MANAGERIAL AND DECISION ECONOMICS, VOL. 15, 443–457 (1994)

Are Baseball Players Paid their Marginal Products?

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Previous researchers found that baseball players under the reserve clause had been paid considerably less than their contributions to club revenues. We ask, has the new contractual system of free agency and final-offer arbitration brought baseball salaries into line with marginal revenue products? Using public data for the 1986 and 1987 seasons, our basic answer is yes, major league salaries generally coincide with estimated marginal revenue products, though significant deviations exist. Experienced players are paid in accord with their productivity; young players, however, are paid less than their marginal revenue product, on average. This result is closely related to the market structure within baseball.

Baseball, the national pastime, is a game of statistics that has proven to be an intriguing labor market for economists, particularly given its potential for estimation of individual productivity. Moreover, in recent years major league baseball (MLB) has experienced regime changes in contractual institutions and in the nature of competition for talent, player remuneration and recovery of player development costs. An analysis of salary and productivity relations in baseball is useful because professional sports is a sizable, high-visibility business (MLB revenues surpassed $1 billion in 1989) and the analysis may yield insights into salary and productivity relations in markets where econometric estimation of individual productivity is more difficult.

In the pioneering econometric study of baseball, Scully (1974) found that players were paid only 10–20% of their marginal revenue product (MRP) in data for the 1968–9 seasons. Scully interpreted these results as monopsony exploitation encouraged by the 'reserve clause' which ties a player's services to one team. Subsequent researchers modified Scully's basic model, used more recent data, improved estimation procedures and found that baseball players were paid between 30% and 50% of their career MRPs (Medoff, 1976; Hill, 1985). More recently, Scully (1989, p. 153) asserted that with the coming of free agency, 'More or less, players began to be paid their expected net contribution to club revenues', though no statistical test was presented to support this conclusion. Zimbalist (1992, pp. 126–128) found that hitters were underpaid by 13–25% from 1986 to 1988 but with a negligible difference by 1989.

The purpose of this paper is to analyze pay-performance results in a refined Scully–Medoff type model using data primarily from the 1986–7 seasons. The question we seek to answer is, have the new institutions of free agency and final offer arbitration brought baseball salaries into line with marginal revenue products? Our answer basically is yes: 1986–87 salaries generally coincide with (discounted) marginal revenue products, though significant deviations exist. Three features distinguish our study from others. First, most previous studies used limited and confidential samples of player salary data, while we use salary data publicly available for replications or extension and include *all* players, both hitters and pitchers, who were on a major league roster as of 31 August 1986 and 31 August 1987.[1] This allows direct comparison of players salaries with MRP estimates and avoids estimation of so-called salary bargaining models as previous researchers have

CCC 0143–6570/94/050443–15

done. The data also avoid the interpretation problems inherent in studies using 1976–7 data which were confounded by MLB expansion into Toronto and Seattle and allow us to analyze whether any economic evidence of owner collusion exist during the 1986–7 period. Second, a systematic analysis of final-offer arbitration in baseball—established three years before free agency—has been virtually overlooked yet we find it has a stronger independent effect on salaries than the much-publicized free agency.[2] Third, we test the 'superstars' model of Rosen (1981) and MacDonald (1988) and find that the salaries of the very highest paid players in MLB disproportionately exceed their relative productivity advantage, as the superstars model predicts.

THE WAGE-DETERMINATION FRAMEWORK

From 1879 to MLB's first collective labor agreement in 1968, various kinds of reserve rules had effectively bound a player's baseball services to one team until that player's rights were transferred. The usual presumption is that the reserve clause kept salaries below those that might prevail in a more competitive environment (Miller, 1991). An alternative interpretation is that these contracts, rather than generating monopsony outcomes in a baseball cartel, were a privately and socially efficient means to finance player development and the inevitable failure of most minor league players to produce in the majors. By this view, the reserve clause might have been an efficient device for recovering the costs necessary to produce the high quality contests desired by customers. This paper does not answer this question.

Baseball's second collective bargaining agreement in 1970 brought a crucial event: the owners agreed to replace the baseball commissioner with an impartial arbitrator in the grievance procedure. Major changes swiftly followed. In 1973 a final-offer salary arbitration procedure was instituted. In 1975 players Andy Messersmith and Dave McNally played out their contracts and argued in a contract grievance that a team could renew a players' contract for only one year after it expired. The MLB Uniform Player Contract stated that the team could extend a contract for a year but was silent on whether a team could extend its control over a player's services indefinitely into the future. Arbitrator Peter Seitz shocked the baseball world by ruling that the contract language only permitted the team to control an unsigned player for one season, and thereafter the player was a free agent. The owners fired Seitz but nevertheless lost when the courts refused to reverse the decision. McNally later retired but Messersmith used his new freedom to sign a 3-year $1 million contract with the Atlanta Braves. Meanwhile, average salaries escalated from $29 000 in 1970 to $150 000 in 1980.

