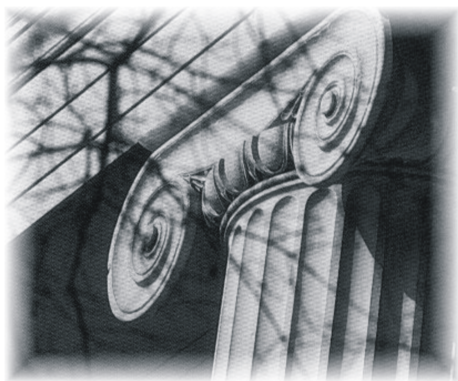
THE UNIVERSITY OF ALABAMA

ECONOMICS, FINANCE AND LEGAL STUDIES

WORKING PAPER SERIES



Working Paper No. 04-09-01

RENT-SEEKING WITH SCARCE TALENT: A MODEL OF PREEMPTIVE HIRING

Sami Dakhlia and Paul Pecorino

Culverhouse College of Commerce and Business Administration
The University of Alabama

September 2004

RENT-SEEKING WITH SCARCE TALENT:

A MODEL OF PREEMPTIVE HIRING*

Sami Dakhlia and Paul Pecorino

Department of Economics, Finance and Legal Studies
The University of Alabama
Tuscaloosa, AL 35487-0224

Abstract

In the standard model of a rent-seeking contest, firms optimally employ resources in an attempt to win the contest and obtain the rent. Typically, it is assumed that these resources may be hired at any desired level at some fixed, exogenous per-unit cost. In many real-world rent-seeking contests, however, these resources consist of scarce, talented individuals. We model a rent-seeking contest in which the talent available for employment is scarce and in which the rent obtained from winning the contest may also differ from participant to participant. Talent scarcity leads to preemptive hiring by the player receiving the larger rent. In the traditional analysis, as the size of the rents converges, the levels of effort and the probability of winning also converge. By contrast, when talent is scarce, the player receiving the larger rent hires it all and wins the contest with probability 1. This is true even if the difference in rents is small. Interestingly, this outcome may be Pareto-inferior to the outcome associated with the interior Nash equilibrium. We also characterize the condition under which talent ceases to be scarce. For a simple rent-seeking game, this requires at least 50% more talent than is employed at the interior Nash equilibrium.

Keywords: rent-seeking, scarce talent, labor market, lobbying, preemptive hiring.

JEL code: D44, D72.

*Dakhlia: Tel: (205) 348-2927; E-mail: sami@ua.edu. Pecorino: Tel: (205) 348-0379; E-mail: ppecorin@cba.ua.edu. We would like to thank David Levine, Stefan Szymanski and workshop participants at the University of Alabama for providing helpful comments on the paper, and we thank Maria Crawford for editorial assistance. Dakhlia thanks the Culverhouse College of Commerce and Business Administration for supplemental summer research support.

1. **Introduction**

Many economic activities take the form of a contest. Tullock (1967) and Krueger (1974) provide prominent examples of lobbying the government to receive monopoly rents or valuable import licenses, but there are others. Civil litigation also embeds a contest in which each party to the dispute can compete through its chosen level of legal expenditure.[1] Contests have also been used to model internal labor markets and patent races.[2] Finally, sports franchises clearly engage in contests to be crowned champion and earn the associated rents.

One important aspect of these contests is that they employ talented individuals who are potentially scarce. When talent is scarce, firms competing in a contest may engage in preemptive hiring, the purpose of which is, in part, to deny talent to a rival. For example, in lobbying, it is useful to have well-connected former officeholders to plead your case to the government. At any one time, however, there are a fixed number of ex-office holders engaged in lobbying, and some have more clout than others. Furthermore, a particular lobbyist can potentially be employed to represent either side of the policy question. Thus, if the steel industry retains former Senate Majority Leader Bob Dole to help it lobby for trade protection, part of the benefit of this is that the steel users' association is denied Bob Dole's services in lobbying *against* trade protection.[3] Similarly, in the sports example, part of the benefit of the New York Yankees acquiring Alex Rodriguez in a trade is that his services are denied to the rival Red Sox, who might otherwise have been able to acquire him via a trade.

Lawyers may also represent scarce talent, particularly in specialized areas of the law. In principle, lawyers may represent either side in a dispute, so that part of the value of hiring a talented litigator is the denial of her services to your rival. For example, in 1997 a tax ruling

[1] See Tullock (1975), Plott (1987) and Farmer and Pecorino (1999).
[2] See Loury (1979) on patent races. On labor markets, see Lazear and Rosen (1981) and Rosen (1986).
[3] This example is not based on Bob Dole's actual lobbying activity.

allowed Dana Corp. to deduct its annual retainer paid to Wachtell, Lipton, Rosen and Katz even though the firm did little to no work for them in most years. This law firm specialized in corporate takeovers and one of the stated reasons for the retainer was to deny their services to rivals.[4]

The idea that a contest participant may employ scarce talent preemptively is central to this paper. When talent is scarce, the outcome of the standard rent-seeking game differs quite sharply from the outcome when scarcity is not an issue. We analyze a two person rent-seeking game in which the size of the rent may differ across the participants. In the standard model (without talent scarcity), as the value of the rent to the two parties converges, the level of rent-seeking activity by each party (i.e., the amount of talent employed) and the probability that each party will obtain the rent both converge.[5] By contrast, when talent is sufficiently scarce, even a small difference in the size of the rent may lead to a corner solution in which the party with the larger rent buys all the talent and wins the rent with probability 1.

