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Classic Promotion Tournaments Versus Market-Based Tournaments

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Abstract
As initially formulated in the seminal analysis of Lazear and Rosen (1981), an important perspective for understanding the role of promotions in firms is the tournament perspective. That is, a promotion and, in particular, the wage increase associated with a promotion is a prize that serves as an incentive for workers to exert effort and take other actions beneficial to the firm such as the accumulation of human capital. In this paper I consider whether the best way to model promotion tournaments is by having firms commit to prizes ex ante as in Lazear and Rosen's initial formulation, or whether promotion prizes should be modeled as arising from the signaling role of promotions and the competition between firms for promoted workers.

Keywords
compensation, promotion, tournament perspective, prizes, competition

CLASSIC PROMOTION TOURNAMENTS

VERSUS MARKET-BASED TOURNAMENTS

By

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ABSTRACT

As initially formulated in the seminal analysis of Lazear and Rosen (1981), an important perspective for understanding the role of promotions in firms is the tournament perspective. That is, a promotion and, in particular, the wage increase associated with a promotion is a prize that serves as an incentive for workers to exert effort and take other actions beneficial to the firm such as the accumulation of human capital. In this paper I consider whether the best way to model promotion tournaments is by having firms commit to prizes ex ante as in Lazear and Rosen's initial formulation, or whether promotion prizes should be modeled as arising from the signaling role of promotions and the competition between firms for promoted workers.

I. INTRODUCTION

One of the key insights in the personnel economics and organizational economics literatures is the notion of a promotion tournament. That is, as initially put forth in Lazear and Rosen's (1981) seminal analysis, promotions at firms and, in particular, the wage increases associated with promotions should be thought of as prizes that increase effort and result in other beneficial outcomes such as the accumulation of human capital. In this paper I consider how promotion tournaments should be modeled. Specifically, should they be modeled as prize structures committed to by the firm ex ante as in Lazear and Rosen's initial formulation, or should they be modeled as arising from the signaling role of promotions and the subsequent competition between firms for promoted workers?

Most of the papers in the tournament literature follow Lazear and Rosen's (1981) analysis where tournaments arise because firms commit to future levels of compensation.[1] In their basic analysis there is a single firm that hires two identical workers where each worker's output depends on a stochastic term and the effort level chosen by the worker. In order to increase effort levels the firm commits to a high wage or prize for the worker who produces the higher output and a low wage for the worker who produces the lower output. Further, Lazear and Rosen show that by appropriately choosing the spread, i.e., the difference between the high and low wages, the firm can induce efficient effort levels. In this approach the worker who produces more and earns the higher subsequent wage is thought of as being promoted where the spread represents the wage increase due to the promotion.

This analysis has been extended in various ways. For example, as will be discussed in more detail later, Rosen (1986) extends the analysis by considering multi-round tournaments. In each stage of that analysis workers compete in pairs, where the winners in each stage proceed to compete in the following stage until only a single winner remains. The main result in that analysis is that the tournament prize structure is convex in the sense that the wage increase

[1] Surveys that discuss the tournament literature include Lazear (1999), Gibbons and Waldman (1999a), Prendergast (1999), Lazear and Oyer (2010), and Waldman (2010).

associated with winning the last round of the tournament is larger than the increases associated with winning earlier rounds. Other important extensions include Lazear's (1989) model of sabotage and wage compression, and Meyer (1992) that considers a multi-stage tournament model and shows the possibility of biased promotion contests.

All of the extensions mentioned above follow the Lazear and Rosen approach of assuming that the prize structure arises from commitment. That is, a firm setting up a promotion tournament commits to future compensation levels and also rules concerning who will be promoted. But there is a small set of papers that take a different approach. Gibbs (1995), Zabojnik and Bernhardt (2001), Ghosh and Waldman (2010), and Zabojnik (2010) all build on Waldman (1984a) and investigate what I will call market-based tournaments. In a market-based tournament it is assumed that firms do not have the ability to commit to future compensation levels or rules concerning who to promote. Rather, tournaments arise because the signal associated with a promotion results in potential employers willing to bid more for promoted workers which, in turn, causes the current employer to pay large wage increases upon promotion in order to reduce the probability of turnover.[2]

Market-based tournaments are similar to a Lazear and Rosen type tournament, hereafter classic tournament, in many ways, but there are also important differences. Just as in a classic tournament, the wage increase associated with promotion can result in higher worker effort or other actions beneficial to the firm such as the accumulation of human capital. Also, as will be discussed in more detail later, some of the predictions of classic tournaments are also predictions of market-based tournaments. For example, in a classic tournament effort is higher when the wage spread or prize is higher, while market-based tournament theory makes the same prediction. But the two theories differ in important ways including how the size of the prize is determined. In a classic tournament the firm commits to the prize early on and the magnitude of

[2] In addition to Waldman (1984a), other theoretical papers that have investigated the signaling role of promotions include MacLeod and Malcomson (1988), Ricart i Costa (1988), Waldman (1990), Bernhardt (1995), Owan (2004), and Golan (2005).

the prize is chosen with the knowledge that a higher prize induces more effort. In contrast, in a market-based tournament the effect of the prize on effort is ignored by the firm at the time the prize is chosen (because those effort choices are in the past) and rather the size of the prize is determined by expected wage offers of other firms and current turnover considerations.

In this paper I compare and contrast classic tournament theory with market-based tournament theory with a specific focus on which approach better matches the relevant empirical evidence. My conclusion is that most of the evidence does not allow us to distinguish between the theories, one important finding in the literature is more easily explained by classic tournament theory, while another finding is better explained by market-based tournaments. So, as I discuss in detail towards the end of the paper, maybe the correct approach is a hybrid approach that combines the two theories.

The outline for the paper is as follows. Section II presents a basic classic tournament model taken from Lazear and Rosen (1981), derives results from this model that will be useful for the later discussion of the empirical evidence, and also discusses relevant extensions and related analyses. Section III presents a market-based tournament model from Ghosh and Waldman (2010) and then presents extensions and related analyses that are useful for considering the empirical evidence. Section IV first discusses the literature that tests predictions of the classic tournament approach, then discusses the empirical literature on asymmetric learning in labor markets, and ends with an overview and synthesis. Section V presents concluding remarks.

II. THE CLASSIC TOURNAMENT APPROACH

In the first subsection I present the basic model in Lazear and Rosen (1981) and derive and discuss some standard results from that model. In the second subsection I discuss a few extensions of the classic tournament approach and related analyses, where the main paper emphasized is Rosen (1986) because that paper provides a prediction that is useful for distinguishing between classic and market-based tournaments.

A) The Basic Lazear and Rosen (1981) Model

In the basic Lazear and Rosen (1981) model there are two identical workers and a single firm, where the output of worker i is given by $y_i=e_i+\varepsilon_i$. In this equation e_i is worker i's effort level and ε_i is the realization of a stochastic term drawn from the density function $f(\varepsilon)$ which has zero mean. There is a disutility for effort given by $c(e_i)$, $c'>0$ and $c''>0$, and each worker has a reservation utility level U_0. Further, in their most basic model everyone is risk neutral.

The compensation rule used by the firm is quite simple. There are two wages, w_H and w_L, where the worker who produces the higher output is paid w_H and the worker who produces the lower output is paid w_L. One can interpret the worker producing the higher output as receiving a promotion and the difference in wages, w_H-w_L, sometimes referred to as the spread, is the prize associated with being promoted. Note that one feature of this compensation scheme is that the firm does not need to observe the exact output levels produced, but instead only needs to observe which worker produces more.

Each worker chooses the effort level that maximizes the worker's utility which means that the effort level chosen equates the marginal benefit of additional effort with its marginal cost. Let e_j^* denote the equilibrium effort level of worker j. Then worker i's effort choice satisfies equation (1).

$$(1) \qquad (w_H-w_L)(\partial \text{Prob}\{y_i(e_i)>y_j(e_j^*)\}/\partial e_i)=c'(e_i),$$

where $\text{Prob}\{y_i(e_i)>y_j(e_j^*)\}$ is the probability i's output exceeds j's output given i chooses effort level e_i and j chooses e_j^*. Focusing on symmetric Nash equilibria, (1) reduces to (2).

$$(2) \qquad (w_H-w_L)\int_{\varepsilon_j} f(\varepsilon_j)^2 d\varepsilon_j=c'(e_j^*)$$

Equation (2) tells us that an increase in the spread causes the equilibrium effort choice to rise since $c'(e_j^*)$ must rise and $c''>0$.

