Rank Order Tournaments—Lazear & Rosen[1]

Definition: *Tournament* – A labor contract in which workers are paid a share of a purse instead of a salary or hourly wages, or performance based compensation based on output (such as bonuses).

Tournaments are common:

- Salespeople are paid prizes for outselling their peers.
- Up or out promotion decisions.
- Some industrial settings use explicit tournament wages.

However, tournaments are not as common as performance based pay, such as sales commissions or bonuses for reaching specific goals. Tournaments force workers to vie against one another and pay them according to their order of finish (called, rank order).

Tournaments are different from the Super Star phenomenon. Pyramiding of talent across firms, such as the sorting of talent between the orchestras in big cities, those in smaller cities, and those in Podunk places is *not* a tournament, at least not in the Lazea-Rosen sense. It is best described by the super star effect, another paper that Rosen wrote.

The Lazear & Rosen paper on tournaments is seminal and elegant. With elegance comes subtlety, and this causes confusion. It is useful to have a sense of the road map of the paper before working through the model.

L&R 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 is structured as follows:

- Two competitors vie for first and second place prizes paid by a firm organizing the tournament. Both competitors are identical and risk neutral, as is the organizer.

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[1] Lazear, Edward P. and Rosen, Sherwin . "Rank and Order Tournament: An Optimal Labor Contract" in <u>Journal of Political Economy</u> vol. 89. 1981, p 841-864.

- Competing takes effort. So, players will only participate in the competition if the expected prize is large enough to offset the cost of the anticipated effort they will expend.
- The decision-making process is two-fold. On one hand, the players determine the level of effort that they will have to exert to win the top prize. This effort level is shown to be a function of the prize spread and not the average level of the prizes. The bigger the spread, the more effort each player will be forced to exert in order to maximize the expected payoff.
- On the other hand, having determined the amount of effort that will be required, the player makes a determination of whether the expected prize is large enough to compensate for the work involved. If the expected share of the purse is insufficient to offset the pain caused by the prize spread, the player declines participation.
- In equilibrium, the tournament organizer is forced by competition to set prizes that are efficient on both margins of the players' decision making. The firm sets a prize spread that induces the efficient level of effort and it is forced to pay a purse that is sufficient to compensate for the pain evoked by the spread of the prizes it sets.

A. The Set-up in the Context of Piece Rate Pay

Consider the case of identical individuals ($i = 1, n$) who produce output q_i by applying effort m_i. The production process is affected by randomness, however. The mapping of effort into output is one to one except that it is disturbed by an error term, ε_i. That is,

$$q_i = m_i + \varepsilon_i$$

Let the error term be distributed with zero mean and standard deviation, σ. Supplying effort is costly to the individuals based on a function $C(m_i)$. Individuals are hired by firms. The only cost to the firms is the payments to workers. Assume that the workers and the firms are risk neutral.

First, consider the situation where the workers are paid on a piece rate basis. The firm agrees to pay workers r per unit of q. The expected earnings of each worker is

$$E\left[rq - C(m)\right] = rm - C(m)$$

Each worker maximizes expected wealth by setting $r = C'(m)$. (Expected wealth is their objective because they are risk neutral.) Earnings vary around this expectation, of course. Sometimes workers enjoy substantial returns above the cost of the effort they put forth. Other times they are under-compensated for their work, whereupon they curse and swear that the fates have conspired against them.

The firm enjoys profits of the difference between receipts and expenses. The firm receives V per unit of q while paying r per unit to each worker. The firm has no decision making alternatives in the case of piece-rate-pay. Competition drives r to V so that the firm makes zero profits. The firm is just a construct that is useful in imagining the formation of tournaments in this setting.

B. Workers' Behavior in the Tournament Contract

Next, consider the case of the tournament. Suppose that 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, suppose that 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. Let the high prize be W_1 and the low prize be W_2.

For any given worker the expected earnings are E[Prize] - $C(m)$. We can specify the expectation about the prize by labeling P as the probability of winning the tournament, with (1-P) as the probability of not winning. Expected earnings are then

$$PW_1 + (1-P)W_2 - C(m)$$

The worker supplies effort, m, in order to maximize expected wealth just like in the piece rate case. The FOC and SSOC look like

$$(W_1 - W_2)P'(m) - C'(m) = 0$$

and

$$(W_1 - W_2)P''(m) - C''(m) < 0$$

which give an optimum at m^*.[2]

The first and second derivatives of $C(m)$ are easy to imagine; C', $C''>0$. However, the relation between effort and the probability of winning is a bit more complicated. Let's think about what P means in the context of a tournament between individuals j and k, looked at from j's perspective. This identifies P as:

$$P = \text{prob}(q_j > q_k)$$

This says that person j out-produces person k and thereby wins the tournament.

$$P = \text{prob}(m_j - m_k > \varepsilon_k - \varepsilon_j)$$

This says that for person j to win, his net excess expenditure of effort must exceed his net dose of bad luck.

The best way to think about the probability is to imagine a density of bad luck, $\varepsilon_k - \varepsilon_j$, which we will call x. Let this density be $g(x; 0, \psi)$, that is, x is distributed with zero mean and some variance labeled ψ. P is the integral of this density of bad luck up to (m_j-m_k), i.e.,

$$P = \int_{-\infty}^{m_j - m_k} g(x; 0, \psi)\, dx$$

The idea is that player j chooses its effort level as a stake in the bad luck density. If j pushes effort beyond k, this moves the mark into j bad luck zone, $\varepsilon_k - \varepsilon_j > 0$. This means that it will take bad luck for j to lose. That is, j steals some of k's good luck and thus raising the probability of winning above ½. This is shown in Figure 1. The shaded area under the density is the

[2] Where P' is the derivative of P w.r.t. m. More on this in a moment.

probability. Because *j* pushes its effort above *k* it overcomes some of the probability of bad luck and raises the probability of winning above 50%.[3]