The scarcity of talent converts the standard rent-seeking game into an auction-like mechanism. The player with the higher rent wins this "auction" with probability 1 because she is willing to make a larger total bid (in the form of wages paid to scarce talent) than her opponent.[6]

We also characterize the condition under which talent ceases to be scarce. Under a simple rent-seeking technology, the existence of an interior Nash equilibrium requires at least 50% more total talent than is hired at the interior equilibrium.

---

[4] See *The Wall Street Journal*, July 28, 1997. The headline on the article is "Companies Can Deduct Retainers To Keep Lawyers From Rivals", and the article notes that other companies in addition to Dana Corp. have also engaged in the practice of hiring of law firms to keep them from rivals.

[5] For example, see Epstein and Nitzan (2002, pp. 138-9).

[6] While talent scarcity converts the standard rent-seeking game into something akin to an auction, it is important to note that it is not an auction. A player employing less talent than his opponent can still win the contest. In the terminology of the literature, our game is imperfectly discriminating (Nitzan, 1994, p. 45). By contrast, Baye et al. (1993) model the rent-seeking game as an all-pay auction, which is perfectly discriminating (i.e., the high bid is always awarded the rent). The all-pay auction does not have a pure strategy Nash equilibrium (Baye et al, 1993, pp. 290-1). The game we analyze does have a pure strategy interior Nash equilibrium in the absence of talent scarcity.

2. Background

The analysis of rent-seeking contests dates to Tullock (1980), and an enormous literature has ensued. Our discussion of this literature is brief and necessarily incomplete. Surveys of the rent-seeking literature can be found in Tollison (1982) and Nitzan (1994). A key aspect of our analysis is that we allow for the size of the rent awarded to differ between contest participants. The case of asymmetric rents is analyzed by Hillman and Riley (1989), Nti (1999) and Epstein and Nitzan (2002). Because we focus on a labor market interaction, our work bears some resemblance to Lazear and Rosen (1981) and Rosen (1986). However, their analysis concerns workers who compete in a tournament setting and the types of incentive structures which make these tournaments optimal from the firm's perspective. Our focus is on firms who hire talented labor in order to compete with other firms. Another related strand of the literature concerns delegation in a rent-seeking contest. Papers in this line include Baik and Kim (1997), Wärneryd (2000) and Schoonbeek (2004). Because of the moral hazard problem, delegation can lead to lower total expenditure in the rent-seeking contest. In our analysis, we ignore any moral hazard problem which might arise between the firm and the talent it hires. This allows us to focus on the implications of talent scarcity.[7]

The literature on the economics of team sports has provided the analysis which is most closely related to the one we present in this paper. This literature is surveyed by Szymanski (2003).[8] In the analysis of sports leagues, it is sometimes assumed that talent is in fixed supply. Authors who have made this assumption have used a non-Nash conjecture $dT_2/dT_1 = -1$ to reflect

[7] Presumably, talented individuals with foresight would have reputation concerns which would help to alleviate the moral hazard problem.
[8] Also see Szymanski and Késenne (2004) and Palomino and Sákovics (2004).

this scarcity in each team's first order condition (Szymanski, 2003, pp. 1164-1168), where the *T*s reflect the talent hired by each team.[9]

Our approach differs from this literature in several ways. First, our analysis is of the standard rent-seeking game in which the size of the rent is fixed. The literature on sports leagues is concerned with issues such as competitive balance and revenue sharing. In these models, the rent earned by a team is a function of its relative holdings of talent. Competitive balance is incorporated into the model by allowing that the rent received if a team wins might ultimately decline in its own probability of winning.[10] In other words, the rent received by the winning team may be lower in a highly unbalanced sporting contest. Since the issue extends beyond the sports league example, we strip away the institutional features discussed above to focus on the role of talent scarcity in the standard model. In addition, the sports league literature focuses its attention on interior solutions only, whereas our focus is more general: indeed, in the standard model, as long as talent is scarce, we will find ourselves at a *corner* solution in which the party with the larger rent buys all the talent and wins the contest with probability 1. Thus, whenever we find ourselves at an interior solution, it *must* be the case that the talent constraint is nonbinding. It follows, furthermore, that the conjecture $dT_2 / dT_1 = 0$ always applies at the interior equilibrium for the standard rent-seeking game.