Given risk neutrality, the firm chooses the spread that yields first-best effort. That is, given the production function is $y_i=e_i+\varepsilon_i$, the spread is chosen so that $c'(e_j^*)=1$. If, on the other hand, the workers were risk averse, then the firm would reduce the spread which would provide

partial insurance to the workers and the result would be an equilibrium effort level below the first best.

In addition to analyzing how a promotion tournament works, Lazear and Rosen compare the optimal tournament compensation scheme with the optimal piece-rate or linear contract. They find that in the case of risk neutrality the two compensation schemes are equally efficient since they both result in first-best behavior. In the case of risk aversion they show that in some cases tournaments are superior while in others linear contracts are more efficient. Mookherjee (1984), however, allows for non-linear contracts and shows that the optimal non-linear contract is typically superior to the optimal tournament.[3] Although, consistent with an earlier point, one reason tournaments may be used despite Mookherjee's result is that tournaments require only ordinal information, while Malcomson (1984) makes the related point that tournaments may be used when output is not verifiable because tournaments are feasible in such a setting while standard output-based contracts are not.

One final point concerning the classic tournament model concerns the issue of commitment. If we think of the classic tournament model as a model of promotions, then it makes most sense to envision the model as a reduced form version of the following two-period model. In period 1 the workers choose effort levels, outputs are produced, and the workers are paid some fixed wage independent of output. In period 2 workers again choose effort levels, produce outputs, and are paid wages. Lazear and Rosen's analysis can be thought of as investigating the ability of the firm to induce high period-1 effort levels by paying a higher period-2 wage to the period-1 worker who produces the higher output.

But when thought of in this way clearly Lazear and Rosen are assuming that the firm can commit and that there are no competitive constraints on what the firm can commit to. For example, in the above analysis the firm chooses w_H and w_L taking into account how these wage rates affect worker effort choices. But in the two-period version of the model these are first-

[3] Green and Stokey (1983) and Nalebuff and Stiglitz (1983) also compare tournaments and contracts but are subject to the same criticism that they do not focus on optimal contracts.

period effort choices and the wages are determined in the second period. In the absence of commitment, in the two-period model the firm would not take into account how second-period wages affect first-period effort choices since those choices have already been determined by the time those wages are chosen. Also, there could be constraints on what the firm can commit to because in period 2 workers would have the option of leaving and taking a wage offered by an alternative employer. So, if we want to think of the classic tournament model as a model of promotions, we are implicitly assuming that when workers are young the firm commits to future wage levels and the wage offers of alternative employers are sufficiently low that they do not serve as constraints.[4] I will come back to this point at the end of the paper.

B) Extensions and Related Analyses

There are a number of extensions of Lazear and Rosen's (1981) basic tournament model and also some important related analyses. A simple but important extension is to allow n workers in the tournament rather than two.[5] If we continue to restrict the analysis to symmetric outcomes, then holding the prize fixed means that in equilibrium the probability a randomly chosen worker wins the prize is 1/n rather than 1/2 and more importantly the marginal benefit to additional effort falls so equilibrium effort also falls. This leads to one of the testable predictions of the classic tournament approach which is that the prize is an increasing function of the number of workers competing for the prize. That is, since if the prize is held fixed effort falls as the number of competing workers increases, an optimal tournament which achieves the efficient effort level has a prize that increases with the number of competitors.

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[4] See Waldman (2003) for a more extensive discussion of the classic tournament approach and commitment – this paper is described briefly in the next section. Also, rather than assuming commitment, one can think of the classic tournament approach as a reduced form of a repeated-game setting where w_H and w_L are determined by reputation considerations, although Zabojnik (2010) shows that in a competitive setting the full commitment outcome cannot be achieved through repeated interaction no matter how large is the discount factor.

[5] See Green and Stokey (1983) and O'Keeffe, Viscusi, and Zeckhauser (1984) for analyses along this line and Prendergast (1999) for a discussion.

Another basic extension is to consider asymmetric tournaments, i.e., the workers are heterogeneous in various ways. Lazear and Rosen (1981) present a number of analyses of asymmetric tournaments (see also O'Keeffe, Viscusi and Zeckhauser (1984)), where the specific analysis I want to focus on is where the players have heterogenous abilities and these abilities are publicly observable.[6] In such a case having a standard tournament with a single prize does not result in efficient effort levels. Rather, Lazear and Rosen show that efficiency is achieved by biasing or handicapping the tournament so that either the lower ability player wins as long as this worker's output is not too much below the higher ability worker's output or the prize is larger if the lower ability worker wins.

Another important extension concerns the issue of sabotage which has been explored in a number of papers including Lazear (1989), Garvey and Swan (1992), and Drago and Garvey (1998). Lazear considers a setting where workers can exert effort in both productive and sabotage activities, where sabotage reduces the outputs of other workers. The return to exerting effort in sabotage is that, since the tournament prize goes to the worker with the highest output, by exerting effort in sabotage a worker increases the probability he or she will win the prize. Lazear shows that in such a setting higher prizes result in more sabotage. Further, as a result of this relationship the firm reduces the prize below the level it would choose if the possibility for sabotage was not present, and this argument in turn serves as a potential explanation for wage compression which is a phenomenon frequently described by personnel managers. Drago and Garvey (1998) extend the theory and show that in addition to the size of the prize being positively related to sabotage, it is also negatively related to the amount of effort workers exert in helping co-workers. Drago and Garvey also conduct an empirical analysis which I discuss below.

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[6] In this particular analysis Lazear and Rosen assume that the two workers have different marginal costs of effort, but this can be interpreted as different abilities since a higher ability worker should have a lower cost of choosing an effort level consistent with any specific expected output.

From our perspective the most important extension is Rosen's (1986) analysis of multi-stage tournaments since this analysis provides one of the predictions that will help us distinguish between the two approaches for modeling real-world tournaments. Rosen considers a single-elimination tournament with a single winner at the end of the tournament. In round 1 workers compete in pairs, where the low output worker in each pair does not compete again while the high output worker goes on to round 2 and is paired with another round-1 winner. Subsequent rounds work similarly until only a single winner remains at which point wages are paid, where the wage a worker receives depends on the number of rounds he or she wins. Rosen assumes workers are identical and risk neutral. Also, rather than trying to solve for the optimal prize structure, Rosen characterizes the prize structure that results in workers exerting the same constant effort level from round to round.

Rosen's main result is that the monetary prize for winning a round is higher in the last round than in previous rounds. To see the logic here suppose there are 2^n workers which means the tournament has n rounds. Denote w_k as the wage received by a worker who wins k rounds, c* as the disutility from the constant effort level, and e* as this effort level. In each round except the last the prize for winning the round has two components – the direct prize for winning that round and the prize for remaining in the tournament and having a positive probability of winning further rounds. For example, consider a worker who wins the first n-2 rounds. The prize for winning round n-1 is the direct monetary prize for winning round n-1 which equals w_{n-1}-w_{n-2} plus the expected prize for participating in subsequent rounds which equals $(1/2)(w_n-w_{n-1})$-c*.

We can now derive Rosen's main result. In equilibrium in round n-1 the marginal benefit for the worker increasing effort should equal the marginal cost. The marginal benefit is the increase in the probability of winning multiplied by the sum of the direct monetary payoff for winning round n-1 which equals w_{n-1}-w_{n-2} plus the expected prize for participating in subsequent rounds which equals $(1/2)(w_n-w_{n-1})$-c*, while the marginal cost is c´(e*). As above, call the sum of the direct monetary payoff for winning in round k plus the expected return for participating in subsequent rounds the prize for winning in round k.

To keep effort the same across rounds means the prize should be the same across rounds. This means the prize in round n-1 should equal the prize in round n. This yields equation (3).

(3) $$w_{n-1}-w_{n-2}+(1/2)(w_n-w_{n-1})-c^*=w_n-w_{n-1}$$

Rearranging equation (3) yields $w_n-w_{n-1}=2(w_{n-1}-w_{n-2}-c^*)$. We also know that the prize in round n-2 should equal the prize in round n-1. This yields equation (4).