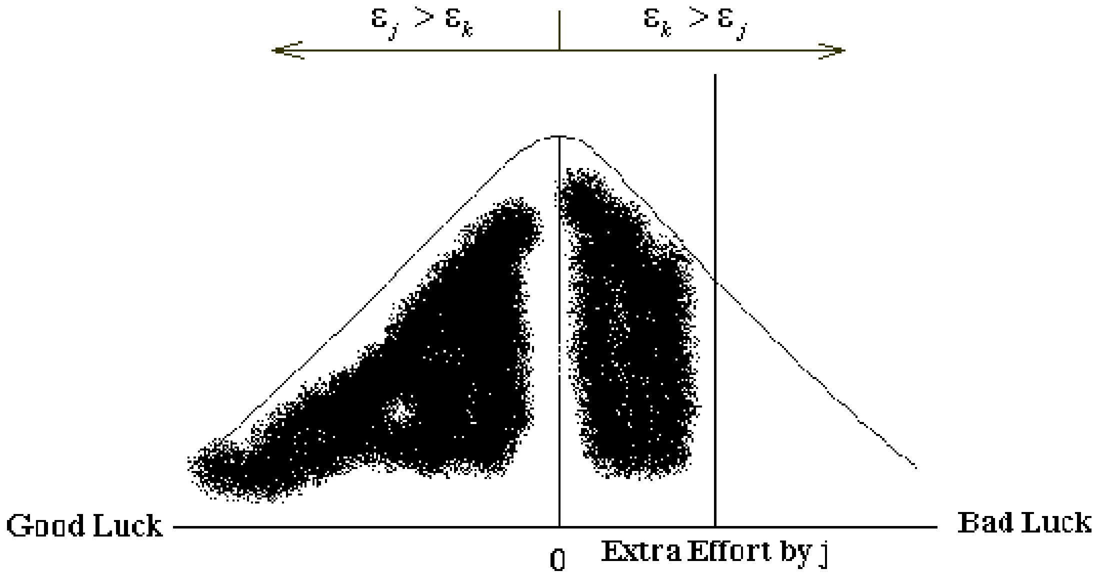

Figure 1: Probability of Winning

It is revealing to graph the distribution using computer simulation. The following simple SAS program generates two normal variates with different mean and the same variance. The program does some sample statistics. The variable 'diff' measures winning. If 'diff' is positive then worker *j* wins. The probability of winning is given by the frequency of the variable 'diff' greater than zero. The frequency plot of 'diff' shows that it has a normal shape.

```
data tourneys;
mj=1.5; mk=1; s=2;
do i=1 to 10000;
x=rannor(123579)*s+mj;
y=rannor(123579)*s+mk;
diff=x-y;
output;      end;
proc univariate; var diff; run;
proc gchart; vbar diff
        /type=percent midpoints=-10 to 10 by 1
        raxis=0 10 20 30 ;
run;
```

The program can be simulated to show changes in the probability of winning as the parameters of the game change. As the effort put forth by the two workers is closer together, the probability of winning converges toward .5 and the density of 'diff' becomes centered on zero. As the variance of the distribution of production changes, the effect on the density of winning changes. Changes to 's' in line 2 show this effect. For instance, if 's' is changed from 2 to 1, the density of winning (i.e., 'diff') becomes much more peaked.

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[3] Thanks go to Tom Evans for suggesting this development of the probability. The discussion in the Lazear and Rosen paper is not quite as lucid on this as it might be. They talk about a cumulative distribution function, called

Lazear and Rosen assume that the error terms of the productivity functions, ε*ᵢ*s, are normally distributed. The density of bad luck, *x*, is then normally distributed with a variance of two times the variance of the error terms.

In this context, then, we can identify the derivative of *P* w.r.t. effort, *m*. It is

$$P' = g(x\big|_{x=m_j-m_k};0,2\sigma^2)\,.$$

This value is simply the height of the density at the point of the effort differential.

At this point we have identified the probability of one person winning as a function of his own effort level, the effort level of his competitor, the distribution of bad luck. To make this operational, we must identify the effort level of the competitor. A harmonious equilibrium assumption is that termed *Nash-Cournot*. It means that we assume each competitor optimizes against the optimal investment of his competitor with the expectation that the competitor will not change his production strategy in response to alternative choices. Each player expects that his competitor will do the best thing based on the expectation of his own choices, but since effort is already determined when the strategy of the other player is revealed, there is no feedback.

Given that both players employ a Nash-Cournot strategy, the equilibrium is that $m_j^* = m_k^* = m^*$. The FOC for each player then say that the marginal cost of effort must equal the spread of prizes times the height of the density function at $[m_j^* - m_k^*] = 0$. That is,

$$\left[W_1 - W_2\right]g(x\big|_{x=0}) = C'(m^*)$$

The Nash-Cournot assumption also means that the SSOC is satisfied for normal distributions because $P''(m) = g'(0)$ is the slope of the density at its mean, which is zero.[4]

The comparative statics are captured by expressing worker-optimized effort as:

$$m^* = m^*(\left[W_1 - W_2\right],\sigma) \qquad 1$$

The function $m^*(.)$ defined by the FOC and SSOC of the worker's optimization process yields comparative static results. The parameters of the problem are W_1, W_2, and the distribution of luck. Mechanically we derive results in terms of the prizes separately, i.e., we take the derivatives $\partial m^*/\partial W_i$, for i = 1&2.

However, the more meaningful interpretation is to think of the tournament in terms of the purse and the spread, that is, (W_1+W_2) and (W_1-W_2). The comparative statics say that the players do not adjust effort based on purse, that is, $W_1 + W_2$, but only on spread. In other words, the partial of m^* w.r.t. an increase in the higher prize is equal to the negative of the partial w.r.t. the lower prize. Hence, a change in purse that leaves the difference unchanged has no effect on effort.

Purse does affect behavior, but not through the function $m^*(.)$ as it is defined by the FOC and SSOC. Purse determines whether the workers will play the game. The probability of winning

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G(.), which is the integral of *g*(.).

[4] We write *g*(0) as shorthand for $g(x{=}0;\,0,2\mathrm{s}^2)$.

the higher prize, given the Nash-Cournot assumption, is 50/50. If expected earnings are negative, i.e.

$$\tfrac{1}{2}\left[W_1 + W_2\right] - C(m^*) < 0, \qquad 2$$

then the competitors don't compete. They stay home.

The other result concerning the behavior of the tournament players is the change in effort w.r.t. a change in the variance of the distribution of bad luck, i.e., σ. Differentiating w.r.t. this parameter yields:

$$\frac{\partial m^*}{\partial \sigma} = \frac{(W_1 - W_2)\dfrac{dg}{d\sigma}}{C''}$$

The sign of this expression depends on the relation between g and σ. To evaluate this we must make some assumption about the distribution of ε. A reasonable assumption is that it is normal. In that case, if the variance of the normal distribution increases, the height of the density at the mean becomes smaller, i.e., $g(0)$ falls.[5] This implies that an increase in variance causes effort to fall.

C. Organization of the Tournament by Firms

Next we analyze the behavior of the firms. Workers optimize subject to the constraints imposed on them by the firm. The firm is in control of the purse and the prize spread, and in the tournament setting, it adjusts these to maximize profits. However, the forces of competition limit the firm in the dimension of both purse and spread.