---

[9] As Szymanski (2004) correctly argues, the Nash equilibrium is the proper solution concept for the type of contest we analyze, and we employ this throughout. Our expanded model of the contest includes an auction for talent. When talent is scarce, Team 1 may recognize $dT_2/dT_1 = -1$ in the Nash equilibrium of the expanded game, and Team 2 may recognize that $dT_1/dT_2 = -1$. Thus, we do not employ a non-Nash conjecture as a solution concept, but the model is able to produce an effect that mimics the effect this conjecture would produce in the simple model of the contest.

[10] This would tend to eliminate the types of corner solutions we analyze in this paper. When competitive balance affects the size of the rent, neither party wants too unbalanced a contest. By contrast, when the rent is fixed, there is no loss associated with an unbalanced contest, and corner solutions will occur when talent is scarce.

3. An Example

Consider two civil engineering firms, say, Artemis & Co. and Babel, Inc., competing for the winning design of a large project, say, an inter-continental underwater tunnel connecting Morocco and Spain across the Strait of Gibraltar. Let it be the case that the only talented people for this project are the four famous chief engineers formerly involved in the similar Franco-British "Chunnel" project linking Paris to its new-found London suburb. Indeed, for indispensable credibility, any design for this new project (the Funnel?) ought to be supervised by at least one of the four talented former Chunnel chief engineers; of course, the more, the better.

For simplicity, we shall assume that the use of talent in this contest only affects the probability of winning. Thus, if Artemis were to hire two chief engineers, whereas Babel were to hire only one, then Artemis's probability of winning the contest would be 2/(2+1)=2/3; if, on the other hand, Artemis were to hire one chief engineer while Babel hired three, then Artemis's probability of winning would be 1/(1+3)=1/4. While the model in Section 4 treats talent as a continuous variable, for the purpose of exposition, our example here is discrete.

Finally, we shall assume that ---perhaps because of a cost advantage--- Artemis receives a higher rent from winning the contest than does Babel. If Artemis wins the contest, it receives a rent of $1,000,000 (nothing otherwise); if Babel wins, it receives a rent of $500,000 (and nothing otherwise). Last, but not least, chief engineers have reservation wages of $100,000.

If the chief engineers receive their opportunity wage, then Artemis's expected profit is 1,000,000 ($T_A/(T_A+T_B)$) – 100,000 T_A, and Babel's expected profit is 500,000 ($T_B/(T_A+T_B)$) – 100,000 T_B, where T_A is the number of engineers hired by Artemis and T_B is the number of engineers hired by Babel. If this were the standard game without talent scarcity, we could represent it in normal form. In thousands of dollars, we would obtain the following:

		Babel				
	Talent hired	0	1	2	3	4
Artemis	0	(0,0)	(0,400)	(0,300)	(0,200)	(0,100)
	1	(900,0)	(400,150)	(233,133)	(150,75)	
	2	(800,0)	(467,67)	(300,50)		
	3	(700,0)	(450,25)			
	4	(600,0)				

In the standard game, there is a Nash equilibrium at $(T_A, T_B)=(2,1)$. In the presence of talent scarcity, however, Artemis recognizes that increased hiring on their part can result in fewer engineers being employed by Babel. We can think of this as *preemptive hiring*. If Artemis ups its wage offer to \$100,000 + ε, it can hire all four engineers and earn approximately \$600,000, i.e. about \$133,000 more than at the interior Nash equilibrium. Thus, the interior equilibrium fails to exist.

The situation we have described is still not an equilibrium, because Babel is also willing to pay more than \$100,000 for a chief engineer. However, it would be an equilibrium for Babel to offer \$125,000, only to be outbid by Artemis, who hires all the available talent at \$125,000 + ε. At this corner solution, Artemis wins the contest with probability 1 and earns (approximately) 1,000,000 – 4 x 125,000 = \$500,000, while Babel earns 0. By contrast, in the absence of talent scarcity, Artemis wins the contest two-thirds of the time and expects to earn \$467,000 on average. As this example demonstrates, talent scarcity converts a rent-seeking contest into an auction-like mechanism in which the player receiving the highest rent always wins.

In our subsequent, more general model, we keep the simple contest success function of this example: the probability that Team *i* wins is equal to $T_i/(T_1+T_2)$, where T_i is the amount of talent hired by Team *i*. While the specific conditions we derive for our results depend upon this specification, the basic insights do not. In the appendix we consider a more general contest success function and show that Team 1 will always outbid Team 2 for additional talent as long as Team 1's rent R_1 exceeds Team 2's rent R_2. It is this rent-driven willingness to bid for talent which drives the results of our paper, not the specific functional form of the contest success function used in the main body of the paper. Furthermore, this willingness of Team 1 to outbid Team 2 will hold even if R_1 exceeds R_2 by an arbitrarily small amount.

