

10. Tournaments

Lazear & Rosen¹ make the following points in their paper:

- A compensation scheme for two workers based on a tournament can be constructed so that the expected earnings, effort, and productivity of both workers are identical to that achieved when workers are paid piece rate. In the tournament, workers are paid prizes according to the ordinal ranking of their productivity. With piece-rate pay, they receive exactly what they produce.
- The implicit argument floating around in the background is that tournaments are superior to hourly wages. In some settings piece-rate-pay is not feasible. For instance, the most common labor contract is not piece-rate-pay but, rather, hourly wages. The L&R model shows that a tournament is superior to hourly wages by proving that optimally structured tournament yields results identical to piece-rate pay, and piece-rate pay is obviously superior to hourly wages. Of course, there is still the question of whether a tournament can be substituted for hourly wages.
- If workers are risk averse, then tournaments are superior to piece-rate-pay. Since an optimal tournament is equivalent to piece-rate-pay for risk neutral workers and since a tournament generally lowers the variance of earnings for the tournament participants, then if workers are risk averse, a tournament is superior.

The L-R Model

The set-up of the model is as follows: The firm, instead of paying workers on the basis of their actual output, pays workers a fixed amount based on pairwise comparisons of workers. That is, the firm conducts a tournament between pairs of workers. The more productive worker gets paid a high prize while the less productive worker gets paid a low prize.

There are two parts of the theoretical story: 1) the workers' behavior reactions and 2) the competitive market equilibrium response imposed on firms. The model shakes out several results: Equally talented workers compete to a stalemate in expected value terms. The winner is decided by luck alone. Each worker assumes the other will respond optimally. This is called a Cournot-Nash equilibrium. It can be simply summed up by saying that when equal workers are paired in a tournament, they compete as if they were playing against themselves. ("I don't know how hard Jill will work, but my guess is that she will work just as hard as me.") The decision process of workers is two-fold. They decide whether they will compete at all based on the average pay (the purse divided by two). Then they exert effort based on the difference between the winner's and loser's pay. If the variance of the production process increases, the workers work less hard. I think that the intuition of this last result is that the more luck controls the outcome, the lower the marginal value of working hard.

At all events, the equilibrium market process exactly offsets this behavior response of workers. The firm can control the amount of effort supplied by workers by means of widening the spread between the winner's and loser's pay. Thus, as the random component of production gets larger, the firm widens the spread. Holding the expected pay unchanged this draws just as

¹ Lazear, Edward P. and Rosen, Sherwin. "Rank-Order Tournament on Optimal Labor Contract" in Journal of Political Economy. Vol 89. 1981. P841-864.

many workers into employment and makes them work just as hard as they would if there were less luck in the production process.²

The other conclusions of the model are straightforward. As the value of output goes up, expected pay increases, but so too does the spread in the tournament payoffs. The increase in spread is necessary to induce more effort, which is appropriate since value has increased. The basic logic of the model is: When value increases, the firm must induce more effort. It widens the spread, which causes workers to work harder. However, when workers work harder, they must be paid more. The firm does this by increasing the purse—expected pay increases.

Some Observations

All of this shows that tournaments and piece rate pay schemes produce identical results in terms of the effort and average output of workers. The economics question is, why would one scheme be preferred to another. Several points are in order:

The tournament has the incentive effect of making workers perform in effort terms exactly as they would if they were paid based on either their effort or their output.³ The tournament is superior to effort based pay if the firm cannot measure effort. However, the firm must be able to measure something.

The tournament structure replaces a wide and continuous distribution of payoffs with two discrete earnings outcomes. Essentially the worker gives up the high end of the earnings possibilities in order to not be stuck with the extreme low end. While the model is formulated with risk neutral workers (and firms), if we modify the model very slightly to account for risk averse workers, the tournament structure will often be preferred to piece rate pay. The firm is a perfect diversification mechanism for the risky outcomes of the production process.