(4) $$w_{n-2}-w_{n-3}+(1/2)(w_{n-1}-w_{n-2})-c^*+(1/4)(w_n-w_{n-1})-(1/2)c^*=w_{n-1}-w_{n-2}+(1/2)(w_n-w_{n-1})-c^*$$

Given $w_n-w_{n-1}=2(w_{n-1}-w_{n-2}-c^*)$, equation (4) yields $w_{n-2}-w_{n-3}=w_{n-1}-w_{n-2}$. In turn, repeating this argument for earlier rounds yields the final conclusion that $w_1-w_0=w_2-w_1=\ldots=w_{n-1}-w_{n-2}=(1/2)(w_n-w_{n-1})+c^*$.[7]

One drawback of this result is that it does not fully capture the empirical evidence. That is, as will be discussed in more detail later, the empirical evidence indicates that promotion prizes grow as workers move up the job ladder but the finding is not confined to the very last step as in the theoretical analysis above. But there are a number of ways of extending the analysis that should result in the possibility that the growth in promotion prizes is not confined to the last step. For example, along the lines of a discussion in Rosen (1986), one could introduce a richer and more realistic production function and solve for optimal effort levels rather than assume effort is constant across rounds. Suppose the return to extra ability or effort is increasing with the hierarchical level as in Rosen (1982) or Waldman (1984b). Then it is likely that optimal effort will increase monotonically with hierarchical rank, and my conjecture is that this would result in the prize for winning a round also increasing monotonically. Another possibility is to allow the number of workers competing in each round to vary. My conjecture is that, if the

[7] Prendergast (1999) argues that in one interpretation of Rosen's model the main result is not due to winning the last round of the tournament being associated with no probability of winning subsequent rounds (see his footnote 76). The differerence between my interpretation above and this discussion of Prendergast is that we employ different interpretations of Rosen's original analysis. I interpret Rosen's analysis in terms of a real-world single-elimination tournament where a participant receives the same monetary prize for winning k rounds and then forfeiting in round k+1 as he or she would receive for winning k rounds and then losing in round k+1. In Prendergast's footnote discussion he interprets Rosen's analysis as a sequence of contests, where a player who forfeits in round k+1 receives a higher monetary prize than a player who loses in round k+1. Both interpretations are consistent with Rosen's formal analysis since forfeiting is an off-the-equilibrium path event in Rosen's model and Rosen never specifies what the monetary prize would be for a participant who forfeits. I would like to thank Canice for e-mail exchanges which helped me better understand his argument.

number of workers competing rose with hierarchical rank, this change would also result in promotion prizes increasing monotonically with job level.

Another model of multi-round tournaments is put forth in Meyer (1992). In that analysis two identical risk-averse workers compete against each other sequentially over two rounds, where the firm can commit at the beginning of the game to have a bias or handicap in the second round. Meyer shows that it is optimal for the firm to conduct the second round so that it is biased in favor of the first-round winner, i.e., the first-round winner also wins the second round unless the other worker's second-period output exceeds the first-round winner's output by at least some amount Δ. The rationale for the result is that, as long as the bias is small, the reduction in second-period effort is second order while the increase in first-period effort is first order. This result provides a potential explanation for fast tracks, i.e., a setting where a worker who earns a first promotion quickly is also more likely to earn a second promotion quickly.[8]

Chan (1996) and Waldman (2003) extend the classic tournament model in a different direction (see also Tsoulouhas, Knoeber, and Agrawal (2007)). Both papers consider classic tournament models where firms have to decide whether to staff a managerial position by promoting from within or hiring an outsider. And using somewhat different theoretical arguments, both papers show that in a classic tournament setting firms have an incentive to favor insiders over outsiders in this decision. For example, Waldman (2003) builds on the discussion concerning commitment mentioned earlier and shows that favoring insiders in promotion decisions can be a way to reduce or avoid time inconsistency (this analysis is also related to an earlier analysis in Malcomson (1984)).

Waldman (2003) starts with the observation that an increase in the probability that an entry-level worker receives a future promotion prize translates into a decrease in the wage a firm must pay to attract entry-level workers. This, in turn, creates a time-inconsistency problem.

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[8] Meyer (1991) is another multi-round tournament model in which the second round is biased in favor of the first-round winner. In this paper output is affected by a stochastic element so the second-round bias arises because being the first-round winner, even after taking into account second-period outputs, adds valuable information concerning which worker has higher innate ability.

From the standpoint of profits starting at the date entry-level workers are hired it is optimal for the firm to limit hiring from the outside for promotion positions because doing so lowers the entry-level wage and thus increases profits. However, at the time promotion decisions are actually made, those entry-level wages have already been paid and from the standpoint of current profits there is no reason to limit the hiring of outsiders for promotion positions. The result is that in the absence of commitment the firm hires too many outsiders for promotion positions and this lowers overall profitability. The conclusion is that to reduce or avoid this time-inconsistency problem and increase overall profitability the firm creates internal bureaucratic rules that make it difficult to hire outsiders for high level managerial positions.

The final related analysis I will discuss is Prendergast (1993). Prendergast considers a model of promotions that does not have a tournament structure. In Prendergast's analysis the problem the firm faces is to provide incentives to workers to invest in firm-specific human capital. He shows that, if higher level jobs place higher values on human capital than lower level jobs, then the firm can solve its human-capital investment problem by committing to high wages for the higher level jobs, i.e., promotion prizes. The logic is that the promotion prize serves as an incentive for workers to invest in firm-specific human capital because investing increases the probability of promotion and thus increases the probability the worker receives the promotion prize.[9] Prendergast's model is not formally a tournament model since there is only a single worker in his model. But it would be easy to incorporate his idea into a two-period classic tournament model and show that tournaments can be used to provide incentives for firm-specific human-capital investments as well as incentives for effort.

III. MARKET-BASED TOURNAMENTS

A few papers have explored market-based tournaments. In the first and second

[9] Prendergast's analysis is closely related to Kahn and Huberman's (1988) classic analysis of up-or-out contracts. One can think of the Kahn and Huberman analysis as showing that, if a firm has only a single job so Prendergast's mechanism for supporting investments in firm-specific human capital is not available, then an alternative is for firms to employ up-or-out rules.

subsections I present and analyze the model analyzed in Ghosh and Waldman (2010) because like Lazear and Rosen (1981) it focuses on a setting where promotion prizes serve as incentives for worker effort. In the last subsection I describe related analyses and extensions, where I focus on extensions that are helpful for addressing findings in the empirical literature.

A) The Market-Based Tournament Model of Ghosh and Waldman (2010)

Ghosh and Waldman consider a two-period model with free entry, identical firms, and labor as the only input. Workers in period 1 are denoted as young while in period 2 they are denoted as old.[10] At the beginning of period 1 all firms and workers know that each worker's innate ability equals θ_H with probability p and θ_L with probability (1-p), where $\theta_H>\theta_L>0$ and $\Theta=p\theta_H+(1-p)\theta_L$. It is also useful to define effective ability where worker i's effective ability in period t is denoted η_{it}. Let θ_i be the innate ability of worker i. Then $\eta_{i1}=\theta_i$ and $\eta_{i2}=k\theta_i$, $k>1$, where k captures general human capital the worker acquires with labor-market experience.

Each firm consists of two jobs, denoted 1 and 2. If worker i is assigned to job j in period 1, then output is given by

$$y_{ij1}=[d_j+c_j(\eta_{i1}+e_{i1}+\varepsilon_{i1})], \tag{5}$$

while if the same worker is assigned to job j in period 2 then output is given by

$$y_{ij2}=(1+s)[d_j+c_j(\eta_{i2}+e_{i2}+\varepsilon_{i2})]. \tag{6}$$

In (5) and (6) e_{it} is worker i's effort choice in period t, ε_{it} is the realization of a noise term drawn from a normal distribution with mean zero and variance σ_ε^2, and s=S, $S\geq 0$, if in period 2 worker i remains with the first-period employer and s=0 if the worker switches employers. That is, S captures the accumulation of firm-specific human capital. A worker can choose any effort level in the interval $[0,e_H]$, where disutility from effort is given by $g(e_{it})$, $g(0)=0$, $g'(0)=0$, $g'(e)$ and $g''(e)>0$ for all $e>0$.