4. The Model

Our basic two-player (or two-team) winner-take-all contest model can be traced back to Tullock's (1980) rent-seeking model. As in Hillman and Riley (1989), we allow for asymmetric rents. The key innovation, however, is to allow for the employment of scarce talent in order to win the contest. Without loss of generality, we are assuming that the first team's rent in case of victory (R_1) equals or exceeds that of the second team R_2: $R_1 \geq R_2$. Furthermore, a limited amount T of rare talent with reservation wage $\overline{w}$ is up for bid, and Team 1 hires T_1 while Team 2 hires T_2 under the feasibility constraint $T_1 + T_2 \leq T$, where $T_1, T_2 \geq 0$.

Talent is allocated in a simultaneous auction. Each team submits a bid which includes a set of wages and the number of units of talent it is willing to hire at each wage. While multiple wages could be submitted, it turns out that the winning bidders will always submit a single wage in equilibrium. Talent is allocated to the high bidder first and then to the low bidder. No talent is allocated to bids below the opportunity wage $\overline{w}$. If the total amount of talent bid for exceeds the amount available, low bidders will receive less talent than requested in their bid and may, in fact, be denied any talent. If talent is scarce and two bidders submit an identical wage, the allocation for each unit of talent may be determined by a coin flip.[11] After talent is allocated by the auction

[11] This would only apply to talent which remains after allocations to any high bidders.

mechanism, both teams are required to pay the wage w_i submitted to the mechanism for each unit of talent which is assigned to them. In equilibrium, if the amount of talent hired $T_1 + T_2 \leq T$, then optimal behavior on the part of both teams implies that they will pay the reservation wage $\overline{w}$.[12]

The game proceeds as follows:

1. Each team *i* submits a bid to the auction mechanism. The bid consists of a wage w_i and a quantity of talent T_i demanded at that wage.
2. Talent is allocated by the auction mechanism described above.
3. The two teams engage in a rent-seeking contest.

Team *i*'s probability of success, that is, of winning rent R_i, is given by the function

$$p_i = \frac{T_i}{T_1 + T_2}. \tag{1}$$

We can therefore write that Team *i* is maximizing expected profit

$$\Pi_i(T_1, T_2) = \left(\frac{T_i}{T_1 + T_2}\right) R_i - w_i T_i, \tag{2}$$

subject to the participation constraint that $\Pi_i(T_1, T_2) \geq 0$ when evaluated at the equilibrium values of the T_i and w_i. If talent is sufficiently plentiful, the outcome of this game will be the familiar interior Nash equilibrium derived in games where the supply of talent is (implicitly) assumed to be a nonbinding constraint. If talent is not scarce, each team will make an unconstrained choice of T_i, while paying the opportunity wage $\overline{w}$. It is easily shown that the interior Nash solution of this game is

[12] Since talent is available for hire at the reservation wage in equilibrium, a bid at the reservation wage will be fully accepted by the auction mechanism.

$$\left(T_1^*, T_2^*\right) = \left(\frac{R_2 R_1^2}{\overline{w}\left(R_1 + R_2\right)^2}, \frac{R_1 R_2^2}{\overline{w}\left(R_1 + R_2\right)^2}\right), \tag{3}$$

where the '*' indicates that this is the level of talent hired in the unconstrained interior Nash equilibrium. Throughout the paper, T_1^* and T_2^* will be used to denote the unconstrained solutions in (3). Also, note that since $R_1 \geq R_2$, $T_1^* \geq T_2^*$.

Using (3), team 1's profit $\Pi_1 = \left(\frac{T_1}{T_1 + T_2}\right) R_1 - \overline{w} T_1$ can be rewritten as

$$\Pi_1 = \left(\frac{R_2 R_1^2}{R_2 R_1^2 + R_1 R_2^2}\right) R_1 - \overline{w} \frac{R_2 R_1^2}{\overline{w}\left(R_1 + R_2\right)^2} = \frac{R_1^3}{\left(R_1 + R_2\right)^2}. \tag{4}$$

Similarly, Team 2's profit is

$$\Pi_2 = \frac{R_2^3}{\left(R_1 + R_2\right)^2}. \tag{5}$$

The analysis of the game without talent scarcity replicates results which are standard in the rent-seeking literature.

5. Talent Scarcity

The solutions in equations (3) – (5) assume that talent is not scarce. As will be seen in Result 1, the critical level of talent is $2T_1^* + T_2^*$. For $T \geq 2T_1^* + T_2^*$, there is no talent scarcity and the standard analysis applies. For $T < 2T_1^* + T_2^*$, talent is scarce and the interior Nash equilibrium described above will fail to exist. Because $T_1^* \geq T_2^*$, this critical level of talent is at least 50% greater than the level employed at the unconstrained interior Nash equilibrium.