The tournament structure is superior to piece rate pay even when workers are risk neutral if measurement of output is more difficult than measurement of rank ordering. Sporting events are like this. Rank is easy to measure but output is extremely difficult. Who knows whether Secretariat was the best horse ever? Were the 1998 Yankees the best baseball team ever fielded? What we can tell with certainty is how these competitors performed against the field on given days. Wet field, dry track considerations fuel speculation across events but not during the competition because everybody plays on the same field.

The superiority of rank order measurement to output measurement is apparent in sports and maybe is equally ubiquitous in the business world. However, another measurement problem is the ability of workers to monitor management. Workers on piece rate pay need to know that they are not being cheated by the firm. This sounds simple, but it is not. Sales people spend a lot of time checking on how much merchandise is shipped and making sure that they get sales credit for it. This checking is not production. It is wasteful measurement. But if the salespeople don't do it, they will be cheated. This may be why salespeople are very often paid in terms of prizes based

² This result is intuitively displeasing. The reason is that we intuitively think in terms of risk averse behavior. This is a result that derives from risk neutral workers. The reason that workers don't work as hard when the variance of the production process increases is that the pay differential isn't large enough, which corrected by the firm in competition.

If the model is modified to allow for risk aversion, I don't think that the firm can perfectly offset the effort reducing effects of variance by increasing the spread. However, with risk averse workers, variance will also reduce effort in a piece-rate setting. Hence, risk averse or risk neutral, theoretically a tournament can be styled to mimic 100% performance pay.

³ With risk averse workers, piece rate pay would actually be less productive than tournament pay.

on who sold the most. Many times it may be easier for them to monitor each other and thereby know who sold the most and who should get the trip to Hawaii, than it is for them to know exactly how much they sold and should be paid for.

In many settings, the workers have no idea how much output they are producing. When a secretary makes coffee or takes someone's shirts to the laundry because the boss is too busy, how much output was created? This is the Alchian & Demsetz point. When team production is involved, it is impossible to contract on a piece rate basis. In this setting, a tournament structure, if feasible, can achieve the effort response among workers that would occur under perfect information contracting. Moreover, the workers can monitor the manager by observing their own relative place and the rewards given to those ahead and behind them.

The example that came up in class concerning the forklift drivers is most interesting. The setting was that forklift operators at some establishment are paid based on their ranking in moving total tons each day. The top mover gets one rate of pay, the second mover gets less, etc. This is a tournament and it has all of the L-R characteristics of pay/performance. The forklift operators compete to move the most. On some days, moving may be more difficult than others, but this does not affect pay. The thing that affects pay is the relative ranking of the operators.

Chicken Farming⁴

Chicken farming offers a very interesting example of tournament contracting in a real business situation.

Integrators (companies like Perdue, Tyson, ConAgra, and the like) buy breeding stock, cultivate eggs (or contract for this), hatch the chicks and then send the chicks, with feed, medical supplies, and some consulting support to chicken farmers who “grow out” the chicks to market weight. The integrators then pick up the chickens and “process” them for market.

Chicken Farmers are paid by the pound of live chickens that go to the processing plant. The story that we have information on concerns the way that Perdue pays its chicken farmers. They are paid on the basis of what is called “settlement costs” (SC). Settlement cost are calculated in the following way:

$$SC = \frac{(\# \text{ of chicks} \times \$.12) + (\text{kilocalories} \times \$.06)}{\text{live weight}}$$

Chicken farmers are paid in cents per pound using the settlement cost formula as shown below. Chicks grow out for 6-7 weeks. They are harvested from several farms simultaneously. Harvests that occur within a ten day period are a cohort that makes up a pool upon which the payout to all of the farmers in the cohort is based.

Data were collected for the years 1981-85 from one integrator, which I believe is Perdue. During this period there were four different payout plans used:

Period	Payout Method	Base	Rate
1. Nov 81-Mar 82	cohort ranked into quartiles	2-2.45¢ / #	+.3¢ / quartile
2. Mar 82-June 84	“	2.6¢ / #	“

⁴ Knoeber, Charles R. and Thurman, Walter N. “Testing the theory of Tournaments: An Empirical Analysis of Broiler Production” in *Journal of Labor Economics*. Vol 12. 1994. P155-179.

