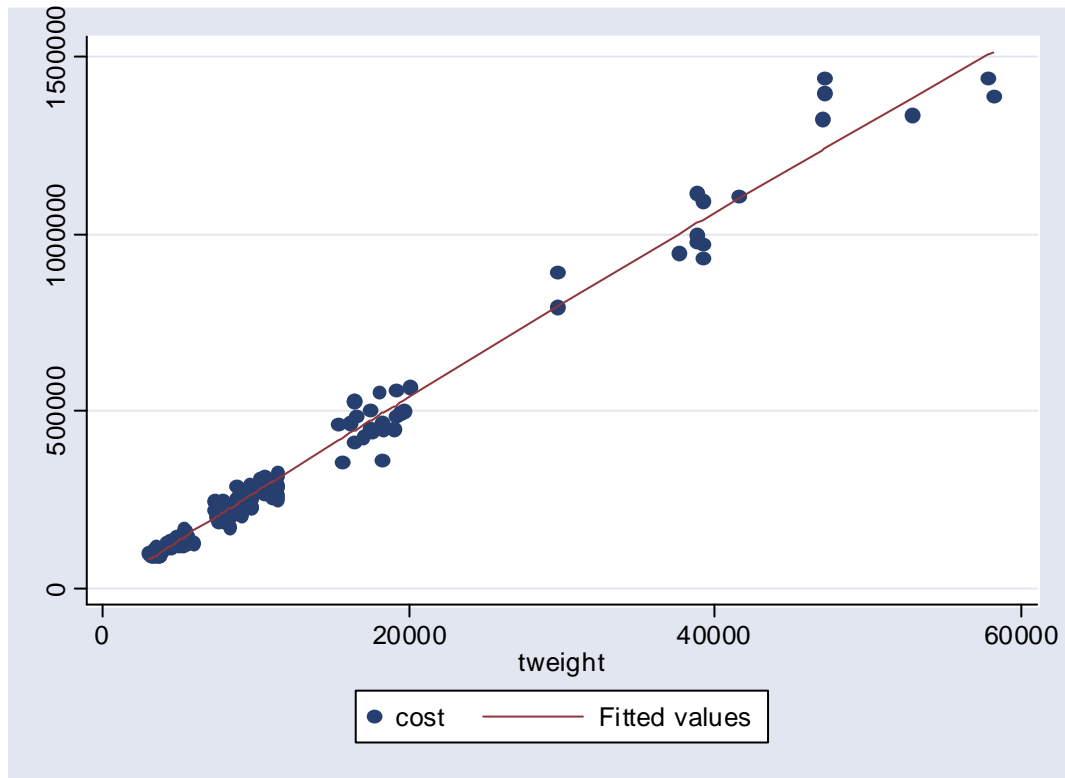**Figure 1: Cost Function for Non-contract Producers**
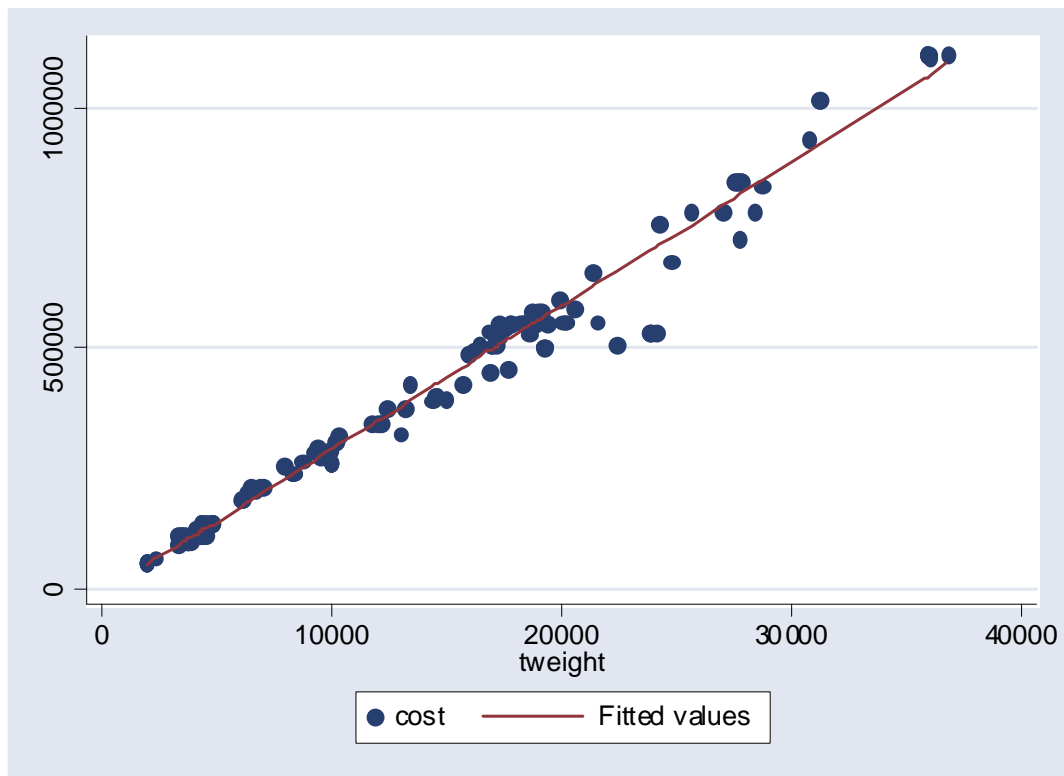
Figure 2: Cost Function for Contract Producers