In 1981 there was a 2-month baseball strike and a major issue was compensation for teams losing free agents. As a result of the strike, the compensation rules were modified but considerable controversy still exists in the literature over the economic impact of the present compensation scheme.[3] In the 1985 negotiations, the owners' target was final-offer salary arbitration rather than free agency because, according to Dworkin (1987, p. 215), 'arbitrators were looking to the high salaries paid to free agents in determining their awards for the junior players eligible to use arbitration'. After a two-day strike in 1985 the players agreed to extend the number of years of professional experience required for final-offer arbitration eligibility from two to three full years of major league service beginning in 1988.

Disagreement over eligibility for arbitration was the principal issue for the 32-day lockout during February–March, 1990, the seventh shutdown in 18 years. The players and owners signed a 4-year agreement in which only the top 17% of players with between two and three years of service are eligible for arbitration (fewer then 20 players), the minimum salary was boosted from $68 000 to $100 000, pension contributions increased, and other provisions.[4] The financial importance of eligibility for arbitration is confirmed in the econometric work presented below. Institutionally, then, MLB players in 1986–7 were grouped into three contract environments: 'rookies' in years 1–2 subject to a team reserve clause and ineligible for salary arbitration and free agency; intermediate players in years 3–6 eligible for final-offer salary arbitration but not free agency; and senior players after 6 years eligible for either final-offer salary arbitration or free agency.

Institutional changes are by no means complete: arbitrators ruled that the owners colluded after the 1985, 1986 and 1987 seasons in order to eliminate competitive bidding for free agents and thereby to reduce their salaries. Owners were fined $280 million in damages. The 1990 MLB agreement calls for automatic triple damages awarded to players if intentional collusion is proven against five teams or more. Overall, average salary rose to \$415 829 in 1986, slipped to \$405 238 in 1987, and rose to \$433 000 in 1988.[5] MLB players averaged \$851 492 in 1991 and topped \$1 million in 1992.[6]

The analysis below assumes that each team owner desires to maximize profits (management is anxious to reduce financial losses or increase the team's market value) and each player seeks to increase his market value. By implication, teams continually attempt to employ all inputs (e.g. scouts, business managers, transportation, managers, coaches, players) in amounts that guarantee that each input's anticipated, discounted marginal revenue product equals its discounted marginal factor cost.[7]

TEAM MODEL AND MARGINAL REVENUE PRODUCTS

A baseball player's market worth can be defined as the amount of team revenue produced by his contribution to attracting paying fans to see and hear the team compete. Estimation of MRPs and monopsony exploitation was originally developed by Scully (1974) and has been modified by a number of authors, for example, Hill (1985), Hill and Spellman (1983), Medoff (1976), Scully (1989), Bruggink and Rose (1990) and Zimbalist (1992). If we ignore the special appeal of superstars for the moment, a player's marginal revenue product essentially is based on each player's contribution to significant team performance variables, the effect of these performance variables on winning percentage, and, in turn, the effect of winning percentage on revenue.

Since econometric experiments revealed no significant nonlinearities, we can specify a linear team 'production function' as follows:

$$WP = a_0 + a_1 RUNS + a_2 ERA + a_3 CONT + a_4 OUT + e_1 \quad (1)$$

where *WP* = percentage of games won by a team times 1000,
RUNS = total team runs for the season,
ERA = team's earned run average per 9-inning game,
CONT = 1 if the team finished within five games of first place in the division and 0 otherwise,
OUT = 1 if the team finished 20 or more games out of first place in the division and 0 otherwise,
and e_1 = a classical 'white noise' stochastic disturbance term.