Result 1:

For $R_1 \geq R_2$ *and* $T \geq 2T_1^* + T_2^*$*, there exists an interior equilibrium under which Team 1 hires* T_1^* *and Team 2 hires* T_2^**, each paying the reservation wage* $\overline{w}$*. The remaining talent is not employed in the contest. Conversely, when* $T < 2T_1^* + T_2^*$*, this interior equilibrium does not exist.*

Since we have an interior Nash equilibrium, by definition, neither team would want to make a small deviation in the amount of talent they hire. However, we must also show that Team 1 would not want to make a *large* deviation either.[13] Should Team 1 hire all the talent[14] at a wage $\overline{w} + \varepsilon,$ it would earn (approximately) $R_1 - \overline{w}T,$ instead of $\frac{R_1^3}{(R_1 + R_2)^2}$. Such deviation is unprofitable as long as

$$R_1 - \frac{R_1^3}{(R_1 + R_2)^2} = \frac{2R_1^2 R_2 + R_2^2 R_1}{(R_1 + R_2)^2} \leq \overline{w}T. \tag{6}$$

Using (3), this can be written as

$$T \geq 2T_1^* + T_2^*, \tag{7}$$

as claimed in the result.

Conversely, if $T < 2T_1^* + T_2^*$, Team 1 does find it profitable to deviate from the interior Nash, and the traditional equilibrium fails to exist. In Result 1 we have merely shown conditions under which (T_1^*, T_2^*) is or is not an equilibrium. In Results 2 and 3, we now show that the alternative equilibrium is always $(T, 0)$ when $R_1 > R_2$.

---

[13] Because Team 1 has the larger rent, we only consider deviations by Team 1. If Team 1 does not wish to deviate from equilibrium, neither will Team 2.

[14] We confirm in the appendix that if it pays to deviate at all, Team 1 will do so by hiring all the talent.

Result 2:

(i) *When* $T < 2T_1^* + T_2^*$, *and* $R_1 > R_2 > .618R_1$, *there exists an equilibrium in which Team 1 hires all talent at a wage* $R_2/T + \varepsilon$, *while Team 2 submits a losing bid of* R_2/T *with a requested quantity of* T *units of talent.*

(ii) *When* $T < 2T_1^* + T_2^*$ *and* $R_1 = R_2 = R$, *all talent is hired at a wage* R/T *and any allocation such that* $T_1 + T_2 = T$ *is consistent with equilibrium.*

Here we discuss part (i) of Result 2: First, consider the behavior of Team 2. Because Team 1 has submitted a bid for all T, talent will be fully employed, regardless of Team 2's action. Suppose Team 2 hires T_0 units away from Team 1 by raising its bid to $w_2 > R_2 / T + \varepsilon$. It will earn an expected payoff of $(R_2 / T)T_0 - w_2T_0 < 0$. With the talent constraint binding, the marginal product of talent is constant for Team 2 at R_2 / T. Thus, if Team 2 attempted to match or exceed Team 1's bid of $R_2 / T + \varepsilon$, it would earn negative profits. As a result, it is better off submitting a losing bid and earning zero profits.

Now consider Team 1. The losing bid of Team 2 ensures full employment of talent, regardless of the actions of Team 1. In equilibrium, Team 1 earns profits of $R_1 - R_2$. If it reduces the amount of talent it hires to $T' < T$ units, its profits become $(T'/T)(R_1 - R_2) < R_1 - R_2$. Thus, it does not want to hire less talent. Given the losing bid of Team 2, Team 1 cannot lower its bid without losing some or all of its talent.[15]

The outcome described in Result 2 (i) is unique, though the strategies which support it may not be unique. In particular, there may be equilibria supporting the same outcome in which Team 2 submits a losing bid of R_2/T on fewer than T units of talent.

---

[15] If Team 1 lowers its bid to R_2/T on all T units, then it will lose, on average, $T/2$ units to Team 2.

Next we turn to part (ii): when the rents are equal, the teams' bidding war leads to full rent absorption by talent. Competitive bidding for talent leads to full employment with each team willing to pay *R/T* per unit of talent. At this wage, the rent is totally exhausted, and both sides earn zero profits. Any allocation of talent (T_1, T_2) such that $T_1 + T_2 = T$ is an equilibrium. Each of these allocations results in a zero expected payoff for both teams. It is not consistent with equilibrium for less than *T* units to be hired, as each team is willing to pay more than the opportunity wage per unit of talent.

One condition of Result 2 (i) is that $R_2 > .618R_1$. This condition ensures that $R_2 / T \geq \overline{w}$ over the relevant range of *T*.[16] We address the case $R_2 < .618R_1$ in Result 3.

Result 3: *Assume that* $T < 2T_1^* + T_2^*$ *and* $R_2 < .618R_1$.

(i) *When* $T \leq R_2 / \overline{w}$, *there is an equilibrium in which Team 1 hires all talent at a wage* $R_2 / T + \varepsilon$, *while Team 2 submits a losing bid of* R_2 / T *with a requested quantity of T units of talent.*

(ii) *When* $R_2 / \overline{w} < T < 2T_1^* + T_2^*$, *there is an equilibrium in which Team 1 hires all talent at a wage* $\overline{w} + \varepsilon$, *while Team 2 submits a losing bid of* $\overline{w}$ *with a requested quantity of* $R_2 / \overline{w}$ *units of talent.*

Proof:

(i) The proof follows the proof of Result 2 (i) exactly.

