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INCENTIVE, PERFORMANCE AND THE CHOICE OF STRATEGY IN BROILER CONTRACT FARMING: A CASE STUDY IN YOGYAKARTA

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INTRODUCTION

Broiler farming has been considered as a risky agribusiness because of its systemic production risk caused by weather fluctuations; strain of chicks; feed quality, etc. as well as due to inputs and outputs prices fluctuations. Under such situation, contract system has been playing an important role to develop broiler farming not only in Indonesia but also in other countries. Although contract farming has been proven as an effective mode to organize poultry industry, some controversial issues regarding factors affect the performance of contract and the choice of strategy between a poultry company as integrator and broiler farmers as growers still arise.

A common contract in broiler farming is that growers exchange control over production and marketing management decisions for a guaranteed price, while integrator bears risk due to changes in relative prices of inputs and outputs. Non-labor inputs such as day old chicks (DOC), feed, OVK (medication, vaccine and other chemical inputs) and technical services are fully controlled by the integrator; and that of the labor input becomes the grower's responsibility. When growers enter the contract, however, they have to provide a significant amount of investment on broiler houses and other facilities (fixed factors). Integrator may implement several type of contract such as tournament, fixed performance standard and profit sharing; and provide incentive and/or compensation to improve the performance of growers. The contract is usually a short term contract based on flock and in a certain period. The contract is renewed regularly depending on market condition.

Inputs and outputs prices, and the structure of payment of the growers are declared explicitly in the contract between integrator and growers; but quantity and quality of inputs are not. Under short term contract in which integrator can learn about the ability of growers, integrator may discriminate growers by differing quantity and/or quality of inputs to growers. The integrator may deliver inputs level in efficient amount from his side and then provide an incentive to growers for improving efforts and performance of contract. Another way, integrator may handicap high quality growers with more flocks or may discriminate quality of inputs to the growers. As investigated in Leemonchai and Vukina (2005), two possible strategies may be practiced by the integrator namely: (1) career concern strategy (high performance grower assigned high quality of inputs, low performance grower assigned low quality of inputs); and (2) Ratchet strategy (high performance grower assigned low quality of inputs, low performance grower assigned high quality of inputs).

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The objectives of this study are (1). to investigate factors affecting the performance of broiler contract in Indonesia and (2). to investigate the choice of strategy in broiler contract farming

MATERIALS AND METHODS

Tournament theory is a basic model to explain contract farming in this study. In the presence of asymmetric information, moral hazard and adverse selection may exist and create a problem between integrator and growers. Following Lazear and Rosen (1981), a simple two player tournament can be modeled as follows:

$$q = \mu + e \qquad (1)$$

q is performance (output). μ is action (effort or investment) taken by a player, and e is a random component. Performance is stochastic but depends positively upon the player's action. This action, however, is costly, and the cost is denoted $C(\mu)$ where $C'>0$, $C''>0$. Players are rewarded with one of two prizes, W_1 or W_2, where $W_1>W_2$. The larger prize, W_1, goes to the player with better performance, and the poorer performing player receives the smaller prize. The probability that player i wins the high prize (performs better) depends positively upon his own action, μ_i, negatively upon the action of his opponent, μ_j, and also upon the distribution of the random component of performance. Letting P be the probability of winning, the expected payoff to player i is

$$\begin{aligned} &P[W_1 - C(\mu_i)] + (1-P)[W_2 - C(\mu_i)] \\ &= P(W_1 - W_2) + W_2 - C(\mu_i) \end{aligned} \qquad (2)$$

Ignoring considerations of risk aversion and holding the opponent's action constant, player i will choose μi to maximize (2). That is

$$\frac{\partial P}{\partial \mu_i}(W_1 - W_2) - C' = 0 \qquad (3)$$

Several results follow from (3). First, effort, μ_i, and so performance, q_i, depend positively upon the prize differential $(W_1\text{-}W_2)$ but are unaffected by changes in the absolute level of prizes that leave this differential constant. Second, effort and so performance depend negatively upon the marginal cost of effort. Third, effort and so performance depend upon the effect that changing effort has on the probability of winning.