[10] Along the lines of the earlier discussion of Prendergast (1993), one could argue that Ghosh and Waldman (2010) is not a tournament model because there is no requirement that only a single worker or some fixed number of workers are promoted. But later I discuss how slot constraints could be added to the model in which case this condition would be satisfied.

A worker's output in each period is privately observed by the current employer, while the period-2 job assignment offered to a worker by the period-1 employer is public information so that as in Waldman (1984a) a promotion serves as a signal of ability. Also, a worker's effort choice each period is privately known by the worker. Note, because a worker's employer in period 1 observes the period-1 output, the firm has an updated belief at the beginning of period 2 concerning the worker's effective ability. Given that, as is discussed below, all workers in period 1 are assigned to job 1, let $\eta_2^e(y_{i11})$ denote this updated belief concerning worker i's period-2 expected effective ability as a function of the worker's period-1 output.

Due to the last-period problem, in period 2 each worker chooses an effort level equal to zero. Let η' be the value for effective ability that satisfies equation (7).

$$d_1+c_1\eta'=d_2+c_2\eta' \tag{7}$$

It is assumed that $c_2>c_1>0$ and $d_2<d_1$ so that, as in Rosen (1982) and Waldman (1984b), output increases more quickly with ability in job 2. Given efforts in period 2 equal zero, we now have that it is efficient in period 2 to assign worker i to job 1(2) when $\eta_2^e(y_{i11})<(>)\eta'$. Also, everyone in the model is risk neutral with a zero rate of discount and there is no worker moving costs or firm hiring or firing costs.

At the beginning of period 1 all firms simultaneously offer period-1 wages and each worker then chooses a period-1 employer. After that each worker i chooses a period-1 effort level, the value for ε_{i1} is realized, and at the end of period 1 each worker i's period-1 employer observes the worker's period-1 output.

Period 2 starts with each worker's period-1 employer offering the worker a job assignment or firing the worker, where this decision is publicly observed. Then all firms offer period-2 wages to workers and each worker's period-1 employer is allowed to make a counteroffer, where a firm does not make an initial offer or counteroffer to any worker it fired at the beginning of the period. Each worker then chooses a firm where a worker stays with the period-1 employer if no other firm offered a higher wage. After that each worker i chooses a

period-2 effort level, ε_{i2} is realized, and at the end of the period the period-2 employer privately observes the period-2 output.

The analysis is restricted to parameterizations that satisfy $d_1+c_1(\Theta+e_H)>d_2+c_2(\Theta+e_H)$ which means all workers are assigned to job 1 in period 1, while it is also assumed that $k\theta_L<\eta'<k\theta_H$ which means it is efficient in period 2 to assign some workers to job 1 and some to job 2. Further, the analysis focuses on Perfect Bayesian equilibria where beliefs concerning off-the-equilibrium path actions are consistent with each such action being taken by the type with the smallest cost of choosing that action. This assumption is similar to the proper equilibrium refinement first discussed in Myerson (1978).[11]

B) Analysis

I will start with three basic features of equilibrium in this model. First, it exhibits a winner's curse result similar to that found in Milgrom and Oster (1987). Second, promotions serve as signals like in Waldman (1984a). Third, as is also shown in Waldman's analysis, because of the signal fewer workers are promoted than is first-best efficient.

We know that promotions serve as signals because promotions are publicly observable, while ability levels, effort levels, and outputs are not. Given this, consider how wage offers are determined. Because there are counteroffers and beliefs are that off-the-equilibrium path actions are taken by the type with the smallest cost of choosing that action, in period 2 in equilibrium firms other than a worker's period-1 employer are only willing to offer the worker a wage equal to the expected productivity at such a firm produced by the lowest expected ability worker with the same labor-market signal, i.e., same age and job assignment. In turn, this is also what the period-1 employer pays in period 2 because this is all that is required to keep the worker (Ghosh

[11] Ghosh and Waldman analyze this model comparing standard promotion practices, i.e., there are no restrictions concerning which job a worker is assigned to in period 2, and up-or-out contracts, i.e., a retained old worker cannot be assigned to job 1. They also conduct this analysis both when effort is not a factor and when it is. Here my focus is solely on standard promotion practices when effort is a factor.

and Waldman focus on the unique equilibrium with no turnover which is the only equilibrium if S is sufficiently large). This is exactly the winner's curse result of Milgrom and Oster (1987).[12]

So what happens in period 2 in equilibrium is that there is a critical value, call it η^+, such that when $\eta_2^e(y_{i1}) \geq \eta^+$ worker i is assigned to job 2, while when $\eta_2^e(y_{i1}) < \eta^+$ the worker is assigned to job 1.[13] Further, given the winner's curse result just described and that period-2 effort levels equal zero, the period-2 wage for workers assigned to job 1 equals $d_1+c_1k\theta_L$, while the period-2 wage for workers assigned to job 2 equals $\max\{d_1+c_1\eta^+, d_2+c_2\eta^+\}$.

The next step is to consider the value η^+. η^+ is the value such that a firm is indifferent between assigning an old worker it previously employed to job 1 or job 2. That is, given period-2 effort levels equal zero, η^+ satisfies equation (8).

$$(8) \qquad (1+S)[d_2+c_2\eta^+]-\max\{d_1+c_1\eta^+, d_2+c_2\eta^+\}=(1+S)[d_1+c_1\eta^+]-[d_1+c_1k\theta_L]$$

One can show that in equilibrium not everyone is promoted, i.e., $\eta^+ > k\theta_L$, which means $\max\{d_1+c_1\eta^+, d_2+c_2\eta^+\} > d_1+c_1k\theta_L$. Since $d_1+c_1\eta' = d_2+c_2\eta'$ and $c_2 > c_1$, equation (8) now yields $\eta^+ > \eta'$ (which in turn implies $\max\{d_1+c_1\eta^+, d_2+c_2\eta^+\} = d_2+c_2\eta^+$). That is, fewer workers are promoted than is efficient. The logic is that there is a higher wage a firm pays a promoted worker due to the signal and the higher wage offers of alternative employers. As a result, a firm only promotes a worker in period 2 when the worker is significantly more productive in job 2 than in job 1.[14]

Given these results, the full equilibrium is as follows. In period 1 all workers are assigned to job 1 given the parameter restrictions. Further, they are paid a wage above expected

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[12] In the Milgrom and Oster (1987) model this result holds for any Perfect Bayesian equilibrium. But there is no firm-specific human capital in their analysis and it is the incorporation of firm-specific human capital which necessitates the added assumption involving beliefs concerning off-the-equilibrium path actions imposed by Ghosh and Waldman for this result to hold in their model.

[13] Ghosh and Waldman assume that a worker is promoted when the firm is indifferent between promoting and not promoting the worker which is why when $\eta_2^e(y_{i1}) = \eta^+$ the worker is promoted.

[14] Golan (2005) investigates a related model without effort choice but with counteroffers and shows that, in contrast to what is found in Waldman (1984a) and elsewhere, the promotion rule is efficient. In Golan's model, however, output in the low level job is independent of ability. So one result of the Ghosh and Waldman analysis is to show that, even with counteroffers, the promotion rule will not be efficient if output in the low level job is positively related to worker ability.

productivity due to a zero-expected-profit condition and that in period 2, because of firm-specific human capital and asymmetric information, each firm earns rents on the workers it employed in period 1. Also, workers choose a positive level of effort, denoted e_1, that can be equal to, above, or below the efficient period-1 effort level. Further, although Ghosh and Waldman do not show the result, it would be easy to derive results in this model consistent with the prediction from classic tournament theory that effort levels, in this case period-1 effort levels, increase with the size of the promotion prize.

In period 2, as indicated above, all workers remain at the period-1 employer and workers are promoted when $\eta_2^e(y_{i11}) \geq \eta^+$, where $\eta^+ > \eta'$. Further, the wage of workers not promoted equals $d_1 + c_1 k\theta_L$, the wage of promoted workers equals $d_2 + c_2\eta^+$, and period-2 effort levels equal zero because of the last-period problem. Note that, given $\eta^+ > \eta' > k\theta_L$ and equation (7), we have that $d_2 + c_2\eta^+ > d_1 + c_1 k\theta_L$, i.e., there is a strictly positive wage increase due to promotion.