Winning percentage is an appropriate index of team success on the field which correlates extremely well with potential alternatives like rank or tournament success. Further, fans pay on an *ex ante* basis for entertainment rather than *ex post*; therefore, an increase in winning percentage from 0.500 to 0.550 is not likely to be worth noticeably less than an increase from 0.550 to 0.600, despite the fact that hindsight may reveal that the latter may have secured a championship season.[8] In contrast to Zimablist (1992), the variable *RUNS* is the appropriate measure of offensive production for both hitters and teams because it gives weight not only to hitting or slugging averages but also to offensive production like walks, stolen bases, runs scored on defensive errors, sacrifice flies, sacrifice bunts and similar efforts. For analogous reasons, *ERA* is the best overall defensive measure because it reflects a pitcher's and team's ability to prevent runs from scoring. Experiments with other measures of defensive performance like team fielding averages confirm that teams do not differ enough in non-ERA defensive production to be significant (also see Hill and Spellmen, 1983). The variable *CONT*, originally introduced by Scully (1974), is intended to capture the effect of team morale, hustle, 'clutch' performance, and other factors important to contending for a divisional title or pennant not captured by *RUNS* and *ERA*. In other words, a team in a close race for a title is likely to have a slightly higher win percentage than another team not in a close race despite identical offensive and defensive production totals. The variable *OUT*, also used by Scully, captures the demoralization and poor timing that surrounds losers, including 'playing out the string' in September and bringing up players from the minor leagues. Obviously a more complex model might also specify *CONT* and *OUT* as functions of *RUNS* and *ERA*, but in the present model *CONT* and *OUT* act as control variables to avoid upward bias in estimates of the *RUNS* and *ERA* coefficients.[9]

The second team equation fundamentally is a demand or consumer valuation expression. It explains variations in team revenue as a linear function of five variables: two quality of performance variables (winning percentage and a 0-1 binary with 1 assigned to teams with more losses than wins during the previous three seasons) and three urban control variables (total income and population in the metropolitan area and presence of another MLB team in the area, a substitute good).

$$REV = b_0 + b_1 WP + b_2 POP + b_3 Y + b_4 LOSER + b_5 TT + e_2 \qquad (2)$$

where REV = estimated total team operating revenue from gate receipts, local and national broadcasting receipts, concession and parking income, minus estimated nonplayer expenditures,
WP = winning percentage,
POP = metropolitan statistical area population in millions,
Y = personal income in the metropolitan area in \$billions,
$LOSER$ = 1 if team's WP falls below 0.500 averaged over previous three seasons, and 0 otherwise,
TT = 1 if there is another major league baseball team in the metropolitan area (New York, Chicago, San Francisco/Oakland and Los Angeles) and 0 otherwise,
and e_2 = a 'white noise' stochastic disturbance term.

Most previous models failed to produce point estimates of MRP because they estimated gross MRP estimates and net MRP via *ex post* subtraction of nonplayer team costs from gross MRP. However, profit maximization theory implies that all nonplayer inputs are employed approximately in amounts such that prospective, discounted mrp = mfc and nonplayer expenses therefore can be subtracted directly from revenues to determine how much current player services add to revenues at the margin. Nonplayer salary costs estimated at \$9.6 million per team are subtracted from gross revenues.[10]

Gross revenue figures include estimates of gate receipts and net concession income per fan. Gate receipts were allocated on an 80%/20% ratio with the home team keeping the larger share, a close approximation to actual practice. Net concession and parking income was estimated at \$2.00 per fan times home attendance; two club representatives agreed with this estimate. In accord with actual practice, national broadcasting revenues were divided equally among the teams while specific local broadcasting revenues were added for each team.[11] Overall, player salaries represent 40% of gross revenues in 1986 and 35% in 1987 and team profit (including farm system expenses) represented 22% of gross revenue in 1986 and 35% in 1987.

Estimation of Eqn (2) by OLS methods is defective, as is well known (Johnston, 1984; Kmenta, 1986; Judge *et al.*, 1985), because the estimates will be biased and inconsistent (that is, as the sample size increases indefinitely the estimators do not converge on their true population values). Unless it can be shown that the endogenous variable WP in Eqn (1) and the same WP used as a regressor in Eqn (2) is distributed independently of e_2, application of classical OLS leads to inconsistent estimates.[12] WP is likely to be correlated with the disturbance term in Eqn (2) because excluded variables from Eqn (1) like managerial skill, fan enthusiasm, promotions, etc. also influence Eqn (2). The correct 2SLS estimation technique involves three steps: (1) apply OLS to Eqn (1) to obtain parameter estimates reported in Eqn (1a) below, (2) obtain the OLS predicted values of WP from a regression of WP on all predetermined regressors in the system, and (3) obtain 2SLS estimators by an OLS regression of REV on WP and the predetermined variables in Eqn (2) to obtain estimates (2a) reported below. This technique yielded the following parameter estimates for the pooled 1986–7 data (absolute t-ratios in parentheses):

$$\begin{aligned} WP = {} & \underset{(10.42)}{461.42} + \underset{(7.49)}{0.53}\,RUNS - \underset{(8.25)}{86.37}\,ERA \\ & + \underset{(2.25)}{22.44}\,CONT - \underset{(2.21)}{20.03}\,OUT \\ & \mathrm{DF} = 47,\ F = 70,\ R^2 = 0.86 \qquad (1a) \end{aligned}$$

$$\begin{aligned} REV = {} & \underset{(1.13)}{7.56} + \underset{(2.20)}{0.027}\,WP - \underset{(3.25)}{9.63}\,POP + \underset{(3.84)}{0.75}\,Y \\ & - \underset{(5.89)}{8.53}\,LOSER - \underset{(2.29)}{4.69}\,TT \\ & \mathrm{DF} = 46,\ F = 28,\ R^2 = 0.75 \qquad (2a) \end{aligned}$$