Let's look at purse first. Competition forces the firm to pay a purse equal to the expected production of the workers. In other words, competition among firms drives profits for all firms to zero, and in this case it is zero *expected* profits. The purse becomes:

$$W_1 + W_2 = (m_j^* + m_k^*)V$$

Since the optimal behavior of the tournament competitors is identical, this can be written as

$$W_1 + W_2 = 2m^*V$$

However, the firm has to make the right choice of in terms of the spread of prizes even to achieve zero profits; the wrong choice means that the firm experiences losses. By choosing the spread the firm raises or lowers its expected receipts because $m^*(.)$ is a function of spread. While m^* is everywhere increasing in the spread up to the point where expected worker returns are zero, competition again limits the behavior of the firm. In order to attract workers, the firm must offer a spread for any given prize that maximizes worker returns. Thus the firm's behavior is aligned with the worker's interests by competition. The firm chooses the spread in a way that

[5] Note the typo in the L-R paper—for the normal, $g(0)=1/[2\ \sigma\ \sqrt{\pi}]$.

maximizes expected earnings to the worker. Under the Nash-Cournot assumption that $P = ½$, expected worker returns can be written as:

$$m^* V - C(m^*)$$

The partial of workers' expected earnings w.r.t. the spread is given by

$$\left[V - C'(m^*)\right] \frac{\partial m^*}{\partial (W_1 - W_2)} \qquad 3$$

where $\partial m^* / \partial(W_1 - W_2)$ is derived from the comparative statics of the workers behavior function. Since this partial is not zero, (3) is set equal to zero by adjusting the spread so that V is equal to $C'(m^*)$. This says that the firm chooses the optimum spread based on the equality of worker's marginal cost and the marginal value of output.

In the Lazear-Rosen model, the workers get all of the surplus. However, the distribution of the surplus between $m^* V$ and $C(m^*)$ has no implications in the model. Consider the model derived in the context of a monopsonist contracting with the two workers. The monopsonist will maximize expected profits:

$$\pi = 2m^* V - R$$

where $R = [W_1 + W_2]$ is the purse and m^* is the optimal behavior of the workers as given in equation (1). The monopsonist maximizes profit by the optimal choice of purse and prize spread subject to the participation constraint identified in equation (2). The monopolist must pay the workers enough to get them to play.

The constrained objective function of the firm can then be written in Lagrangian form as:

$$\max_{\{S,R\}} \pi = 2m^*(S)V - R + \varphi \left(\frac{R}{2} - C(m^*(S)) \right)$$

where S is the prize spread, $[W_1 - W_2]$, and φ is the Lagrangian multiplier. The first order conditions reduce to two equations in prize spread and purse:

$$V = C'(m^*(\tilde{S}))$$
$$\tilde{R} = 2C(m^*(\tilde{S}))$$

So, the monosonist chooses the spread of prize based on the same condition as the competitive firm. It equates the marginal cost of output to the price of output.

Notice that (3) proves two major propositions of the paper: First, it proves that hourly wages are inefficient. Hourly wages are defined by this model as a spread of zero. The optimal spread is not zero. Second, this proves that the optimal tournament is identical to piece-rate-pay. Equation (3) is the same result that we found in the case of piece-rate pay.

D. Competitive Equilibrium Comparative Statics

The equilibrium of the workers' behavior and the firm's behavior reduces to three equations that identify the level of the spread and the purse:

$$\tilde{S} = \tilde{W}_1 - \tilde{W}_2 = C'(\tilde{m})g^{-1} \qquad 4$$

$$\tilde{R} = \tilde{W}_1 + \tilde{W}_2 = 2\tilde{m}V \qquad 5$$

$$V = C'(\tilde{m}) \qquad 6$$

The first is the worker's effort-behavior function, the second is the zero profits market condition, and the third is the market condition that identifies the optimal spread of prizes. These can be solved for the two prizes separately. Note that the effort function denoted in equations (4) – (6) is not starred but rather designated with a '~'. This is to indicate that the effort function in these expressions is a restricted form of the effort function shown in Equation (1). It is the worker behavior function given the optimal tournament structure chosen by the firm. That is,

$$\tilde{m} = m^*([\tilde{W}_1 - \tilde{W}_2], \sigma)$$

This point is apparent in a moment.

The comparative statics can be derived formally, but they are reasonably clear from inspection. The two parametric changes that interest us are: What happens when the value of output goes up, and what happens when the randomness of production increases? To answer the first question, when the value of output goes up, effort becomes more valuable, the firm increases the spread to account for this, and it is forced to pay more to the workers to compensate for this.

The answer to the second problem is somewhat more paradoxical. When the variance of productivity increases, the tendency of workers is to exert less effort because the marginal effect of effort has fallen. However, the firm can completely offset this by increasing the spread, which it does. Within the equilibrium of the market for workers paid through a tournament, the variance of production has no effect on effort, the value of production, or the expected pay to workers. It only affects the spread of prizes.

The comparative statics are derived formally in the following way. The comparative statics tell us the changes in the behavior response variables—spread, purse, and effort—w.r.t. changes in the economic environment variables—price and the standard error of bad luck. The following matrix representation summarizes the effects:

$$\begin{bmatrix} 1 & 0 & -C''/g \\ 0 & 1 & -2V \\ 0 & 0 & -C'' \end{bmatrix} \begin{bmatrix} \dfrac{\partial \tilde{S}}{\partial V} & \dfrac{\partial \tilde{S}}{\partial \sigma} \\ \dfrac{\partial \tilde{R}}{\partial V} & \dfrac{\partial \tilde{R}}{\partial \sigma} \\ \dfrac{\partial \tilde{m}}{\partial V} & \dfrac{\partial \tilde{m}}{\partial \sigma} \end{bmatrix} = \begin{bmatrix} 0 & -C'\dfrac{\partial g}{\partial \sigma}/g^2 \\ 2m & 0 \\ -1 & 0 \end{bmatrix}$$

Solving the system of equations gives the following results:

$$\frac{\partial \tilde{S}}{\partial V} > 0\ ;\ \frac{\partial \tilde{R}}{\partial V} > 0\ ;\ \text{and}\ \frac{\partial \tilde{m}}{\partial V} > 0$$

When price goes up, the spread goes up because the firm must increase the effort level of the players in order to satisfy equation (3). That is, an increase in V requires that C' to increase, but to get C' up, the firm must increase the spread. Competition forces the firm to pay out the increased value of the output to the players; this implies that the purse increases.