The point I would like to emphasize is the mechanism generating positive effort levels in period 1. The mechanism is similar to what drives positive effort levels in the classic promotion tournament model discussed in the previous section. In both cases what is driving the effort choice is that added effort increases the probability of a promotion and, as just indicated, with that promotion comes a higher wage. The difference between the approaches is the rationale for why a promotion increases the wage. In the classic tournament approach a firm realizes that the prize associated with a promotion serves as an incentive for worker effort and, in response, commits to a prize that maximizes firm profitability taking into account how the size of the prize affects effort levels chosen. In contrast, in the market-based tournament approach it is assumed that firms cannot commit when workers are young to wage rates when workers are old. Instead, what drives the higher promotion wage is the positive signal concerning worker ability when a promotion occurs and the higher wage offers other firms offer promoted workers in response to the signal. Further, since there is no direct relationship between this mechanism and efficient effort choice, depending on the parameterization, the period-1 effort choice can be equal to, above, or below the efficient effort level.

Another way to view this result is as an asymmetric-learning version of Holmstrom's (1999) classic analysis of effort choice and career concerns. Holmstrom considers effort choice in a model with a single job and symmetric learning. In that model output is publicly observable while at the beginning of a worker's career the worker's innate ability level is not known. The result is that each worker provides high effort early in the career because this improves firms' beliefs concerning the worker's innate ability level and thus increases wages later in the career. The Ghosh and Waldman model is an asymmetric-learning version of this argument. In their model outputs are not publicly observable but job assignments/promotions are. The result is that each worker provides high effort early in the career to increase the probability of promotion because promotions improve other firms' beliefs concerning the worker's innate ability, which in turn increases the worker's wage at the current employer.

Finally, one advantage of the market-based tournament approach over the classic tournament approach is that it provides an explanation for a puzzle first discussed in Baker, Jensen, and Murphy (1988). That paper asks, why is it that promotions are used to provide incentives rather than have incentives solely provided through monetary-based awards such as bonuses and non-promotion related salary increases? That is, since promotions are used to allocate workers across positions, having promotions also serve an incentive role will sometimes result in inefficiencies because the individual optimally assigned to the higher level job is not always the same individual as the one who should be rewarded from an incentives perspective. The market-based tournament approach is an explanation for this puzzle because in that argument promotions have an incentive role not because that is part of the optimal design, but rather because the signaling role of promotions means incentives are an inherent part of the promotion process.

C) Extensions and Related Analyses

A closely related analysis to the one described above appears in Zabojnik and Bernhardt (2001). The main difference is that, rather than focusing on promotion prizes serving as

incentives for effort, in the Zabojnik and Bernhardt analysis the promotion prizes serve as an incentive for worker investments in human capital. Other than this difference the basic logic is quite similar. A promotion serves as a signal that the worker has accumulated a high level of human capital so alternative employers are willing to bid more for a promoted worker (human capital in their model is partially general which is why alternative employers are willing to bid more when they see the promotion signal). In turn, to stop promoted workers from being bid away a firm pairs promotions with large wage increases and these promotion prizes serve as an incentive for workers to invest in human capital.

One other difference between the Zabojnik and Bernhardt analysis and the Ghosh and Waldman analysis discussed above is that, like in Lazear and Rosen's analysis, in Zabojnik and Bernhardt's analysis a firm promotes only a single worker. Although below I describe a variant of the Ghosh and Waldman analysis that has this feature. Also, in addition to developing the basic theoretical argument, Zabojnik and Bernhardt show that it serves as a potential explanation both for the empirical finding that larger firms pay more even after controlling for labor quality and the finding of inter-industry wage differences.[15]

One extension of the Ghosh and Waldman (2010) analysis appears in Ekinci (2011). In the Ghosh and Waldman analysis in each period each worker is paid a wage that is independent of output and incentives arise solely from signaling and the resulting increased wages associated with promotions. The result, as discussed, is that effort levels in period 2 equal zero because there are no future promotion wage increases to serve as incentives for effort. In Ekinci's analysis in each period workers sign bonus contracts, i.e., each worker earns a base wage and a bonus where the bonus is paid only when output is high. So in this analysis incentives arise both from promotions serving as signals and from bonuses. This approach avoids the unrealistic last-

[15] Papers that find that larger firms or establishments pay higher wages include Lester (1967), Brown and Medoff (1989), and Davis and Haltiwanger (1996). Papers concerning inter-industry wage differences include Dickens and Katz (1987), Krueger and Summers (1987,1988), and Murphy and Topel (1987).

period result of zero effort in Ghosh and Waldman's analysis since bonuses serve as an incentive for effort even when there is no possibility of future promotion.

Ekinci first shows that this model can explain the standard finding in the empirical literature that bonuses are more frequent and larger at higher levels of the job ladder – this is found, for example, in the classic empirical study of internal labor markets found in Baker, Gibbs, and Holmstrom (1994a,b). The logic is that at higher levels of the job ladder there are fewer future promotion opportunities and so bonuses become more important in providing incentives. Ekinci then develops three testable implications concerning how bonuses should vary with worker and job characteristics and provides supporting evidence for the predictions using the Baker, Gibbs, and Homstrom data set.

A second extension involves incorporating slot constraints into the model. By slot constraints I mean there is a single managerial or job-2 position at a firm in any period. That is, assume as before that each firm consists of jobs 1 and 2, but now there is a single job 2 or managerial position that can be staffed or left vacant. In considering slot constraints I will also make two other changes. First, the number of young workers a firm employs in period 1 is publicly observed. Second, as in Greenwald's classic analysis of asymmetric learning in labor markets, there is a small probability a worker switches employers in period 2 for exogenous reasons which are independent of worker ability (such as being the trailing spouse) and the realization concerning whether or not this is the case occurs immediately after the period-1 employer makes its wage counteroffer. As is discussed further later, this assumption avoids or at least reduces the winner's curse result concerning wages seen in the earlier subsection and this is important for finding the main result emphasized below.[16]

Introducing slot constraints into the model complicates the analysis significantly, so I will just provide a partial analysis here. My focus will be on the size of the prize associated with promotion in the case where firm-specific human capital is substantial so there is no turnover

[16] It is also assumed that if an old worker assigned to job 2 in period 2 leaves for exogenous reasons, the firm is not allowed to assign a different period-1 employee to the managerial position.

other than the turnover for exogenous reasons and the production function is such that a firm always wants to assign a worker to job 2 in period 2.[17] As in the analysis of the previous subsection, an old worker's wage in period 2 is determined by the wage offers of other firms. Given this, consider the wage paid to a worker who is promoted, i.e., assigned to job 2, from within. Because there is turnover due to exogenous reasons and no other turnover due to high firm-specific human capital, the expected effective ability of a specific old worker initially assigned to job 2 in period 2 who then moves equals the expected effective ability of that same worker not conditioning on the fact the worker moved. In other words, given how turnover works in this specification, there is no winner's curse or negative selection associated with turnover that causes potential employers to bid below the average productivity of a promoted worker. So the wage paid to a worker promoted from within equals the expected productivity of the worker at a different firm which itself is positively related to the worker's expected effective ability.

As indicated, the focus is on the prize associated with promotion, i.e., the difference in period 2 between the wage paid to the worker assigned to job 2 and the wage paid to workers assigned to job 1, and specifically how this difference varies with the number of young workers hired by the firm in period 1.[18] Let n_j denote the number of young workers hired by firm j in period 1. Consider the wage paid to the worker assigned to job 2 in period 2 by firm j. The worker assigned to job 2 will be the worker among firm j's period-1 workers with the highest period-1 output. Further, as n_j rises the expected effective ability of this worker rises since the firm is choosing the best worker from a larger pool, so the period-2 offers for this worker rise which in turn means the worker's period-2 wage rises if the worker stays with the period-1

[17] A specific parameter restriction that guarantees the first condition is $(1+S)[d_1+c_1k\theta]>d_2+c_2k\theta$ for all θ, $\theta_L\leq\theta\leq\theta_H$. The second condition is satisfied if one of the parameter restrictions of the previous subsection is relaxed and it is instead assumed that $\eta'<k\theta_L$.

[18] If the analysis is restricted to symmetric equilibria and it is assumed that in period 1 a worker chooses randomly between firms making identical wage offers, then the number of workers hired by a firm in period 1 will vary with the random choices of workers in period 1 concerning which offers to accept.

employer (it also rises if the worker leaves). In particular, the wage rises by kc_2 multiplied by the increase in expected effective ability.