Assume that both players maximize (2), treating their opponent's effort as fixed, and the resulting Nash equilibrium exists. Optimal design of the tournament requires that, at this equilibrium, the marginal cost of effort, C', equals the marginal value product of effort, V. For simplicity, let V be constant. From (3), then, optimal tournament design requires that

$$\frac{\partial P}{\partial \mu_i}(W_1 - W_2) = V \qquad (4)$$

for μ_i and μ_j at their equilibrium values. Adjusting prize differential $(W_1\text{-}W_2)$ ensures the optimum.

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If players are identical, equation (4) describes the optimal tournament. If players are not identical, however, an additional problem remains. Players do not have incentives to sort themselves efficiently into pure contests, and if players know both their own ability and that of their opponents, mixed contests are inefficient. Because of the natural advantage more able players possess, both they and the less able will not work hard enough; the more able because they are likely to win anyway, the less able because they are to lose anyway. Two mechanisms might solve this problem. First, tournament organizers can assign players to assure that tournaments are pure contests. Second, a handicapping system can generate efficient mixed contests. Such system gives the less able player a head start (makes it harder for the more able player to win). Under an efficient reward structure, the more able player remains more likely to win and has higher expected income.

All of those above framework presume that players choose actions (effort) only affect mean performance but not the variance of performance. If players can choose actions that affect both the mean and variance of performance, there is an additional implication of tournament theory. With heterogeneous players, the more able will avoid high-risk actions because win by a little or a lot, is still the winner with the same prize. The less able player will choose more risky actions because lose by a little or a lot, is still losing; and by varying the actions, the possibility to win will increase. Consequently, where tournaments encompass players of unequal ability, there should be a negative relation between ability and variance of performance.

It is hypothesized that (1) Performance of contract is affected by number of chicks, grow-out length, grower's ability, performance incentive, price incentive, compensation, type of contract and harvesting season and (2) Integrator discriminates growers through (i) determination of performance standard, (ii) delivering high quality inputs to more able growers

Unlike previous studies that only estimated settlement cost to investigate the performance of contract, this study will estimate three equations/models namely feed conversion ratio (FCR), settlement cost (SC) and production function (Q). Moreover variable measurement in this study also differs with those previous ones. Due to lack of data, previous studies such as Knoeber and Thurman (1994); and Leemonchai and Vukina (2005) have used residual from regression of settlement cost equation as proxy of grower's ability. This paper uses difference FCR (FCR^{diff}) for measuring grower's ability. This measurement is more appropriate since performance incentive of growers depending on the difference between actual FCR (FCR^{act}) and standard FCR (FCR^{std}). These following models are estimated to investigate factors affect performance of growers:

$$FCR_{it}^{act} = a + b_1 CN_{it} + b_2 L_{it} + b_3 FCR_{it}^{diff} + d_1 D_1 + d_2 D_2 + d_3 D_3 + d_4 D_4 + \sum_{k=2}^{3} d5D5_{it}^{k} + e_{it} \qquad (1)$$

$$SC_{it} = a + b_1 CN_{it} + b_2 L_{it} + b_3 FCR_{it}^{diff} + d_1 D_1 + d_2 D_2 + d_3 D_3 + d_4 D_4 + \sum_{k=2}^{3} d5D5_{it}^{k} + e_{it} \qquad (2)$$

$$Q_{it} = a + b_1 CN_{it} + b_2 L_{it} + b_3 FCR_{it}^{diff} + d_1 D_1 + d_2 D_2 + d_3 D_3 + d_4 D_4 + \sum_{k=2}^{3} d5D5_{it}^{k} + e_{it} \qquad (3)$$

$$FCR_{it}^{std} = a + b_1 CN_{it} + b_2 L_{it} + b_3 FCR_{it}^{diff} + d_1 D_1 + d_2 D_2 + d_3 D_3 + d_4 D_4 + \sum_{k=2}^{3} d5D5_{it}^{k} + e \qquad (4)$$