Again, in order to say something about the comparative statics w.r.t. σ, we must make an assumption about the distribution of ε, and again, let's say it is normal. Hence, $dg/d\sigma$ is negative. This means:

$$\frac{\partial \tilde{S}}{\partial \sigma} > 0; \frac{\partial \tilde{R}}{\partial \sigma} = 0;\ \text{and}\ \frac{\partial \tilde{m}}{\partial \sigma} = 0\,.$$

An increase in variance has the marginal effect on workers of inducing them to supply less effort. The firm can perfectly offset this by increasing the spread. Hence, the equilibrium effort is unchanged as is the level of the purse. (Interesting. How can this result hold in the limit as σ approaches infinity?)

E. Discussion and Extensions

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 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 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.[6] The tournament is superior to effort based pay if the firm cannot measure effort.

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 (one not noted by Lazear and Rosen) 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,

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

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 is why salespeople are very often paid in terms of prizes based on who sold the most. It is 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 (1972)[7] 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.

F. Empirical work

The major focus of prior empirical studies of the tournament model has been the responsiveness of players to incentives. Bull, Schotter, and Weigelt (1987) perform experimental tests of the tournament model. They look at a two person game using students as subjects. Their findings are that the tournament model is generally supported. Tournaments on average induce the same level of effort as direct pay for performance. Furthermore, factors that predictably affect the level of effort in the tournament setting do yield the predicted effect. Bull, et al., vary the cost of effort and the degree of randomness in offsetting ways. The prediction is no effect on effort, which is what they find. However, there is no test of the relation between purse and prize spread.

Ehrenberg and Bognanno (1990) investigate the incentive effects present in professional golfing. In professional golf, the prize structure is constant across tournaments. Thus, prize differentials between finishing positions increase proportionately with the purse. This means that when performance is compared between tournaments, a larger purse implies larger differentials between finishing positions and, therefore, larger purses should result in better performance. The authors find this to be the case. However, their research does not present a direct test of the relation between the prize structure and purse.

Knoeber and Thurman (1994) draw evidence from an industrial setting that does offer variation in these two features of the tournament setting. They examine payments made to chicken farmers who, for a period of time, were compensated in the form of a tournament. During this time, base pay changed but the incremental pay remained the same. The Lazear-Rosen model says that for players who choose to participate in a tournament, performance should remain the same as average pay changes but the prize differential remains the same. This is what the Knoeber and Thurman find. However, the authors have data from only one tournament organizer. Hence, they are unable to investigate competition among firms for player/workers.

Knoeber and Thurman say that tournament theory predicts that there should be no relation between the amount of effort exhibited by a player and the size of the purse. Their description of the tournament model in this regard is correct within the context of their test of the

[7] Alchian and Demsetz. "Production, Information Costs, and Economic Organization" AER, Vol.62, No. 5 (Dec., 1972), pp. 777-795.

theory. However, it is not complete and it is somewhat misleading as it applies to some empirical work. The Lazear-Rosen tournament model is more completely described as a two-step decision making process by the players. Purse has no affect on the marginal effort exerted by the players once they are competing. However, it does have an impact on their willingness to play. This aspect of the theory is important because this is the driving force of the equilibrium that we are able to observe in the motorcycle racing data from Terkun.

An aspect of tournaments observed in practice that is not well developed by the theory is the presence of multiple competitors. Many, indeed, most tournaments involve competition among more than two competitors. Rosen (1988) develops the model for elimination tournaments and shows that the prize differences should optimally increase between elimination levels. However, when a tournament is conducted among many players simultaneously competing, theory does not speak loudly about how the prizes are optimally scaled.

Ehrenberg and Bognanno skirt this issue. They perform two tests of tournament theory. First, they regress golf scores accumulated over a whole tournament on the tournament purse. Second, they look at scores in the final round of golf tournaments. In the final-round analysis, they treat the marginal prize as the differential in payout that occurs if the player moves up or down one position from his third round finish. This is an insightful way to handle the problem, but it dodges the issue of how prize differentials across the entire range of payouts influence behavior.

Knoeber and Thurman suggest that constant differentials between competitors/workers may be optimal though they do not explicitly develop the underlying theory. In chicken production, tournament payouts were characterized by constant payment increases as growers moved up the ladder.[8] Knoeber and Thurman do not specifically discuss the efficiency characteristics of this plan except in the context of workers of different abilities. The ordinal ranking payout system was changed to a payout system based on comparison of individual grower productivity to the average. Here, too, payments were a linear function based on differences from the average. Producers receive a base price per pound for the average level of performance. Performance is based on a producer's cost of production relative to the mean across producers in a cohort. Producers then are rewarded bonuses or incur penalties according to a linear performance scale as their cost deviates from the mean. That is, they are paid the base plus or minus the difference between the mean cost of production and individual costs of production. Rewards increase in proportion to the decrease in production costs (and vice versa) but the difference between successive rewards neither grows nor contracts.[9]

Linear differentials between either ordinal ranks or explicit productivity measures may be efficient. However, there are two points that give pause to this conclusion. First, in chicken farming, the prize structure is dollars per pound, and the payment is based on this payout times the pounds delivered to the processor. The linearity of this payment process is arguable. Everything else the same, if the reward structure increases the payment per pound as efficiency increases, and if the behavior that results in a higher payment per pound also results in more

[8] When paid in a tournament format, growers were grouped in quartiles based on their relatively productivity. The payments made to each quartile were linear increases from the base.

[9] The issue is complicated somewhat by the fact that the reward scale is price per pound. To some extent, the lower is a producer's cost of production, the higher is total pounds. The variation in total pounds across producers in a cohort is not known with precision.

pounds delivered to the processor, then the actual payout is an increasing function of effort.[10] Second, on the theory side, Cheung (1983) in discussing piece-rate pay asserts that an increasing payout is optimal.

Terkun and Maloney report the results of an analysis of prize structures among competing sponsors in a tournament. In motorcycle racing, different firms sponsor prizes in the same race. Some of these sponsors are in direct competition with each other. That is, racers who compete for the prizes paid by one sponsor are not eligible for the prizes paid by another. They find that where there is direct competition among sponsors, sponsors are forced to lower the incentive intensity of their prize differentials as other sponsors pay more money.[11] This result is a specific prediction of the simple Lazear and Rosen model of tournaments.

This is an interesting test of tournament theory because there has been no previous research specifically analyzing the competitive equilibrium among tournament organizers. Indeed motorcycle racing may offer a unique opportunity to engage this experiment. This may be the only place where we see firms competitively bidding for a common pool of workers by posting payment offers in the form of tournament prizes.