3. June 84-Nov 84	SC averaged across cohort	$\frac{3.2\text{¢ /\# avg; } 2.6\text{¢ min}}{}$	$\pm(\text{SC}_i - \text{avgSC})$
4. Nov 84-Dec 85	"	$\frac{3.4\text{¢ /\# avg; } 2.8\text{¢ min}}{}$	"

Periods 1 & 2 were classical tournaments in that the cohort was ranked and the payout was based on rank. Periods 3&4 were not tournaments in the traditional sense because the payout was calculated based on the actual productivity of each farmer. However, there was an averaging scheme based on the overall productivity of the cohort. Each farmer was paid a base cents per pound that was either increased or decreased as the farmer's settlement costs decreased or increased around the average for the cohort.⁵

I don't really see much difference between the two schemes. In both, our integrator is contracting to pay the farmers based on the productivity that they achieve *relative* to each other. One is ordinal; the other is cardinal. But, so what? In neither case does a farmer know what the average is going to be and hence must compete based on some kind of Cournot/Nash equilibrium, i.e., farmer A assumes that the others will act more or less like farmer A. Hence, farmer A is playing against himself. This is the essence of the Lazear-Rosen model.

It seems to me that the most important feature of the chicken farming contracting process is that the form of the payment to the chicken farmers is one that insulates them from any opportunistic behavior on the basis of the integrator. For instance, if the integrator tries out a new type of food that is less nutritious, this does not affect the payment to the farmers. They are paid on their performance relative to the rest of their cohort.⁶

Empirically, the authors claim to have shown that tournaments matter and are efficient. There were several things about the empirical results that concerned me. I would like to have seen separate tests of the equality of responsiveness between periods 1 and 2, and between periods 3 and 4. Even so, it is a very interesting story.

Query to Knoeber:

Hey, Chuck. Haven't talked in a while. Hope things are going well. Come down here and see us sometime.

I lectured on the chicken paper yesterday in my graduate class (property rights/contracting stuff). This is the tourney paper in JLabE. Fact is, I had never read it before. I have always just given the story based on our many conversations about it. I am sorry I waited so long. Good paper.

As a consequence, I have a number of questions. First, it seems to me that the payout in periods 3&4 is much higher than in periods 1&2. The average Settlement Cost across the entire sample was 20 with a standard deviation of 2.52. This means that a one standard deviation improvement in period 3 would yield a payout of $3.2+2.52=5.72$; whereas being approximately the same

⁵ The payout in periods 3 and 4 seems to be a good bit higher than in periods 1 and 2. The average SC across the entire sample was 20 with a standard deviation of 2.52. This means that a one standard deviation improvement in period 3 would yield a payout of $3.2+2.52=5.72$; whereas being approximately the same difference from the mean in period 2, which would put you in the top quartile, yielded a payout of $2.6+.9=3.5$. This difference seems too big.

⁶ There is potentially some effect in that total live weight may be less. However, my guess is that the harvest period is determined by when the birds reach market weight. If the integrator tries out a new food that proves to be less nutritious, then they are harvested later. This imposes a time cost on the farmers but not a feed cost.

difference from the mean in period 2, which would put you in the top quartile, yielded a payout of $2.6 + .9 = 3.5$. This difference seems too big. Am I reading it right?

Second, I don't really see a difference in the incentive structure between the ranking payout scheme in periods 1&2 and what you call the LRPE in periods 3&4. In both Perdue (?) is contracting to pay the farmers based on the productivity that they achieve relative to each other. One is ordinal; the other is cardinal. But, so what? In neither case does a farmer know what the average is going to be and hence must compete based on some kind of Cournot/Nash equilibrium, i.e., farmer A assumes that the others will act more or less like farmer A. Hence, farmer A is playing against himself. This is the essence of the Lazear-Rosen model.

The most compelling argument that I can come up with for tournaments in the work place is that it shifts the risk of the rise and fall of average output from the worker to the firm. This is appropriate because the firm has control over this &/or can diversify this more easily.

The following example came up in class: A company with some kind of inventory lot pays its forklift operators on the basis of a tournament of tons moved. First place gets so much pay per hour, second less, etc. Why do this? My answer is that the tons will vary depending on what is being transported that day, but the pay will vary only on the basis of relative effort. Can you think of something else?