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$$MR_{it} = a + b_1 CN_{it} + b_2 L_{it} + b_3 FCR_{it}^{diff} + d_4 D_4 + \sum_{k=2}^{3} d5D5_{it}^{k} + e_{it} \quad (5)$$

FCR^{act}_{it} = Actual FCR of flock grower i harvested in time t
FCR^{std}_{it} = FCR standard of flock grower i harvested in time t
FCR^{diff}_{it} = FCR difference (FCRstdit-FCRactit) represents ability of grower i in flock harvested in time t
Q_{it} = Weight of live chicks of flock grower i harvested in time t (kg)
SC_{it} =Settlement cost of flock grower i harvested in time t (Rp/kg)
= (feed cost +chicks cost + medication cost)/Q
CN_{it} = Number of chicks of flock grower i harvested in time t
L_{it} = Grow-out length of flock grower i harvested in time t (day)
MR_{it} = Mortality rate of flock grower i harvested in time t (%)
D1 = Dummy variable for performance incentive
D1=1 if flock *it* received performance incentive and 0 otherwise
D2 = Dummy variable for price incentive
D2=1 if flock *it* received price incentive and 0 otherwise
D3 = Dummy variable for compensation
D3=1 if flock *it* received compensation and 0 otherwise
D4 = Dummy variable for harvesting season
D4=1 if flock *it* was harvested in August-December and 0 otherwise.
D5 = Dummy variable for type of contract
D5=1 if flock *it* was under k contract and 0 otherwise
k= 1, 2, 3.

Types of contract:

1. Fixed performance standard
2. Profit sharing
3. Direct management by the integrator

The data used in this paper is provided by a poultry shop integrator in Sleman District consisting of production information of growers under contract during one year from January 1, 2005 to December 31, 2005. In total we have 472 flock's data. Twelve percent of flocks (56 out of 472) produced by the integrator and that of another 88% flocks (416 out of 472) produced by the growers. Total numbers of growers are 76 people. Four percent of growers (3 out of 76) are treated to practice profit-loss sharing contract with the integrator and that of 96% growers practiced tournaments (see Table 1). Flocks and growers were located in Sleman, Bantul, Kulonprogo, Gunungkidul and Klaten District. In profit-loss sharing contract, the integrator does not provide incentive to growers; while in fixed performance standard contract the integrator provide incentive to growers.

Table 1. Number of Flock and Grower by Type of Contract

Item	Type of Contract	Total

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	Fixed Performance Standard	Profit Sharing	Direct Management by Integrator	
Flock	395	21	56	472
Grower	73	3	1	77

RESULTS AND DISCUSSION

Summary of data

This paper focuses on grower's flocks. For brief understanding regarding the difference performance between flocks raised by integrator, profit-loss sharing contract and tournaments contract, Table 2 summarize the data from those three types of flocks.

Table 2. Summary of Data by Types of Flocks

Data	Type of contract			Average
	Fixed performance standard	Profit sharing	Direct management by integrator	
Number of chicks	5,339	8,524	10,684	6,115
Feed (kg)	14,215	22,733	30,405	16,515
Grow-out length (day)	37	37	37	37
Mortality rate (%)	4.88%	4.94%	5.20%	4.92%
Weight of live chicks (kg)	8,401	13,234	17,630	9,711
FCR[1]	1.705	1.710	1.721	1.708

[1]Feed conversion ratio (total feed divided by total weight of live chicks)

Table 2 shows that performance of flocks under fixed performance standard contract are relatively better than that of flocks under profit-loss sharing contract as well as integrator's flocks. This result indicates that incentive system implemented by the integrator effectively encourage growers to increase their farm efficiency.