This is an important test of tournament theory because it offers independent corroboration of the fundamental principles. Tournament theory is based on the premise that workers respond to prize incentives by working harder, and working harder is not free. On the one hand, this has been tested by examining the behavior of tournament participant. On the other hand, Terkun and Maloney find support for the nested proposition that firms recognize that they can get more out of workers by increasing the incentive intensity of prizes paid in a tournament setting, but that this comes at a price that must be compensated for in the competitive equilibrium. Taken together there is evidence that workers respond to the incentive effects of tournaments, and this is confirmed by the independent observation that firms also recognize these responses and anticipate this behavior when making their wage offers.

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Knoeber, Charles R. and Thurman, Walter N., “Testing the Theory of Tournaments: An Empirical Analysis of Broiler Production,” *The Journal of Labor Economics*, Vol. 12, 1994, pp: 155-179.

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[10] There is a caveat in that the birds are harvested when they reach a target weight. How much variation is present in total weight across growers is not precisely known.

[11] Terkun and I assume that all motorcycle racers are of identical ability. This fact is putatively false as shown by the fact that some racers win consistently and some never win; some receive large salaries, and some receive no salary at all.

1. Does the fact that our assumption is contradicted by reality cast doubt on the validity of our theory?
2. What is lost by making this assumption?
3. What could be gained by modifying the assumption to account for the fact that racers have different abilities?
4. What is gained by assuming that all racers are the same?

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See also Lecture 10, Econ 827, Property Rights, M.T. Maloney, 'www.clemson.edu/~maloney'.

First Winner Advantage:

This concerns a problem in sports that we all have mused about. Consider a contest in which there are three stages. An example is women's professional tennis. The game is determined by winning two out of three sets. The question is, Does the winner of the first round gain a competitive advantage by this early victory because the loser is disheartened and plays less hard? Simple tournament theory offers an answer.

Assume that the two contestants have identical talent. In the first stage, they will exert identical effort and the probability of winning for each must be .5. One wins and the other loses. We want to know how their effort levels change and possibly diverge in the second set.

Let G be the payoff from winning the contest. P is the probability of winning (defined for each stage). Effort comes at a cost. Let m be effort and $C(m)$ be the cost of effort. Cost increases at an increasing rate as more effort is exerted; i.e., the first and second derivatives of cost with respect to effort are positive.

The objective function of the first stage winner in the second stage can be specified as:

$$\pi_1 = P(m_1)G + [1 - P(m_1)]\{\overline{P}G - C(\overline{m})\} - C(m_1)$$

where π_1 is the net, expected payoff from winning the second round of the contest. The objective function of the first stage loser looks like:

$$\pi_0 = P(m_0)\{\overline{P}G - C(\overline{m})\} - C(m_0)$$

The bracketed expression in each is the net expected payoff from winning the last round, should it be played. In that event, $\overline{P}$ is again one-half and $\overline{m}$ is the optimal effort at that point. The important thing is that these values are unaffected by the choice of effort in the second round.

The second stage objective functions can be explained as follows: the first stage winner can win the prize in the second stage (this is the first term on the right side of his objective function). Failing that, she has the right to compete in the third stage and this has an option value. The first stage loser must win to stay in the hunt for the prize in the third stage. In the second stage the first stage loser is only playing for the option value of getting to the third stage.

The first stage winner's objective function is the probability of winning, P, times the payoff, G, plus the probability of losing, (1-P), times the third stage expected outcome (the bracketed term) all minus the cost of effort in the second stage. The first stage loser’s objective function is the probability of winning the second stage times the expected net earnings in the third stage minus the cost of effort in the second stage.

The first order conditions are fairly simple:

$$\frac{\partial \pi_1}{\partial m} = P'(m_1)G - P'(m_1)\{\overline{P}G - C(\overline{m})\} - C'(m_1) = 0$$
$$\frac{\partial \pi_0}{\partial m} = P'(m_0)\{\overline{P}G - C(\overline{m})\} - C'(m_0) = 0$$

where P' is the change in the probability of winning as the competitor exerts more effort, and C' is the increase in cost as effort increases. As noted above, the probability of winning and the cost of effort in the final stage, should it occur, are not affected by effort in the second stage.

Collecting terms and rewriting allows us to compare the implied behavior of the two players:

$$G - \{\overline{P}G - C(\overline{m})\} = \frac{C'(m_1)}{P'(m_1)} >< \frac{C'(m_0)}{P'(m_0)} = \{\overline{P}G - C(\overline{m})\}$$

The expression on the left of the inequality is the behavior of the first stage winner. The expression on the right of the inequality is the behavior of the first stage loser. In both cases, the players equate the net payoff from winning to the ratio of the marginal cost of effort, C', divided by the marginal effect of effort on the probability of winning, P'. Identification of the marginal effect of effort on the probability of winning is problematic. Fortunately, it cancels out.

On each side of the inequality, optimal effort is driven by the level of the prize. That is, as prize money increases, so does optimal effort, i.e., $\frac{\partial m_i}{\partial G} > 0,\ i = 0,1$. As prize money increases, in order to balance each of the equalities, C'/P' must increase, which it does as the player puts forth more effort. This is true because the cost of effort rises faster than the probability of winning as the competitor plays harder. If this weren't true, the player would exert infinite effort.

This means that there is a unique, optimal effort level for both players that is based on the net payoffs that they face in the second round. If they face different payoffs, they will respond with different effort levels. So the inequality hinges on the net payoffs.

Thus, we can write:

$$[G - \{\overline{P}G - C(\overline{m})\} > \{\overline{P}G - C(\overline{m})\}] \Rightarrow [m_1 > m_0]$$

If the left side dominates, then m_1 is bigger than m_0 and the first stage winner plays harder in the second round than does the first stage loser. The payoff in second stage for the first stage winner is the prize, *G*, should she win. However, the incentive of this payoff is muted by the net payoff from the third stage because losing in the second stage does not eliminate the first stage winner. On the other hand, the first stage loser is playing only for the net expected payoff from the third stage.

This inequality can be rewritten as:

$$[G > 2\overline{P}G - 2C(\overline{m})] \Rightarrow [m_1 > m_0]$$

Note that the right-most expression can be simplified:

$$2\overline{P}G - 2C(\overline{m}) = G - 2C(\overline{m})$$

because $\overline{P}$, the probability of winning in the third stage, is one-half. In the last stage, both players have identical incentives and, hence, will exert equal effort, so the probability of winning is equal.