Because, if not, then it seems to me that in the chicken case, this is all that is happening and it happens across all the payout schemes that you investigated.

By the way, what were the t-stats on gamma 2, 3 and 4 separately?

Response from Chuck on some questions.

Mike

Sorry that it has taken me a while to respond to your note asking about chickens. I've been out of town. Glad you liked the paper.

As to your questions: I think that you have figured the per pound payout right for the top quartile in periods 1&2 (3.5) and if someone performed better than the average (in the tournament) by 2.52 cents in period 3, he would be paid 5.72 cents per pound. The 2.52 cents, however, is the standard deviation of performance over the entire sample. If much of the variation is common to all growers in a tournament (say is due to seasonal temperature change), then the standard deviation for growers in a particular tournament is much smaller. In fact, Wally and I have estimated that about half of the variation in performance is common. This would get the pay for a good (one standard deviation above average) performer down to about 4.4 cents per pound in period 3. I think that this is about right.

I also have tried to figure out why the contract was changed to LRPE from the pure tournament. My impression is that almost all companies now use some form of LRPE. I suspect that it has to do with the fact that growers aren't homogeneous (unlike in Lazear-Rosen). LRPE seems (to me)

to provide stronger incentives to the best growers (those who could make the top quartile without trying very hard). Since the quality of the house that the grower provides is an important determinant of the quality of the grower, providing stronger incentives to the best growers also encourages growers to improve their houses.

I agree that the primary reason to use tournaments is to shift the risk from common variation in performance to the company who has better control over these risks or at least better ability to bear risk. Another possibility is that it provides incentives for the company to find better ways to do things (the payout to the workers is fixed--only its distribution is determined by the tournament) so improvement in average productivity redounds to the company. Absent the tournament (here, I'm thinking of pay by a piece rate), pay scales would have to be adjusted (downward) to allow the company to benefit from productivity improvements that it instigates. This renegotiation would likely be very contentious. Pay by tournament (or LRPE) eliminates the need to renegotiate. This is another reason to use tournaments, but it also applies to LRPE.

I can't lay my hands on the t-statistics from Table 1, but I have asked Wally (he's much better organized than I am and, not surprisingly, he's also a much better econometrician) to check his records. I'll send them along when I hear back from Wally.

Follow up from Chuck:
Mike

Sorry it took me so long to finish my response to your questions about the "chickens" paper. I asked Wally for the t-stats that you wanted, but somehow it got put off. Anyway, here it is:

The parameter estimates (and t-stats) for the gammas are

gamma 2: .0697 (1.021)
gamma 3: .1588 (1.861)
gamma 4: .2309 (3.013)

In going through the records, we found a similar request from the referee. Apparently great minds (yours and the referee's) think alike.

Hope all is well at Clemson. Are you still doing stuff on retail competition in electricity? I did a bit of consulting work last summer for some folks putting together a study for the NC Legislature. Ran into your "All FERC'ed Up" paper. I've been kinda proud of the titles to a couple of my papers, but you win hands down.

Best regards

Chuck

For your third paper, investigate the following:

I am told that in Steven Cheung's '83 paper in JLE, he made a point that exceptionally productive workers in a piece-rate setting should be paid at a higher rate than mandated solely by the piece schedule. Why should this be?

Also, I don't really see a difference in the incentive structure in the chicken farming paper between the ranking payout scheme in periods 1&2 and what Knoeber and Thurman call the LRPE in periods 3&4. In both the integrator is contracting to pay the farmers based on the productivity that they achieve relative to each other. One is ordinal; the other is cardinal. But, so what? In neither case does a farmer know what the average is going to be and hence must compete based on some kind of Cournot/Nash equilibrium, i.e., farmer A assumes that the others will act more or less like farmer A. Hence, farmer A is playing against himself. This is the essence of the Lazear-Rosen model.

Discuss the nature of tournaments in the work place and analyze whether the two different contracts in the chicken farming example should exhibit different effort levels from the farmers?