Shifting risk from growers to integrator

The Principal-Agent theory states that in the contract, risk is shifted from agent to principal. This sub-section will test whether or not such theory exists in the broiler contract farming where the risk of grower is transmitted to the integrator. This sub-section also further investigates the main source of risk in broiler farming. We measure the risk of broiler farming by coefficient of variance of gross income; and identify two sources of risk namely production risk and prices risks.[1] Four models are simulated to understand the role of contract farming to reduce the risk of growers, i.e.:

(1) Model A calculates gross income of growers if they fully control inputs and outputs prices
(2) Model B calculates gross income of growers if inputs and outputs prices fully controlled by the integrator as the case in the broiler contract farming

[1] Gross income is calculated by substracting selling values with feed cost, chicks cost and OVK cost.

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(3) Model C calculates gross income of growers if they can only control output prices, while inputs prices controlled by the integrator
(4) Model D calculates gross income of growers if they only control inputs prices, while outputs prices are controlled the integrator.

As seen in Table 3 that the result of analysis supports P-A theory. The risk of growers is reduced by contract farming mainly through a guaranteed output prices. The regression result in Table 4 shows that effect of output price variability on income risk is relatively higher than others. Further investigation in Table 5 shows that mortality rate fluctuate relatively more than others, but its effect on income fluctuation still less than that of output price variability...

Table 3. Gross Income of Growers under Tournament Contract

Integrator control of	Grower control of	Gross income	Standard deviation	Coefficient of variance
	Input-Output	8,759,256	8,782,745	100.27
Input-Output	Nothing	6,926,212	4,893,492	70.65
Input	Output	1,160,892	7,132,767	614.42
Output	Input	13,421,278	8,963,569	66.79

Table 4. Factor affecting Gross Income Variability

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.022887	0.543711	5.559731	0.0000
LOG(CV-Mortality rate)	0.353853	0.122733	2.883127	0.0056
LOG(CV-Feed price)	-0.201979	0.154982	-1.303241	0.1980
LOG(CV-DOC price)	-0.314753	0.125468	-2.508638	0.0152
LOG(CV-Output price)	0.479161	0.182946	2.619139	0.0114
R-squared	0.329837	Prob(F-statistic)		0.000201
Durbin-Watson stat	2.238291			

Table 5. Coefficient of Variance of Mortality and Input-Output Prices

Data	Average	Standard deviation	Coefficient of variance
Mortality rate	4.8%	4.7%	98.21
Feed price	2,561	120	4.68
DOC price	2,510	423	16.86
Output price	7,235	733	10.13

Table 6. Structure of Gross Income of Integrator

Source of income	Average	Standard deviation	Coefficient of variance
Input distribution	7,598,364	5,347,468	70.38
Selling output	(4,662,022)	6,613,108	(141.85)
Total	2,936,342		

From this analysis we also can understand why integrator fully controls inputs and outputs prices. Theoretically income of integrator comes from distributing inputs and the

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difference of output price in the market and in the contract. Income of integrator from output side is risky. In order to increase income from output side, the integrator implements incentive system. The incentive will increase grower's effort and increase the performance of broiler farming. Finally, the better performance of farming will increase integrator's income. Only controlling output prices is less attractive for integrator. As seen in Table 6 that majority of income of integrator is actually from input distribution, not from right to sell the output. Even during last year income from selling output was minus because output price in market was lower than that of explicitly declared in the contract. By controlling inputs the integrator can ensure his income from margin of inputs that can be used to guarantee income of growers when the risk appears.

Performance of contract

To investigate factors affect performance of growers, we estimate equation 2 as follows. The results are presented in Table 7. Like our prediction that performance of growers is significantly affected by number of chicks, grow-out length, grower's ability and type of contract. The sign of number of chicks is positive, consistent with the finding of Knoeber and Thurman (1994). Increasing 1000 chicks will increase settlement cost/performance of growers by Rp 86. Grow-out length negatively affects the performance. It means that longer time needed to grow the chicks reduce the settlement cost. This sign of grow-out length, however, is not like to our prediction. The negative sign may happen because we measure grow-out length by subtracting final catching with placement date of chickens. On the other hand, chicks are usually harvested in several days. It may be better to use weighted average to calculate grow-out length.