(ii) See the appendix.

---

[16] To see this, use equation (3) and set *T* to its maximum value, $2T_1^* + T_2^*$.

Once again, the outcomes described in Result 3 are unique, although there may exist other strategies for Player 2 which support these outcomes. Part (ii) of the result deals specifically with the case where the reservation wage $\overline{w}$ exceeds R_2 / T. As a result, the winning bid by Team 1 is $\overline{w} + \varepsilon$ rather than $R_2 / T + \varepsilon$.

In summary, when the level of talent is low, Team 1 finds it profitable to engage in preemptive hiring, which denies available talent to Team 2. What may come as a surprise, however, is that preemptive hiring occurs even for talent levels that *exceed* the level employed at the interior Nash equilibrium $T_1^* + T_2^*$. Indeed, to ensure that the talent constraint is nonbinding, we need at least 50% more talent than is employed in the absence of talent scarcity.[17]

When $T_1^* + T_2^* < T < 2T_1^* + T_2^*$, an interior Nash equilibrium fails to exist, but under some parameter values, *both* parties would actually prefer to be bound to the interior Nash strategies $\left(T_1^*, T_2^*\right)$ while paying the reservation wage. That is, under some circumstances, the corner solution is Pareto-inferior to the outcome associated with the interior Nash equilibrium.[18] This dilemma is the object of the next result:

Result 4: *If* $T_1^* + T_2^* < T < 2T_1^* + T_2^*$ *and* $R_2 > .618R_1$, *the resulting corner solution is Pareto-inferior to the outcome associated with* $\left(T_1^*, T_2^*\right)$ *where each team pays the reservation wage.*

[17] For $2T_1^* + T_2^* < T \leq R_1 / \overline{w}$ the interior equilibrium exists, but a corner solution along the lines described in Results 2 and 3 may also exist. However, this corner solution is pareto dominated by the interior Nash equilibrium. In addition, for some talent levels, the corner solution may require that team 2 play a weakly dominated strategy as part of the equilibrium. For $T > R_1 / \overline{w}$, the interior Nash equilibrium is unique.

[18] When we say the outcome is pareto inferior to the interior Nash outcome, we are considering the welfare of Team 1 and Team 2, but not the welfare of the talent.

The corner solution is a direct consequence of Result 2. Team 1's profits are smaller under preemptive hiring than the interior Nash outcome if $R_1 - R_2 < \frac{R_1^3}{(R_1 + R_2)^2}$, which simplifies to $R_1^2 - R_1 R_2 - R_2^2 < 0$. With $R_1 > R_2 > 0$, this condition simplifies further to $R_2 > \left(\frac{\sqrt{5}-1}{2}\right) R_1 \approx 0.618 R_1$, as stated in the result.

Note that Result 4 pertains to rents of comparable size, arguably a common case. Ironically then, even though Team 1 hires all the talent and always wins the unbalanced contest, it may end up being disappointed with the final outcome and may preferred the allocations associated with the interior Nash equilibrium.

In this type of situation, we might expect the teams to seek institutional features and mutual arrangements with the express purpose to prevent corner solutions and to restore the rents associated with the interior Nash equilibrium. In the sports example, for instance, these features might include salary caps and limits on roster size.

In addition to the types of institutional restrictions listed above, there may be other real world factors which may move the outcome of a rent-seeking contest away from the corner solution we have identified above. We have modeled talent as a passive actor who merely accepts any wage at or above the reservation level. Of course, talent takes an active role in bargaining for its wages. Assuming it goes to the highest bidder, allowing talent to bargain actively will not affect our results on talent allocation or the conditions under which a corner solution will occur. However, it will affect rent distribution. The level of rents retained by Team 1 in the corner solution is an upper limit, which could be reduced by active bargaining on the part of talent. More interestingly, talent may not always go to the high bidder. For example, if the Yankees already have the best third baseman in baseball, the second-best third baseman is unlikely to sign with them, even in the event that they are the highest bidder. In addition, players may have locational preferences which lead them to accept something other than the highest offer available to them. In terms of the model, high bids which are ε above the second place bid will not always be "winning" in the real world. This phenomenon may (in some circumstances) keep us away from the types of corner solutions identified in this paper. However, this caveat to our results is likely more important in the sports example in the law, lobbying or patent race examples discussed in the introduction.

6. Conclusion

We have introduced talent scarcity into the standard model of rent seeking. As long as talent is scarce, we end up with an unbalanced contest in which the team receiving the higher rent buys up all the talent and wins the contest with probability 1. This is true even if the smaller rent is arbitrarily close to the larger rent in size. By contrast, in the absence of scarcity, when the rents converge, so do the levels of rent seeking activity and the probability of victory.