In what way, the chicken farming problem relate to Cheung's argument?

Follow up on papers

I think that we all agree that Cheung says something like the following:

- (1) Can't use piece rate pay when components and contributions change often, when variety of activities by same worker, or when there is substantial random variation in the production process.
- (2) Pay best people at higher rate to equalize rental on capital. That is, capital with a high cost must necessarily produce more output to justify its high price.

Point (2) is part of the answer to the following series of questions:

Why pay the best more? That is, why have an increasing scale of pay?

Why do the best insurance sales people and the best real estate agents get higher commission rate? Golf tournaments have increasing rewards. Why?

In general there are three possible reasons:

1. Marginal Cost of Effort—better people work harder
2. Capital Rental Rate—Cheung's point
3. Unequal Competitors—Lazear and Rosen: Players/workers with different abilities create a problem in a competitive setting. The better players choose low risk strategy while the worse choose high risk. Both shirk, i.e., don't work as hard as if pitted against opponent of equal ability.

How can pricing/tournament structure solve this? Here is where we look to chickens:

(a) In the chicken case, what Knoeber and Thurman call LRPE is not really. The pay per pound increases with performance. Hence, the rate of pay is increasing at an increasing rate with respect to performance. This is my feeling and the point was also made in one of the papers, so I at least have some support. It also mitigates one of the claims that I made, specifically that the pay structure for chickens takes out all of the variation induced by integrator actions. If the integrator tries a new food additive that is bad, the rate of pay per pound will not be diminished, but the total pounds and, hence, total income will be. (K&T seem to try to deny that the system is an increasing pay structure. Obviously, they call it a LRPE. I will query K some more on this point.)

Given (a), then (b) the case of chickens seems to include all the possible reasons for a levered rewards pay structure: There is chicken house capital (Cheung's point); there are unequal competitors (L&R); and there may also be increasing marginal cost of effort (several of you made this point).

Finally, the chicken industry has an unusual organizational structure, but it is envious. Chicken raising is jobbed out because it can be. Letting independent profit claimants raise the chickens significantly reduces shirking.

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Economics 827
Assignment 3

Workers can be paid by a variety of schemes. Payment by hourly wages or salaries is least desirable for employers. Workers must be monitored, and there is no direct monetary incentive for workers to improve their performance.

Piece rate pay is exactly tied to performance, making it a desirable pay scheme for employers. More able workers find it easier, or less costly, to produce output and therefore earn a higher wage. Piece rate pay is only practical when (1) output is countable, (2) output is produced individually, and (3) there is not a lot of random variation in the production process.

A tournament scheme may be used instead of piece rate pay when direct output cannot be cheaply counted and/or when factors beyond the workers' control influence production. The defining characteristic of a tournament is that workers are paid based not on absolute but on relative performance. The highest-ranking worker receives the biggest reward.

In "The Contractual Nature of the Firm," Cheung⁷ noted that the most productive workers are given the best machines to use. The best workers are then offered a bonus, above regular piece rate pay, when their output is especially high. Cheung says that this bonus is explained by

⁷ Cheung, Steven N.S., "The Contractual Nature of the Firm." *Journal of Law & Economics*, vol XXVI (April 1983).

the desire of the firm to equalize the rental value of its machinery, drawing the highest possible output from the best machines.

Payment Schemes for Contract Growers

Growers of broiler chickens are paid based on their performance; their goal is to maximize the delivery weight of the chickens subject to feed and time constraints. The integrator could pay the contract growers piece rate: the output is individually produced and is easily measurable. However, a piece rate system would subject the grower's output (and income) to variation beyond his control. Cheung states that piece rate pay will not be used when "components or contributions either change often or entail a variety of activities by the same worker."⁸ For the grower, the contributions that vary include temperature, flock size, the length of the time the chicks are with the grower, and experiments by the integrator with feed and with the breeding of the chicks.

Because there are factors beyond the control of the growers, a type of tournament system is used rather than a piece rate system. Contract producers of broiler chickens are currently paid based on their performance relative to the average of the harvest group. There was a time when the producers were paid based on their ranking, by quartile.