Thus, our inequality reduces to:

$$[2C(\overline{m}) > 0] \Rightarrow [m_1 > m_0]$$

Thus, the first stage winner faces a higher payoff in the second stage, which means that she will exert more effort in that stage. The payoff to the first stage winner in the second stage is $2C(\overline{m})$ bigger than the payoff to the first stage loser. This means that the odds are that the first stage winner will win the match just because the first stage loser shirks in the second stage. Or, put differently, the first stage winner gains an advantage because she is willing to put out more effort in the second round than is the first stage loser. There is a relative shirking effect by the first stage loser.

While the result implies that there is a bias in the outcome for the first stage winner, we can calculate the magnitude of the effect on the basis of the payoffs from the game. It turns out that the effect necessarily must be small.

First, for the loser of the first stage to find it profitable to play the second stage, it must be true that expected net payout from the second stage is positive. Recall the first stage loser's payoff function:

$$\pi_0 = P(m_0)\{.5 \cdot G - C(\overline{m})\} - C(m_0)$$

We are not sure about the values for $P(m_0)$ and $C(m_0)$. We know that $P(m_0)$ must be less than one-half because the other player exerts more effort in the second stage. However, we are not sure exactly how much effort either exerts relative to the effort they will put forth in the last stage, should it occur. Intuitively, effort increases for both players throughout the contest.

Even so, we can get an approximation of the magnitude of our problem by making the simplifying assumptions that $P(m_0) = .5$ and that $C(m_0) = C(\overline{m})$. Thus, the second stage participation constraint is:

$$\tfrac{1}{4}G - \tfrac{3}{2}\overline{C} > 0\,.$$

In other words, if *C* in the second round is bigger than something like one-sixth of *G*, the loser of the first round will simply concede defeat at that point.

To put this in perspective, the payoff difference for the two players after the first round is $2\overline{C}$. The participation constraint shown above says that the winning prize must be something like three times this amount. This implies that the shirking effect in the second stage by the first stage loser is substantially less than the overall incentive to play the game.

M.T. Maloney
11/26/2003

Note: The idea for this discussion comes from the Ph.D. dissertation of Todd McFall at NC State. His derivation is slightly different, but reaches the same conclusion.

MARKET POWER & THE ORGANIZATION OF TOURNAMENTS

BY
M.T. MALONEY
CLEMSON UNIVERSITY*

Abstract: An extension of tournament theory to include the case of market power gives additional insight into the factors that influence the firm's choice of labor contracts. When the firm has market power it can extract the full surplus from workers by paying them tournament wages. The only way to achieve the same result with ordinary labor contracts is to make workers pay for a higher wage. When there is randomness in the production process, non-linear pricing even of this sort becomes problematic. Transactions costs make tournament wages the more likely choice for the firm when it attempts to exploit market power.

Introduction

Tournament theory has gained a solid place in the lexicon of labor markets. Since the seminal paper by Lazear and Rosen (1981) we have become aware of the ubiquitous circumstance of tournament wages as a component of worker compensation. Indeed, the more we look, the more we find.

Even so, tournament theory is nagged by the problem originally addressed by Lazear and Rosen. Since tournament wages possess the same efficiency characteristic as piece-rate pay, what "breaks the tie in practical situations."[12] Lazear and Rosen appeal to measurement cost. For instance, they say, "Salesmen, whose output is easily observed, typically are paid by piece rates, whereas corporate executives, whose output is more difficult to observe, engage in contests."[13] But even here the sands shift beneath the theory. It is very common for salesmen to be paid by contests as well.[14]

This puzzle pops up again and again. Consider, for example, the labor market described by Knoeber and Thurman (1994). They report data taken from the records of a major chicken processing company in its dealings with farmers contracted to raise birds. Over the course of the sample period, the processor changed its labor contracts from tournament-based wages to mean-adjusted piece-rate pay. What caused this change in regime? Measurement costs alone do not seem to be the explanation.

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* Thanks go to Dan Benjamin and Jiangxia Wang for helpful comments. Additionally, a debt is owed to Benjamin and Bob Tollison for encouraging me to work on this topic. Contact information at end.

[12] Lazear and Rosen, p. 848, (paraphrased).

[13] Id.

[14] Personal experience yields two examples of firms using tournament wages in addition to sales commissions. United Healthcare circa 1990 held contests among its sales staff offering expense paid trips to Paris for the top performers. Brunswick as far back as the 1980s has sent the top sales people to Hawaii.

Another example echoes the same riddle. It has been observed that from time to time in some southern textile firms, production-line waste material is collected by forklift operators on a periodic, intermittent basis. Once a week or so, forklift operators set about the plant picking up bundles of waste and depositing these at a common site. The pay for this chore comes from a pool that is split among these workers based on the *rank order* of their performance. In other words, for this particular chore, these workers are paid tournament wages. Interestingly, they are paid tournament wages when they could just as easily be paid by the piece. That is, the scores used to rank them ordinally could be used to pay them directly.

This paper uses a simple extension of the Lazear-Rosen model to help explain these phenomena. The extension involves the effect of market power in the organization of labor markets.

Market Power in the Tournament Model

The simple Lazear-Rosen model is familiar: two risk neutral, equally matched player/workers are paid from a purse comprised of a high and low prize. The high prize is paid to the top performer; the loser gets the low prize. These tournament wages are paid by a competitive firm and all surplus goes to the workers. The results of the model are equally familiar. Workers perform identically in an efficiently structured tournament compared to piece-rate pay.

Even though Lazear and Rosen set up the model using the assumption of competitive tournament organizers, this is not necessary to derive their results. Their model implicitly embodies a surplus between the value of output and the worker's cost of effort to produce that output. In the competitive setting, firms are forced to pay out this surplus to the workers.

In the Lazear-Rosen framework, optimal effort is implied by the following equation:

$$\left[W_1 - W_2\right]g = C'(m^*) \qquad 7$$

where W_1 and W_2 are the high and low prices, g is the height of the density of luck in determining the winner, m is effort, and C is the cost of effort to the worker.[15] Thus, optimal effort by the worker, m^*, is an implicit function of the prize spread and variance of winning, but not a function of expected earnings.

Expected earnings enter worker decision-making through the participation constraint. The worker will only play if the expected payout is at least as large as the cost of effort. That is,

$$\tfrac{1}{2}\left[W_1 + W_2\right] - C(m^*) \geq 0 \qquad 8$$

where one-half the purse is the expected prize.[16]

In competition, the purse equals the value of output, V, times expected production, i.e.,

$$W_1 + W_2 = 2m^*V \qquad 9$$

[15] The notation here is nearly identical to Lazear and Rosen; see p. 846. Production is characterized by a noisy relation between labor effort supplied, m, and output, q; $q=m+\varepsilon$, where ε has zero mean and constant variance.
[16] Given homogeneous workers and the assumed Nash-Cournot equilibrium.

and the expected prize to each player is m^*V. In order to be competitive the firm maximizes the difference between the expected prize and the cost of effort by the optimal choice of prize spread. This gives the condition that:

$$V = C'(m^*) \tag{10}$$

which is the same result found for competitive piece-rate pay.