Now consider the wage paid to old workers assigned to job 1 in period 2 by firm j. We know that the expected effective ability averaged across all n_j workers at the beginning of period 2 must equal $k\Theta$. There are thus two factors determining how the average expected effective ability of old workers assigned to job 1 changes as n_j rises. First, that there is an increase in the expected effective ability of the worker assigned to job 2 suggests that the average expected effective ability of the workers assigned to job 1 should fall since the average expected effective ability across all n_j workers is unchanged as n_j rises. Second, that the worker assigned to job 2 becomes a smaller proportion of firm j's workers, i.e., $1/n_j$ falls, suggests that the average expected effective ability of workers assigned to job 1 should rise. One can show that the second effect dominates, which means that the wage for old workers assigned to job 1 rises and it rises by kc_1 multiplied by the increase in the expected effective ability of old workers assigned to job 1. So both the wage for the promoted worker and the wage for old workers not promoted rise with n_j, but given $c_2>c_1$ it will frequently be the case that the wage for the promoted worker rises faster with n_j than does the wage for old workers assigned to job 1. That is, the model is capable of capturing the prediction that the size of the prize rises with the number of workers in the pool from which the worker is drawn.[19]

Above I show a specific variant of the Ghosh and Waldman (2010) framework that can capture the prediction that the size of the prize associated with promotion is positively related to the size of the pool from which the promoted worker is drawn. But in fact there are various specifications that can capture this since it follows from a basic intuition of market-based

[19] To see this consider the following simple example. Let $\theta_L=0$, $\theta_H=1$, $p=1/2$, and $\sigma_\varepsilon^2=0$ (assuming that $\sigma_\varepsilon^2=0$ means that there is full learning by the period-1 employer at the end of the first period). Let η_{j1}^e be the expected effective ability from the standpoint of a period-2 potential employer of workers firm j assigns to job 1 at the beginning of period 2, while η_{j2}^e is the analogous probability for the worker assigned to job 2. Simple calculation yields that if $n_j=2$ then $\eta_{j1}^e=1/4$ and $\eta_{j2}^e=3/4$; if $n_j=3$ then $\eta_{j1}^e=5/16$ and $\eta_{j2}^e=7/8$; and if $n_j=4$ then $\eta_{j1}^e=17/48$ and $\eta_{j2}^e=15/16$. That is, expected effective ability for the worker assigned to job 2 rises faster with n_j than expected effective ability for the workers assigned to job 1. So since $c_2>c_1$, the size of the promotion prize for this example rises monotonically as n_j increases from 2 to 4 and, if $c_2>>c_1$, it can be shown that the promotion prize rises generally with n_j.

tournament models.[20] As above, consider a market-based tournament model with a single managerial position. The size of the prize associated with being promoted into that position should be a positive function of the strength of the signal associated with the promotion. Since being the winner in a tournament with a larger number of competitors should send a more positive signal concerning the ability of the winner, we have the prediction that the size of the pool should be positively related to the prize associated with promotion.

A final issue of interest is why I changed the specification in the extension to move away from the strong winner's curse result found in Ghosh and Waldman's (2010) analysis described in the previous subsection. Given a specification with a strong winner's curse, the size of the promotion prize is determined by the expected effective ability of a worker with the lowest possible period-1 output that can result in a promotion. If the specification of the model with slot constraints was changed so that there was a strong winner's curse, an increase in n_j would increase the expected effective ability of a promoted worker but would not increase the expected effective ability of a worker with the lowest period-1 output that can result in a promotion. So even though the model would still have slot constraints, if the specification was characterized by a strong winner's curse, it would not predict a positive correlation between the size of the promotion prize and the size of the pool from which the promoted worker is drawn.

IV. THE EMPIRICAL LITERATURE

In this section I discuss the empirical literature concerning promotions, tournaments, and asymmetric learning and what this literature tells us concerning the choice between the classic tournament approach and market-based tournaments. I start with papers that test classic tournament theory, then discuss papers concerning asymmetric learning in labor markets, and end with an overview and synthesis.

[20] For example, Zabojnik and Bernhardt (2001) also find the result in their analysis.

A) Tests of the Classic Tournament Approach

A number of papers have focused on testable predictions of the classic tournament approach. These papers typically focus on one or more of the following six predictions: i) promotions should be associated with large wage increases; ii) effort levels should be positively related to the prize or spread; iii) the size of the prize associated with a promotion should be positively related to the number of workers in the pool from which the promoted worker is drawn; iv) the wage structure should be convex; v) sabotaging co-workers should be positively related and helping co-workers negatively related to the prize or spread; and vi) insiders should be favored over outsiders in filling managerial positions which also has implications for subsequent promotions.[21]

The first prediction that promotions should be associated with large wage increases is in a sense not a prediction since that is the observation that initially motivated the theory. But to be complete let me point out that numerous papers find that promotions are associated with large wage increases. A very partial list of papers that find this result is Murphy (1985), Gerhart and Milkovich (1989), Lazear (1992), Main, O'Reilly, and Wade (1993), Baker, Gibbs, and Holmstrom (1994a,b), and McCue (1996). Of course, this evidence is consistent with both classic tournament theory and market-based tournament theory.[22]

A number of papers investigate the second prediction which is that effort in a tournament increases with the size of the prize. These include Ehrenberg and Bognanno (1990a,b) who study professional golf tournaments, Becker and Huselid (1992) who study auto racing, Audas, Barmby, and Treble (2004) who study promotions at a British financial firm, and DeVaro

[21] DeVaro (2006a,b) tests an additional prediction of the classic tournament approach which is that the presence of factors that depress effort should induce an employer to increase the promotion prize. Although no one has formally looked at whether this prediction holds in market-based tournament models, I do not believe this is a prediction of that approach. DeVaro (2006a) finds evidence consistent with the prediction, while DeVaro (2006b) does not.

[22] Gibbons and Waldman (1999b,2006) provide an alternative explanation for this finding which is based on symmetric learning, human-capital accumulation, and job assignment. But, as pointed out in those papers, given that approach does not incorporate incentives, it is unlikely to represent a full explanation of wage and promotion dynamics inside firms.

(2006a,b) who studies a cross section of establishments across four metropolitan areas (see also Knoeber and Thurman (1994) which tests a related prediction). All these studies find evidence consistent with the prediction. However, although the evidence is consistent with the classic tournament approach, the prediction itself is not particularly specific to the theory. Basically, it is a test of utility maximization since, whatever mechanism is generating the prize, utility maximization predicts that effort should be positively related to the size of the prize. For this reason, the prediction is also consistent with market-based tournaments as mentioned in Subsection III.B.

There are also a number of studies that focus on the third prediction which is that the size of the prize associated with a promotion should be positively related to the size of the pool from which the promoted worker is drawn. This has been studied by O'Reilly, Main, and Crystal (1988), Main, O'Reilly, and Wade (1993), Eriksson (1999), and Bognanno (2001). All but the first study find evidence consistent with the prediction. But remember that in Section III.C it was shown that this prediction is also consistent with market-based tournament theory, i.e., because the size of the signal due to promotion should be larger when the promoted worker is drawn from a larger pool, the prize associated with promotion should also increase with the size of the pool. Thus, this evidence also does not distinguish between classic and market-based tournament theory.