Table 7. Factor Affect Performance of Growers

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.962726	0.123341	80.77363	0.0000
LOG(CNit)	0.086159	0.009878	8.722039	0.0000
LOG(Lit)	-0.115123	0.029983	-3.839567	0.0001
LOG(Incit)	-0.095971	0.004967	-19.32346	0.0000
D1	0.067144	0.017617	3.811353	0.0002
D21	0.029272	0.018592	1.574445	0.1162
D22	0.027396	0.017717	1.546325	0.1228
D23	-0.005971	0.017358	-0.343992	0.7310
D24	0.003000	0.016982	0.176641	0.8599
D25	0.011382	0.017382	0.654812	0.5130
D26	-0.002640	0.016541	-0.159620	0.8733
D27	0.012083	0.017610	0.686128	0.4930
D28	0.014071	0.017245	0.815961	0.4150
D29	0.030547	0.017739	1.722041	0.0858
D30	0.055404	0.017002	3.258636	0.0012
D31	0.000416	0.017287	0.024079	0.9808
R-squared	0.565998	F-statistic		34.34228
Durbin-Watson stat	2.002314	Prob(F-statistic)		0.000000

Effect of grower's ability on performance is negative, implying that settlement cost for higher ability growers being lower than that of low ability growers. Type of contract also significantly affects performance. Settlement cost of grower under tournament is higher than that of under profit-lost sharing contract. In the analysis, we used profit-loss sharing contract as basic condition because average settlement cost of this type of contract being lower than that of tournament. The settlement cost of most of harvesting month does not differ with that of in March. We used March as basic condition because it has lowest average settlement cost compared to other harvesting month. Only settlement cost of October and November is significantly higher than that of in March.

Testing the Handicapping Hypotheses

To investigate handicapping hypotheses, we estimated Equation 3. The results of analysis are presented in Table 8. We measure quality of chicks by mortality rate. Handicapping hypotheses exist if grower's ability significantly affects the mortality rate. Negative effect of grower's ability on mortality rate indicates the presence of career concern; and oppositely positive effect of grower's ability on mortality rate indicates the presence of Ratchet effect.

The result of analysis shows that number of chicks, grower's ability and type of contract significantly affect mortality rate. Increasing number of chicks increase mortality rate by 47%. Oppositely grower's ability has negative effect on mortality, indicating that career concern exist in broiler contract in Indonesia.

Table 8. Factors Affect Quality of Chicks

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.166390	1.369080	1.582369	0.1144
LOG(CNit)	0.469656	0.110094	4.265954	0.0000
LOG(Lit)	0.090021	0.334791	0.268887	0.7882
LOG(Incit)	-0.608255	0.054789	-11.10169	0.0000
D1	-0.346718	0.196180	-1.767347	0.0779
D22	0.016288	0.171168	0.095157	0.9242
D23	-0.107889	0.167126	-0.645556	0.5189
D24	-0.090954	0.162608	-0.559342	0.5762
D25	-0.131364	0.166361	-0.789630	0.4302
D26	-0.047632	0.155316	-0.306678	0.7593
D27	0.136507	0.168306	0.811063	0.4178
D28	-0.216549	0.166343	-1.301821	0.1937
D29	-0.300563	0.175236	-1.715190	0.0871
D30	-0.084397	0.162272	-0.520098	0.6033
D31	-0.241358	0.162173	-1.488271	0.1375
R-squared	0.279458	F-statistic		10.91504
Durbin-Watson stat	1.880965	Prob(F-statistic)		0.000000

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CONCLUSION

(1) In broiler contract farming, risk of growers is shifted to integrator. Most of income variability in broiler farming is explained by output price variability.
(2) Grower's ability (incentive) positively affects performance of contract
(3) Career concern exist in broiler contract farming in Indonesia

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