However, the distribution of the surplus between m^*V and $C(m^*)$ in equations (2) and (3) has no implications in the model. Consider the model derived in the context of a monopsonist contracting with the two workers. The monopsonist will maximize expected profits:

$$\pi = 2m^*V - R$$

where $R = [W_1 + W_2]$ is the purse and m^* is the optimal behavior of the workers as given in equation (1). The monopsonist maximizes profit by the optimal choice of purse and prize spread subject to the participation constraint identified in equation (2). The monopolist must pay the workers enough to get them to play.

The constrained objective function of the firm can then be written in Lagrangian form as:

$$\max_{\{S,R\}} \pi = 2m^*(S)V - R + \varphi\left(\frac{R}{2} - C(m^*(S))\right)$$

where S is the prize spread, $[W_1 - W_2]$, and φ is the Lagrangian multiplier. The first order conditions reduce to two equations in prize spread and purse:

$$V = C'(m^*(\widetilde{S})) \tag{11}$$
$$\widetilde{R} = 2C(m^*(\widetilde{S})) \tag{12}$$

The important result is the first of these. It says that the monopsonist firm does just like its competitive brother. The optimal spread is set such that the marginal cost of worker effort is equal to the value of output. Equation (5) is the same efficiency condition derived by Lazear and Rosen shown in equation (4).[17] Given this spread, the monopsony firm pays the minimum purse necessary to induce the workers to participate.

The only difference between the monopsonist and the competitive firm is the distribution of the surplus.[18] In competition, the workers get it: the purse is $2m^*V$. In monopsony, the firm keeps the surplus. The optimal purse is just sufficient to cover the cost of effort by the workers (equation 6) and the firm pockets the difference between m^*V and $C(m^*)$. However, the prize spread, effort level, and expected output is the same.

Optimal Contracting

The result derived above is really nothing more than showing that a tournament can be used to price discriminate. In the situation where the firm has monopsony power, profits are

[17] See p. 846.

[18] The surplus implicit in the Lazear-Rosen model can be thought of as consumer surplus in the labor-leisure model as discussed later.

enhanced by price discrimination and this is exactly what the tournament does. Of course, the firm could price discriminate using straight wages or piece-rate pay. So the question becomes, Which contract allows for price discrimination with lowest transactions costs?

To illustrate the point, it is enlightening to explore the problem using the standard theory of labor supply. Consider an ordinary supply of labor taken from the labor-leisure model of consumer behavior. The labor market equilibrium is defined by the aggregation of all workers and firms in the market. At this equilibrium, consider the firm's demand for an individual worker and that worker's supply. At the intersection of the worker's supply and the demand for labor by a firm, we can define an income compensated supply of labor. This income compensated supply is based on the utility level enjoyed by the worker at the equilibrium.

Now, assume that demand for labor increases but that this increase is known to be transitory. Figure 1 shows the situation. The initial equilibrium is defined by the demand curve, D_0. The transitory demand is D_1.

Arguably in the face of this transitory shift in labor demand, the firm has monopsony power over workers. If the duration of the shift is sufficiently short, neither workers nor the firm search for alternative offers. In such a case, the firm acting as a single agent against a larger number of workers can exploit its bargaining-power advantage and act as a monopsonist.

This situation offers several possibilities. One, the firm hires additional labor by paying a higher wage and moving along the ordinary supply of labor. However, in doing so the firm sees the cost of labor rising faster than the wage. The marginal factor cost lies above the supply. The firm hires an inefficiency small number of workers. This supply of labor is usually defined based on a standard wage rate paid per unit of labor supplied. It applies equally to the case of piece-rate pay in an expectational sense for risk-neutral individuals.

Alternatively, the firm can offer wages based on a tournament. In doing so, the firm moves along the income compensated supply curve. The equilibrium for the monopsony firm paying tournament wages is the intersection of the compensated supply curve and D_1.

Standard consumer theory tells us that the area to the left of the income compensated supply is the labor surplus for the extra effort and that the area under the compensated supply over this range is the minimum payment that must be made to workers to get them to put forth the additional effort. Along the compensated supply, the area to the left between w_0 and w_1 reflects the amount of non-labor income that the worker would be willing to pay in order to receive the wage rate w_1 instead of w_0. This is labeled A in Figure 1. The firm can monopsonize the workers by capturing this area and only paying the area under the compensated supply, i.e., the area labeled B. The area beneath the function between w_0 and w_1 represents the minimum payment that the worker will accept to supply the addition labor L_0 to L_1. The area under the compensated supply can be interpreted as $C(m^*)$ in the tournament model.

While standard theory is straightforward on these points, what is possibly less clear is that a tournament wage can be structured so that the worker is induced to provide $(L_1 - L_0)$ additional units of labor for a payment of B. However, this can be shown as well. The firm creates a tournament between two players in which the purse is equal to the combined required earnings of the two. In this way the expected payout is equal to the required earnings. The purse is broken into two prizes such that the prize spread induces the extra effort along the compensated supply curve.

The tournament purse is $2B$, which means the expected prize is B for each worker. The purse is split into two prizes. In forming the optimal prize spread, the firm obeys equation (5).

The marginal cost of effort for the worker is defined by the compensated supply curve, and the firm equates this with its demand for labor in choosing the optimal spread. The worker responds according to equation (1). Effort is supplied up to the point where the marginal cost of effort is equal to the prize spread times the height of the density of luck in determining the winner of the top prize. The firm's problem is to find the spread to which the worker responds with $\{L_1,w_1\}$ out of a purse of $2B$.

The worker's response identified in equation (1) depends on the density of luck, which is not defined by the labor-leisure model. In the tournament model this density is based on the random component of productivity. Only if this is large relative to the wage will the firm be unable to structure a tournament that fully exploits its monopsony power.

On the other hand, neither straight wages nor piece-rate pay offer an easy way to capture the workers' surplus. In the case where there is no noise in the relation between effort and output the firm can make a direct all-or-nothing offer to each worker to supply the addition effort ($L_1 - L_0$) for a payment of B and achieve the same result as the tournament, but this is only true when the production process is non-stochastic. Indeed as randomness approaches zero, tournament wages become straight wages, in both monopsony and competition.