While the unbalanced contest would appear to favor the team earning the higher rent, if $R_2 > .618 R_1$, the interior Nash outcome Pareto-dominates the corner solution. Thus, for these parameter values, both teams would potentially prefer institutional restrictions that prevent the emergence of a corner solution.

As long as talent remains scarce, the corner solution is the unique outcome of the game. The elimination of talent scarcity requires at least 50% more talent than is hired at the interior Nash equilibrium of the game without scarcity. Since an interior solution only exists in the absence of talent scarcity, it is never appropriate to employ the conjecture $dT_2 / dT_1 = -1$ at an interior solution of the standard rent-seeking game.

Our results are significant whenever rent-seeking contests employ the skills and talents held by a rather limited number of individuals. This is clearly the case in sporting contests. While lawyers abound, our earlier example shows that talent scarcity appears to be an issue in specialized areas of the law. The same holds true of lobbying and patent races, where a small number of players may constitute the available talent. Thus, the model of preemptive hiring developed in this paper has a potentially large range of applicability.

References

Baye, M.R., D. Kovenock and C.G. de Vries. 1993. “Rigging the Lobbying Process: An Application of the All-Pay Auction. *American Economic Review* 83: 289-294.

Baik, K.W. and I.-G. Kim. 1997. “Delegation in Contests.” *European Journal of Political Economy* 13: 281-298.

Epstein, G. S. and S. Nitzan. 2002. “Stakes and Welfare in Rent-Seeking Contests.” *Public Choice* 112: 137-42.

Farmer, A. and P. Pecorino. 1999. "Legal Expenditure as a Rent-Seeking Game" *Public Choice* 100 (September 1999): 271-88.

Hillman, A.L. and J.G. Riley. 1989. “Politically Contestable Rents and Transfers.” *Economics and Politics* 1 (Spring): 17-39.

Krueger, A. O. 1974. "The political economy of the rent-seeking society," *American Economic Review* 64: 291-303.

Lazear, E. and S. Rosen. 1981. “Rank Order Tournaments as Optimal Labor Contracts.” *Journal of Political Economy* 89: 841-64.

Loury, G. 1979. “Market Structure and Innovation.” *Quarterly Journal of Economics* 93: 385-410.

Nitzan, S. 1994. "Modeling rent-seeking contests." *European Journal of Political Economy* 10: 41-60.

Nti. K.O. 1999. “Rent Seeking with Asymmetric Valuations.” *Public Choice* 98: 415-430.

Palomino, Frédéric and József Sákovics. 2004. “Interleague Competition for Talent vs. Competitive Balance.” *International Journal of Industrial Organization* 22: 783-797.

Plott, C. R. 1987. "Legal fees: A comparison of the American and English rules." *Journal of*

Law, Economics and Organization 3: 185-192.

Rosen, S. 1986. “Prizes and Incentives in Elimination Tournaments.” *American Economic Review* 76: 701-15.

Schoonbeek. L. 2004. “Delegation in a Group Contest.” *European Journal of Political Economy.* 20: 263-72.

Szymanski, S. 2004. “Professional Team Sports Are Only a Game: The Walrasian Fixed-Supply Conjecture Model, Contest Nash Equilibrium, and the Invariance Principle.” *Journal of Sports Economics* 5 (May): 111-126.

Szymanski, S. 2003. “The Economic Design of Sporting Contests.” *Journal of Economic Literature* 41 (December): 1137-1187.

Szymanski, S. and S. Késenne. 2004. “Competitive Balance and Gate Revenue Sharing in Team Sports.” *Journal of Industrial Economics* 52 (March): 165-175.

Tollison, R. D. 1982. "Rent seeking: A survey." *Kyklos* 35: 575-602.

Tullock, G. 1967. "The welfare costs of tariffs, monopolies and theft." *Western Economic Journal* 5: 224-232.

Tullock, G. (1975). "On the efficient organization of trials." *Kyklos* 28: 745-762.

Tullock, G. (1980). "Efficient rent seeking." In J. M. Buchanan, R. D. Tollison and G. Tullock eds. *Toward a Theory of the Rent-Seeking Society.* College Station, Texas: Texas A&M University Press.

Wärneryd, K. 2000. “In Defense of Lawyers: Moral Hazard as an Aid to Cooperation.” *Games and Economic Behavior* 33: 145-58.