The prediction of a convex wage structure has been studied in Lambert, Larcker, and Weigelt (1993), Eriksson (1999), and Bognanno (2001) and all these papers find evidence consistent with the prediction. Also, in their classic study of wage and promotion practices using personnel records, Baker, Gibbs, and Holmstrom (1994a,b) report results consistent with the firm employing a convex wage structure. In contrast to the evidence for the first three predictions, I see this as evidence that favors the classic tournament approach. Although there are no multi-round market-based tournament models that investigate the issue, I do not see a convincing

reason why convex wage structures should be a robust prediction of the market-based tournament approach.[23]

The fifth prediction is that the size of promotion prizes should be positively related to sabotage activities and negatively related to the amount of help provided to co-workers. Drago and Garvey (1998) claim to test the prediction concerning helping behavior using a unique data set of Australian employees that allows the authors to assign individuals to workgroups and measure helping efforts by individuals inside a work group. They find evidence that they interpret as supporting the classic tournament approach but there is an important flaw with their empirical work as a test of classic tournament theory. Specifically, they do not have data on promotions. Rather, they measure the size of promotion prizes using the standard deviation within a work group of residuals from a wage equation. But high residuals could be due, for example, to high-powered incentives in pay-for-performance contracts rather than promotion wage increases. In other words, the Drago and Garvey study is not a valid test of classic tournament theory.[24]

The final prediction which is that insiders should be favored over outsiders in the promotion process has been tested in Chan (2006), Agrawal, Knoeber, and Tsoulouhas (2006), and Oyer (2007). If insiders are favored over outsiders in filling managerial positions, then, focusing on workers at a firm at the same job level, those hired from the outside should be more productive. Oyer (2007) tests this with data on academic economists and finds that outside of the top ten schools, after controlling for school and year of graduation, those hired from the outside are indeed more productive (based on journal publications) than those promoted from

[23] For the market-based tournament approach to generate a convex wage structure the signal associated with a promotion would have to be larger for promotions higher up the job ladder. This is certainly possible if the marginal return to ability rises much faster with hierarchical level at higher levels of the hierarchy than at lower levels (I would like to thank Hodaka Morita and Jan Zabojnik for both pointing this out to me) and/or if the underlying distribution of abilities has a long right-hand tail, but I do not see these possibilities as sufficiently likely to conclude that having a convex wage structure is a robust feature of the market-based tournament approach.

[24] Further, even if there was valid evidence consistent with this fifth prediction of classic tournament theory, it would not allow us to distinguish between the classic and market-based tournament approaches. That is, the same logic that yields that the size of promotion prizes should be positively related to sabotage and negatively related to helping activities in classic tournament theory should predict the same relationships for the market-based tournament approach.

within. Chan (2006) tests the related prediction that, if those at a level hired from the outside are more productive, then they should have a higher probability of subsequent promotions. Using personnel data from a US financial services corporation, Chan finds evidence consistent with this prediction. Finally, Agrawal, Knoeber, and Tsoulouhas consider promotions to CEO positions and also find evidence that supports the theory.

As with most of the other predictions discussed above, this evidence is consistent with market-based tournament theory since it can be explained by asymmetric learning which is at the heart of that theory. That is, if firms know more about insiders than outsiders and are somewhat risk averse in their hiring decisions, then those at a job level hired from the outside will have higher expected ability which can explain both Oyer's and Chan's findings and related arguments can explain the findings in the Agrawal, Knoeber, and Tsoulouhas paper.[25]

B) Empirical Tests of Asymmetric Learning

For the market-based tournament approach to have validity it must be the case that asymmetric learning in labor markets is important because otherwise promotions could not serve as signals. In this subsection I discuss the empirical literature on asymmetric learning including a paper that specifically focuses on the promotion-as-signal hypothesis.

The classic paper testing for asymmetric learning in labor markets is the Gibbons and Katz (1991) study of adverse selection in labor-market turnover. Building on Akerlof (1970), Greenwald (1979,1986) develops an adverse-selection model of labor-market turnover in which workers who move between firms are disproportionately drawn from the low end of the ability distribution. Gibbons and Katz extend this analysis to a setting with both laid-off workers and

[25] Oyer discusses the idea that his results can be explained by asymmetric learning. Chan also discusses the possibility that asymmetric learning can explain his results but rejects the possibility based on an argument that asymmetric learning does not explain his finding that the effect of being an outsider on the rate of subsequent promotions is smaller at higher levels. I do not find this argument persuasive both because it is unclear from what Chan reports that the difference between levels concerning the rate of subsequent promotions is statistically significant, and because the difference between levels that Chan finds could be explained by something as simple as the rate of subsequent promotions at higher levels being lower. Agrawal, Knoeber, and Tsoulouhas do not consider the possibility that asymmetric learning can explain their findings.

those fired in a plant closing, where they show that laid-off workers should be lower ability because adverse selection applies to laid-off workers but not those fired in a plant closing.[26] They then derive three testable implications: i) predisplacement wages should be uncorellated with the type of termination; ii) postdisplacement wages should be lower for laid-off workers; and iii) unemployment duration after displacement should be higher for laid-off workers. They also analyze data from the CPS and find evidence that supports all three predictions.

A number of follow-up studies have investigated the Gibbons and Katz predictions with mixed results concerning whether the original Gibbons and Katz findings are due to asymmetric learning. Some studies such as Doiron (1995), Acemoglu and Pischke (1998), Grund (1999), and Hu and Taber (2011) find results consistent with the Gibbons and Katz interpretation of their findings. For example, Acemoglu and Pischke extend the theoretical framework to show how asymmetric learning can lead firms to provide workers with general training and then show supporting evidence using German data. More recently, Hu and Taber re-examine CPS data and find that the Gibbons and Katz predictions only hold for white males which they explain with an extension of the Gibbons and Katz theoretical framework that incorporates heterogeneous human capital.

But other studies such as Stevens (1997), Krashinsky (2002), and Song (2007) argue that the Gibbons and Katz results are explained by something other than asymmetric learning. Using data from the PSID, Stevens shows that larger wage losses after termination in the case of layoffs can be explained by wage reductions for those terminated in a plant closing that occur prior to the actual termination. Krashinsky argues that the Gibbons and Katz results arise because laid-off workers are disproportionately from larger establishments which pay higher predisplacement wages, while Song makes a similar argument and also shows results consistent with recall bias being important.

[26] To be more precise, in their argument Gibbons and Katz allow for both adverse selection and the possibility that a layoff serves as a signal like in the promotion-as-signal hypothesis.

More recently, a number of studies including Schoenberg (2007), Kahn (2008), Zhang (2008), and Pinkston (2009) have developed other tests of asymmetric learning and those papers mostly find supporting evidence. Specifically, Schoenberg finds evidence consistent with asymmetric learning being important for university graduates but not for high school graduates and dropouts,[27] while Kahn, Zhang, and Pinkston explore a variety of tests and all find evidence consistent with asymmetric learning.

The last asymmetric-learning analysis I will discuss is DeVaro and Waldman (2011). This paper's focus is the promotion-as-signal hypothesis, so it is the paper in the empirical literature on asymmetric learning most relevant for choosing between the classic and market-based tournament approaches. DeVaro and Waldman first extend the basic promotion-as-signal model by allowing workers to vary in terms of their education levels (see Bernhardt (1995) for a related analysis) and then use this model to derive three testable implications. First, holding performance fixed, a worker's probability of receiving a first promotion should increase with the worker's education level. Second, the wage increase due to a first promotion should be decreasing with the worker's education level. Third, the first two relationships should hold more strongly for first promotions than for subsequent promotions.

After developing these testable predictions, DeVaro and Waldman investigate the predictions using the data set first analyzed in Baker, Gibbs, and Holmstrom (1994a,b) mentioned earlier. They find clear evidence for the promotion-as-signal hypothesis for workers with bachelors and masters degrees, while the evidence concerning high-school graduates and PhDs is mixed. Specifically, the predictions that pertain to promotion probabilities hold for all education groups, while the predictions concerning wage increases only hold for bachelors and masters degree holders. Note that it is possible that the reason the wage-growth predictions do

[27] Schoenberg (2007) develops and tests two predictions concerning asymmetric learning. The first is the basic prediction found initially in Greenwald (1979,1986) that workers who turnover should be disproportionately from the low end of the ability distribution. She finds clear evidence for this prediction among university graduates. The second is that the return to ability should be positively related to firm tenure and for this prediction she finds mixed evidence among university graduates. This prediction follows from the specific theoretical model of asymmetric learning that she considers, but I do not believe it is a robust prediction of asymmetric-learning models. So my interpretation is that Schoenberg's findings are consistent with asymmetric learning for university graduates.

not hold for high-school graduates and PhDs is that these workers are in systematically different jobs and the controls DeVaro and Waldman use for job type are not sufficient to control for these differences. Also, they consider various alternative explanations for their empirical findings such as symmetric learning, education provides higher level skills, and coarse performance measures and find that none of the alternatives can explain their empirical findings.