However, if there is a random component, then the firm will not be able to price discriminate by using either standard straight wage or piece-rate pay contracts. With a straight wage contract, the problem is what payment to make to the worker if output falls short of the contracted level for no fault of the worker. If the answer is zero, then the expected payment is not B and the worker refuses the all-or-nothing offer. Solutions to this conundrum can be devised but they will all cause the firm to end up paying more than B on average, thus leaving surplus on the table.

Similarly, standard piece-rate pay will fail. A price discriminating piece-rate scheme pays the worker more as output increases. However, if the worker is unfortunately unlucky, the actual wages earned will fall below the compensated supply curve and the work will stop. Again the firm can attempt to work around the asymmetry created by randomness in the production process, but any patch that involves manipulation of the piece-rate pay schedule will result in an expected payment in excess of B.[19]

It is true that the firm could price discriminate using piece rate pay or straight wages by *charging* the workers for the higher pay rate. In Figure 1, this would mean that the firm would offer wage of w_1 or an equivalent piece rate in exchange for a payment of area A from the worker. This will induce workers to exert additional effort up to L_1 at an expected additional cost to the firm of the area B.

However, making workers pay for the right to receive a higher wage adds transactions costs in the form of additional measurement or monitoring. The Lazear-Rosen model highlights one side of the monitoring problem within the firm. When there is randomness between output and effort, workers have an incentive to shirk. In this case both tournament wages and piece-rate pay align the incentives of the workers with the firm.[20] The other side of the monitoring problem is that workers must monitor opportunism by the firm, and this transaction cost becomes keen if

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[19] Recall that the main conclusion of the Lazear-Rosen model is that tournament wages have the same incentive effect as piece-rate pay in a competitive market. The reason that piece-rate pay is efficient in the competitive setting is that the pay rate is linear and pay averages out for the risk-neutral worker. When the firm attempts to price discriminate by using a non-linear rate schedule, randomness does not average out.

[20] And, by implication, straight wages are inefficient.

the workers are paying a price up front that extracts all of their surplus. Before workers are willing to buy a high wage, they must verify even in an expectational sense that they can earn enough to pay back their investment. With tournament wages, the expected payment is well defined.

As an example let's consider the case of the forklift-driving tournament mentioned in the introduction. In this setting the firm faces a fixed labor market. The task is minor. There is no call auction for these services among competing employers. If we assume that this tournament for refuse collection is a temporary phenomenon, the equilibrium starts from the intersection of demand and supply based on regular wages as shown in Figure 1. When demand increases, the firm is able to exercise monopsony power over the workers.

The firm has two choices. It can charge workers for the right to pick up trash at some price per pound, or it can offer a purse that is shared among workers based on the order of their performance. While either contract might work, the tournament approach arguably has lower transactions costs. If the workers buy the job, they must measure the expected wages by inspecting the work area before they sign on. Each worker must assess the likely amount of trash to be collected and the amount of money that can be expected. With tournament wages their expected rewards are known in advance. So, the tournament contract dominates because it reduces measurement costs of the Barzel sort arising not from the firm's interest in monitoring the workers, but from the workers' interest in monitoring the firm.

There are two points that should be emphasized. First, the tournament dominates standard labor contracts such as overtime pay or a straight piece-rate. If the firm does not charge the workers for the right to the higher wage, it shares some of the surplus with the workers that it can keep by using tournament wages. Second, there is a measurement cost for the workers when faced with tournament wages. They must assess the ability of their competition in order to form an expectation about their winnings. But in the mill example, the workers already have this information. So tournament wages dominate alternative labor contracts.

Conclusions

As first posed by Lazear and Rosen, because tournament wages are equally efficient compared to other forms of performance pay, what determines the structure of the labor contract in practical settings? They suggest that measurement costs will tip the balance. This paper uses the situation of market power to point out an aspect of measurement costs that has been largely overlooked, and one that tips the balance towards tournament wages.

Not only must firms monitor workers, but workers must also monitor firms. Workers are concerned that firms will not pay them the agreed compensation. If the firm has monopsony power over workers, in order to extract the full pound of surplus, the firm must charge workers for the right to work. This heightens the threat of opportunism by the firm. Tournament wages in which a known purse is distributed among workers based on actions observable by them reduces the threat of opportunism. Thus, we can expect tournament wages to be the likely labor contract when firms have market power and there is some randomness in the production setting.

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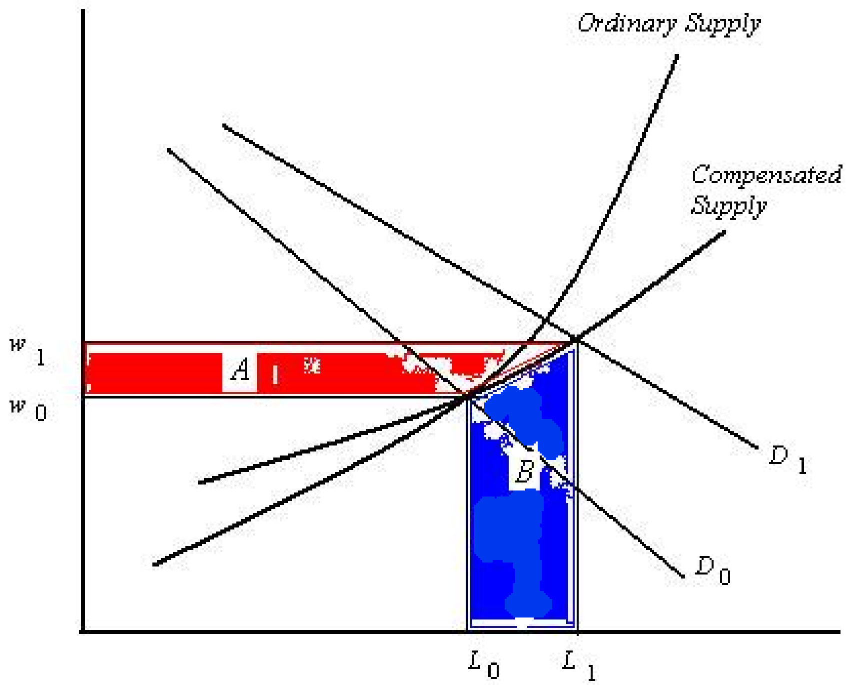
Figure 1: Tournament Wages Under Compensated Labor Supply



Contact Information:

John E. Walker Department of Economics
Clemson University – 223 Sirrine Hall
Clemson SC 29634-1309

Phone: 864-656-3430
Fax: 864-654-0802
Email: maloney@clemson.edu
Internet: www.clemson.edu/~maloney