Types of Tournaments

In a tournament, players compete against one another for prizes. Players are paid based on their rank. The rewards are non-linear in that the incremental reward typically varies from one rank to another. Under linear relative performance evaluation (LRPE), the players compete against one another. A player's reward is a linear function of the difference between his performance and the group's average performance.

The two schemes provide slightly different performance incentives, mainly for the worst players. In a tournament, a good player will play it safe; being likely to win, there is no incentive to gamble. A bad player, likely to lose, does have an incentive to gamble on a high-risk strategy. The potential pay-off of the winner's prize is worth the risk of the "Hail Mary." If it fails, no big deal, as the bad player would have lost anyway.

In a LRPE scheme, the good player has the same monetary reward for improving his performance that the bad player does. The bad player will not risk it all on a "Hail Mary" *unless* there is a guaranteed minimum prize. If there is a guaranteed minimum, the bad player again has incentive to take on a high-risk strategy with the hope of greatly improving his performance.

Empirical Findings

Knoeber and Thurman⁹ empirically tested three hypotheses. The first is that growers react to changes in the type of payment scheme and to changes in the *relative* awards, but not to changes in the level of the awards. The second is that the worst players use the riskiest strategies. The third is that the tournament organizer pre-sorts each tournament's players by ability.

The first hypothesis is that it is players play harder if the relative difference among the prizes increases. Increasing the absolute amount of the prizes without changing the relative differences will not elicit extra effort. Knoeber and Thurman rejected the hypothesis that

⁸ Cheung, page 15

⁹ Knoeber, Charles and Walter Thurman. "Testing the Theory of Tournaments: An Empirical Analysis of Broiler Production." *Journal of Labor Economics*, vol. 12, no. 2 1994.

performance is affected by base pay. They did find that performance differed under a pure tournament that under LRPE.

The hypothesis that the worst players had the highest variability in output (as discussed above) was confirmed.

The third hypothesis is that the tournament organizer (the integrator) either sorts or handicaps players so that tournament quality is more homogeneous. The goal is to prod the good players to work harder, while keeping the bad players from giving up in desperation. Knoeber and Thurman found a periodic pattern to settlement costs, suggesting the integrator grouped growers by ability.

Additional Observations¹⁰

The chicken industry is interesting in that the vertical integration is marred by a jut in the middle. The production firms (Tyson, Perdue, Goldkist, etc.) own neither the land nor the barns in which their chickens are raised. The farmers, or growers, own the land and the buildings. Growers work exclusively with an integrator, and the integrators have concentrated geographic regions. A chicken grower in the Sumter, SC, area works for Goldkist Farms. A grower in Florida works for Tyson. There are very few independent farmers.

The integrator does the scientific research, both in breeding and in the feed. The integrator supplies chicks, feed and advice, sending specialists to the chicken houses to trouble shoot and give advice on climate control, feed and controlling disease (seemingly the most difficult task). Growers are commonly referred to as "laborers."

A typical barn has 30,000 chickens, and five barns is the norm for a profitable, full time grower. The delivery weight of chickens is in the 6-7 pound range. Interestingly, farmers have been known not only to pull out the anemic birds before delivery, but also to keep extremely plump birds for themselves. The average weight of chickens coming out of houses has doubled in the past couple of decades, due largely to scientific advances in feed and breeding. One reason for the integrators to pay based on relative performance rather than absolute performance is that the integrator reaps the reward for productive research.

Although pay is LRPE, there is no sense of intense competition among growers. Rather, payment to the growers is fairly constant unless there is an egregious error, such as a grower kills off all 30,000 chicks.

Summary

Although piece rate pay is directly linked to the value of a worker's output, the contract growers won't accept piece rate pay because of variations in factors beyond their control. The pay scheme based on relative performance protects the growers from the integrator. It also gives the integrator the reward for improving the quality of feed and of the breeds. The literature suggests that a relative performance system sets farmers against one another in competition for top prize; it may be that improvements in the houses and by the integrators have made the players more homogeneous. As such, the awards have become fairly constant.

¹⁰ The source of this information is one of my Economics 200 students, who is a Poultry Science major.