Table 1. Access to Infrastructure

Item (distances in kilometres)	Non-contract	Contract
Distance to urban area	28.36	17.16
Distance to coop credit society	0.43	2.48
Distance to regional rural bank	1.2	6.84
Distance to commercial bank	1.28	6.28
Distance to primary dairy cooperative society	0.48	8.5
Distance to veterinary hospital	.8	0.71

Table 2. Characteristics of Poultry Producers

Item	Non-contract	Contract
Experience in poultry (years)	9.8	4.9
Age	36	39
Years of schooling	11.6	10.9
Proportion of farmers whose main occupation is poultry	72	36
Proportion of farmers whose earlier occupation was in agriculture/poultry/ dairy/ agricultural labour/ agriculture-related business	75	58

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

Item	Non-contract	Contract
Time: Cycle length ,days	48.4	42.6
Flock size, # chicks	6,891	8,149
Feed quantity, quintals	276	277
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%)
Total Cost, Rupees	331,468	424,200

Table 4. Output and Revenues: Averages Per Production Cycle

	Non-contract	Contract
Output: # of birds	6583	7808
Mortality: # of birds	302	388
Average total weight of birds sold (Kgs)	12105	13638
Average Weight per bird, Kgs	1.87	1.87
Gross revenues from bird sales (Rs.)	355,732	37,217
Average Revenues/Kg of bird sold	29.1	2.62

Table 5: Input Sharing: Averages per Production Cycle

Value of all inputs (Rs.)	331,468	424,200
Value of inputs supplied by farmer (Rs.)	331,468	12,249

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. Income Equation: Ordinary Least Squares

Dependent Variable: Income (Rupees) per kg per production cycle

Explanatory Variables	I	II	III
Contract Dummy: C	0.15 (0.2)	0.16 (0.16)	0.2 (0.15)
Season: X_1	---	-0.66 *** (0.13)	-1.23 *** (0.24)
Season squared: X_2	---	0.055 *** (0.01)	0.10*** (0.017)
Experience: X_3	---	0.19 *** (0.05)	0.29*** (0.09)
Experience squared: X_4	---	-0.01*** (0.003)	-0.017*** (0.005)
Years of schooling: X_5	---	-0.006 (0.02)	-0.006 (0.04)
$C*(X_1 - \overline{X}_1)$	---	---	1.16 *** (0.24)
$C*(X_2 - \overline{X}_2)$	---	---	-0.09*** (0.017)
$C*(X_3 - \overline{X}_3)$	---	---	-0.25** (0.11)
$C*(X_4 - \overline{X}_4)$	---	---	.014** (0.006)
$C*(X_5 - \overline{X}_5)$	----	---	0.008 (0.46)
Constant	2.05*** (0.19)	2.99*** (0.39)	3.93*** (0.94)
R^2	0.0019	0.15	0.23
No of Observations	285	285	285

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 8: Income Equation: Instrument Variables

Dependent Variable: Income (Rupees) per kg per production cycle

Explanatory Variables	I	II	III
Contract Dummy: C	0.78** (0.37)	0.86** (0.4)	0.77** (0.35)
Season: X_1	-0.66*** (0.13)	-0.66*** (0.13)	-1.15*** (0.27)
Season squared: X_2	0.06*** (0.01)	0.06*** (0.01)	0.09*** (0.02)
Experience: X_3	0.24*** (0.07)	0.25*** (0.08)	0.41** (0.18)
Experience squared: X_4	-0.014*** (0.003)	-0.014*** (0.004)	-0.02*** (0.01)
Years of schooling: X_5	-0.01 (0.02)	-0.01 (0.02)	0.01 (0.06)
$C*(X_1 - \overline{X}_1)$	---		1.00*** (0.34)
$C*(X_2 - \overline{X}_2)$	---		-0.08*** (0.03)
$C*(X_3 - \overline{X}_3)$	---		-0.22 (0.3)
$C*(X_4 - \overline{X}_4)$	---		0.01 (0.02)
$C*(X_5 - \overline{X}_5)$			-0.01 (0.09)
Constant	2.35*** (0.56)	2.27*** (0.54)	2.53 (1.63)
No of Observations	285	285	285
Hansen's Overidentification statistic: Chisq (1)	--	$\chi^2(1) = 0.211$ p-value = 0.65	$\chi^2(6) = 4.665$ p-value = 0.5875
Instruments	Z_1	Z_1, Z_2	$Z_1, Z_2, Z_1*(X_i - \overline{X}_i)$, $Z_2*(X_i - \overline{X}_i)$

Standard errors in parantheses corrected for heteroscedasticity and within cluster (producer) correlation.
*Significant at 10% level, **Significant at 5% level, ***Significant at 1% level. Z_1 is distance from rural bank and Z_2 is dummy for previous occupation (whether in agriculture or not).

Table 9: Probit Equation: Factors Influencing Participation in Contracting

Explanatory Variables	Coefficients	Marginal Impacts
Distance from Regional Rural Bank	0.18*** (0.02)	0.07
Years of Schooling	-0.04 ** (0.02)	-0.02
Experience	-0.52*** (0.06)	-0.20
Experience squared	0.02*** (0.003)	0.01
Whether previous in Non-Agriculture	0.75*** (0.2)	0.29
Constant	1.92*** (0.27)	--
No. of Observations	50	50

Standard errors in parantheses corrected for heteroscedasticity. *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level.

Table 10: 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.

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.

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.

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