So overall the empirical evidence supports asymmetric learning in real-world labor markets and, in particular, there is evidence that specifically supports the promotion-as-signal hypothesis. In terms of choosing between classic and market-based tournaments, this evidence is clearly consistent with market-based tournament theory. As for the classic tournament approach, in general I do not see anything inconsistent with labor markets being characterized by both classic tournaments and asymmetric learning. However, one of the results in DeVaro and Waldman (2011) does seem problematic for the classic tournament approach. As just discussed, DeVaro and Waldman find that, holding performance fixed, the probability of receiving a first promotion rises with education.[28] But remember Lazear and Rosen (1981) argue that in an asymmetric tournament the firm would like to bias the tournament in favor of lower ability workers. This suggests that, holding performance fixed, the probability of promotion should decrease rather than increase with education. So the DeVaro and Waldman result that for first promotions it increases with education is inconsistent with the classic tournament approach.[29]

C) Overview and Synthesis

There is an extensive literature that tests predictions of the classic tournament approach and most of the findings in this literature are consistent with predictions of that approach. However, as discussed in Subsection IV.A, all but one of the predictions for which there is clear

[28] Belzil and Bognanno (2010) find related results in an empirical study that employs an eight-year panel of promotion histories of a large number of American executives.

[29] Knoeber and Thurman (1994) find evidence consistent with the biasing hypothesis but their evidence does not concern promotion tournaments, so it is not as relevant for the topic of this paper as are the findings of DeVaro and Waldman (2011).

evidence are also consistent with the market-based tournament approach. For example, it is not surpising that, even when promotion wage increases are determined by signaling rather than optimal design, promotions are associated with large wage increases and bigger prizes result in higher effort levels. It is also the case that, since the signal associated with promotion should be larger when the promoted worker is drawn from a larger pool of workers, the market-based tournament approach is also consistent with the size of the promotion prize being positively related to the size of the pool.

The one empirical finding in this literature that seems inconsistent with market-based tournaments is that of a convex wage structure. Rosen's (1986) model suggests that classic tournaments with multiple rounds should have convex wage structures because the prize associated with early promotions include the possibility of many later promotions, while this is not the case when a promotion brings a worker close to the top of the job ladder. So to preserve incentives near the top, it is necessary to have larger promotion prizes for promotions at the top of the job ladder (I also provided a discussion of extensions of Rosen's initial model that should serve to strengthen the argument). There is no clear cut reason why this would be a robust feature of the market-based tournament approach. So the evidence in the literature consistent with convex wage structures points to the classic tournament approach.

The second relevant empirical literature is the literature that tests for asymmetric learning in labor markets. Most of the papers in this literature find evidence that supports asymmetric learning being important which is consistent with the market-based tournament approach, although as I stated earlier, I do not think there is any inconsistency in general between asymmetric learning and the classic tournament approach. But DeVaro and Waldman (2011) find evidence consistent with the promotion-as-signal hypothesis holding for at least some education groups which favors the market-based approach at least for these groups. Further, of particular importance is that DeVaro and Waldman find that for first promotions, even after controlling for performance, the probability of receiving a promotion increases with the worker's

education level. Since classic tournament theory predicts the opposite, this finding is particularly problematic for the classic tournament approach.

So in summary, much of the relevant evidence is consistent with both approaches, evidence consistent with convex wage structures favors the classic tournament approach, and recent evidence concerning how education affects promotion probabilities favors the market-based tournament approach. So possibly the correct answer is that neither theory completely captures how promotion prizes work in real-world labor markets, but each theory captures an important part of the full story. This is what I discuss next.

In the classic tournament approach the firm is able to commit to the size or sizes of promotion prizes and rules concerning who to promote without any constraints. But if promotions serve as signals as suggested by various theoretical papers and some recent empirical evidence, then those signals may constrain the firm in terms of the promotion prizes it commits to. For example, suppose a firm wants to commit to a promotion prize of ten thousand dollars, but when a promotion actually takes place the signal associated with the promotion causes other firms to increase their wage offers for the worker by twenty thousand. Will the firm stay with a promotion prize of ten thousand and let the worker be bid away by alternative employers? If the rents the firm earns from employing the worker are high enough, the answer is no! Rather, the firm will increase the promotion prize to reduce the probability the worker leaves.[30] So I think a plausible hybrid model is that firms commit to promotion prizes and rules concerning who to promote constrained by the wage offers of other firms and, in particular, how the signaling role of promotions affects those wage offers.[31]

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[30] Barron, Berger, and Black (2006) report empirical evidence that counteroffers of this sort are common, although they do not specifically consider the possibility of counteroffers after promotions.

[31] One does not literally have to think that a firm commits to promotion prizes and rules concerning who to promote but rather a commitment-like outcome is achieved through repeated interaction and reputation formation, although Zabojnik (2010) shows that in a competitive setting the full commitment outcome cannot be achieved through repeated interaction no matter how large is the discount factor. Also, note that this hybrid model has some similar features to the model of Harris and Holmstrom (1982) where in a symmetric-learning framework contracting is constrained by the wage offers of alternative employers.

My conjecture is that such a hybrid model is capable of capturing all of the empirical findings I have discussed. Based on the logic of Rosen's (1986) analysis, for promotions at low levels of the job ladder the firm would like to commit to small wage increases upon promotion because the prize for such promotions is already large due to the probability of receiving subsequent promotions. The result is that the wage increases required by the signaling role of promotions serve as binding constraints, so promotion practices at the low end of the job ladder are best understood using market-based tournament theory. This explains the DeVaro and Waldman results concerning how education affects promotion probabilities for first promotions.

On the other hand, consider promotions towards the top of the job ladder. For these promotions the probability of subsequent promotions is small so classic tournament theory predicts that wage increases directly associated with such a promotion must be large in order to preserve incentives. In turn, if the optimal tournament design has large wage increases for promotions towards the top of the job ladder, then the wage increases required by signaling are likely to be non-binding which means that promotions at the top of the job ladder are best thought of as being determined by classic tournament theory. This in turn is a potential explanation for convex wage structures since classic tournament theory predicts promotion wage increases at the top of the job ladder that are consistent with a convex wage structure.

V. CONCLUSION

Lazear and Rosen's (1981) seminal analysis of promotion tournaments was the first paper to theoretically investigate the important role that promotions serve in providing incentives inside firms. The Lazear and Rosen approach is to model a tournament as an optimal design problem where commitment is possible and promotion prizes and rules concerning who to promote are chosen to maximize the profits of the firm. But there is also an alternative approach which builds on the promotion-as-signal hypothesis first put forth in Waldman (1984a). In this argument promotions serve as signals of worker ability and thus alternative employers are willing to bid more for a worker after the worker is promoted. The result is that to stop workers

from being bid away there is a large wage increase or prize associated with being promoted and, just like in the Lazear and Rosen approach, this prize can serve as an incentive for effort and human-capital investment.

In this paper I first reviewed both theoretical approaches and then compared each approach to the relevant empirical literatures. My first point is that what I call the market-based tournament approach is consistent with most of the predictions investigated in the empirical literature that tests the classic tournament approach. As a result, there are only a few pieces of evidence one can point to in trying to choose between the theoretical approaches. On the one hand, the evidence in support of convex wage structures which is predicted by Rosen's (1986) multi-round tournament model points towards classic tournament theory since this evidence does not seem easily explained by the market-based tournament approach. On the other hand, DeVaro and Waldman (2011) find evidence concerning how education affects the probability of promotion that is consistent with market-based tournaments but is inconsistent with the classic tournament approach.

I also suggested a possible resolution of this conflicting evidence which is a synthesis of the two approaches. In this hybrid approach the firm can commit to promotion prizes and practices as in the classic tournament approach but there are constraints on this commitment ability due to the signaling role of promotions. For example, if the unconstrained optimal design indicates that a worker promoted from level 1 to level 2 should receive a ten thousand dollar raise but the signal associated with the promotion means the worker only stays if the raise equals twenty thousand, then the firm is constrained to have the pay increase equal twenty thousand. I argue that such a hybrid model is potentially consistent with all of the evidence put forth in support of the classic tournament approach as well as DeVaro and Waldman's findings concerning how education affects the promotion process.

Finally, I believe that an interesting avenue for future research in this area would be to investigate both theoretically and empirically this hybrid approach for modeling promotion tournaments.[32]

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[32] Wang (2011) already provides some empirical evidence concerning this hybrid approach. She uses the Baker, Gibbs, and Holmstrom (1994a,b) data set to investigate the relationship between promotion and turnover and finds results consistent with the version of the hybrid model discussed in Section IV where the constraints on promotion wages due to signaling are binding at the bottom of the hierarchy but not the top.

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