Appendix

A.1. A More General Rent-Seeking Function

Our results are driven by the willingness of the team receiving the higher rent to outbid the other team for talent. This willingness is not a function of the simple form for our rent-seeking technology. Assume that Team 1 has a probability of winning the contest equal to $p_1 = f(T_1)/\left(f(T_1)+g(T_2)\right)$, where $f', g' > 0$ and $f'', g'' < 0$. Team 2 wins the contest with the probability 1-p_1. Each team has an arbitrary initial endowment of talent T_1^0 and T_2^0. Now let Z additional units of talent become available for hire. Let M_i be the maximum each team is willing to bid for this talent. Assume that each team submits a bid in excess of the opportunity wage. Thus, each team recognizes the fact that if it does not hire the new talent, the other team will. We then have the following:

$$M_1 = \left(\frac{f(T_1^0+Z)}{f(T_1^0+Z)+g(T_2^0)} - \frac{f(T_1^0)}{f(T_1^0)+g(T_2^0+Z)} \right) R_1 = \frac{f(T_1^0+Z)g(T_2^0+Z) - f(T_1^0)g(T_2^0)}{\left[f(T_1^0+Z)+g(T_2^0)\right]\left[f(T_1^0)+g(T_2^0+Z)\right]} R_1, \tag{A1}$$

$$M_2 = \left(\frac{g(T_2^0+Z)}{f(T_1^0)+g(T_2^0+Z)} - \frac{g(T_2^0)}{f(T_1^0+Z)+g(T_2^0)} \right) R_2 = \frac{f(T_1^0+Z)g(T_2^0+Z) - f(T_1^0)g(T_2^0)}{\left[f(T_1^0+Z)+g(T_2^0)\right]\left[f(T_1^0)+g(T_2^0+Z)\right]} R_2 . \tag{A2}$$

The term in parentheses in each equation is the increase in team *i*'s probability of winning when it hires *Z*. An inspection of (A1) and (A2) reveals that $M_1 > M_2$ whenever $R_1 > R_2$. Thus, the willingness of Team 1 to outbid Team 2 is not sensitive to the form of the rent-seeking technology or to assumptions about initial talent levels.

A.2. Material in support of Result 1

The proof of Result 1 requires the following lemma:

Lemma 1: No partial preemptive hiring.

Proof: Team 1's gain in profit would be $\Delta\Pi_1 = R_1 - \overline{w}T - \frac{R_1^3}{(R_1+R_2)^2}$ if it bought all talent T. On the other hand, it would only be $\Delta\Pi_1 = \frac{R_1 T_0}{T} - \overline{w}T_0 - \frac{R_1^3}{(R_1+R_2)^2}$ if it bought some amount $T_0 < T$. The difference between the two is $\left(\frac{R_1}{T} - \overline{w}\right)(T - T_0)$, which is strictly positive as long as $\overline{w} < \frac{R_1}{T}$.

QED.

Intuitively, the constant marginal benefit (R_1/T) of hiring talent always outweighs the constant marginal cost (R_2/T).

A.3. Material in Support of Result 3

What follows is a proof of part 2 of the result. First consider Team 2. Since Team 1 has bid on all T units of talent, all talent will be fully employed, regardless of Team 2's actions. To hire talent away from Team 1, Team 2 must submit a bid $w_2 > \overline{w} + \varepsilon$. If it hired T_0 units at this bid, it would earn a profit of $T_0[R_2/T - w_2] < 0$. That this expression is negative follows from the facts that $R_2/\overline{w} < T$ (as stated in the result) and $w_2 > \overline{w}$.

Next consider Team 1. Team 1 can make a small deviation or a large deviation from the proposed equilibrium. Under a small deviation, talent would still be fully employed. In the proposed equilibrium, Team 1 earns (approximately) $R_1 - \overline{w}T$. If Team 1 deviated from equilibrium by hiring $T' < T$ units of talent, it would then earn $(T'/T)(R_1 - \overline{w}T) < R_1 - \overline{w}T$. Clearly, a small deviation is non-optimal.

Before proceeding further, note that under the corner solution, Team 1 earns, at a minimum, approximately $R_1 - \overline{w}(2T_1^* + T_2^*) = R_1^3/(R_1 + R_2)^2$. This makes use of (3) and is a minimum earnings level, since it is calculated under the assumption that *T* takes on the maximum value stated in the result. From (4), this implies that Team 1's earnings at the corner solution equal or exceed Team 1's earnings at the interior Nash equilibrium. Next note that Team 1's profits are strictly decreasing in Team 2's talent level: making use of (2) and the envelope theorem, we have

$$d\Pi_1 / dT_2 = (\partial\Pi_1 / \partial T_1)(dT_1 / dT_2) + \partial\Pi_1 / \partial T_2 = \partial\Pi_1 / \partial T_2 < 0 .$$

Under a large deviation by Team 1, finally, the talent constraint is not binding and Team 2 will therefore hire $R_2 / \overline{w} > T_2^*$ units of talent. (This inequality can be verified from (3)). Thus, a large deviation by Team 1 leaves Team 2 with more talent than it employs at the interior Nash equilibrium (when it exists). Since Team 1's profits are strictly decreasing in talent hired by Team 2, this would leave Team 1 with less profit than at the interior Nash equilibrium and therefore less profit than at the corner solution in our proposed equilibrium. As a result, Team 1 would not make a large deviation from the proposed equilibrium.

This establishes that the strategies in Result 3, part (ii) do indeed constitute a Nash equilibrium.