The test statistics support the hypothesis that a simple linear, two-equation model fits MLB very well, a 'timeless' game. All coefficients in Eqn (1a) are significant at the 5% level or better (two-tailed t-test). The intercept in Eqn (1a) assigns a winning percentage of 0.461 ($\times 1000$). Each additional *RUN* scored per season increases winning percentage by 0.53 (e.g. from 500 to 500.53). A reduction of one run in a team's earned run average given up per 9-inning contest raises winning percentage by 86 points (e.g. from 500 to 586). Finishing in contention or out of contention each has a 20-point impact up and down, respectively, on winning performance.

All five demand regressors are statistically significant in Eqn. (2a). Since revenue is scaled in $1 million increments, each one point increase in winning percentage (e.g. from 500 to 501) raises revenue by $27 217 per season.[13] Each *ceteris paribus* increase of 1 million in metropolitan population reduces revenue by $9.6 million, probably because per capita income falls with total income held constant in Eqn (2a). Each $1 billion increase in metropolitan income increases revenues by $750 000 and a losing record over the last 3 years lowers revenues by $8.5 million. The presence of another major league team in the same city lowers team revenue by nearly $5 million.

Experiments with alternative variables, specifications and data not reported here confirm the model's stability and robustness.[14] In contrast, Scully (1974) and Bruggink and Rose (1990) use slugging average and strikeout-to-walk ratio as team offensive and defensive variables rather than *RUNS* scored and *ERA*. These models do not produce stable results across data sets and work very poorly with 1986–7 data, primarily because, on theoretical grounds, winning depends on scoring runs and stopping the other team from scoring rather than on power hitting *per se* or striking out batters relative to walks.[15]

Equations (1a) and (2a) also differ in detail from Medoff (1976), who excluded *CONT* and *OUT* in Eqn (1a), used different control variables in (2a) because he failed to specify it as a consumer demand equation, and therefore achieved a relatively low R^2 of 0.58. Experiments with alternative specifications, not reported here, show that the National and American Leagues do not differ significantly in parameter estimates, even though American League teams score 4.95 and National League teams 4.54 runs per game, primarily because of the designated hitter.[16]

Determining whether major league baseball players are paid in accord with their career marginal revenue product requires an independent calculation of individual MRPs derived from models (1a) and (2a) and a subsequent comparison with salaries. Some observers argue that baseball winning percentage is a joint output, rendering it impossible to separate and estimate individual marginal products. While baseball certainly is a team sport, it also is a highly individualistic game. We believe it appropriate to consider each player's value on his own in the absence of explicit attention to 'chemistry' or synergy for three major reasons: (1) hitter versus pitcher is a classic one-on-one confrontation, (2) teams do not differ significantly in fielding, and (3) differences in a player's value to different teams and in the line-up is largely solved by a reasonably efficient market in player talent and a consequently quasi-efficient assignment of players among teams and within team line-ups (see references in note 3).

On the offense, the purpose of a team and its players is to score runs. To calculate career (mean annual) MRP, note from Eqn (1a) that a run scored raises a team's win percentage by 0.5343 and, in turn, from Eqn (2a) a one-point increase in win percentage (*WP*) raises a team's revenue by $27 217. The most productive players score the most runs, whether by getting on base frequently and stealing or by hitting with power or some combination of the two. Therefore, mean runs scored arguably is the best indicator of an offensive player's production because it includes not only hitting performance (e.g. hits, batting average, slugging percentage) but also offensive production like walks, stolen bases, hit batsman, runs scored on defensive errors, and similar efforts. Therefore, we define an offensive players' productivity for 1986–7 as:

$$\begin{aligned}\text{MRP hitter}_i &= 0.534 \times \$27\,217 \\ &\quad \times \text{mean annual runs}_i \text{ scored} \\ &= \$14\,534 \times \text{mean annual runs}_i \\ &\quad \text{scored} \qquad (3)\end{aligned}$$

In contrast, Scully (1974) argues that slugging average (defined as singles plus doubles plus triples plus home runs divided by official at-bats) is the best offensive indicator. However, slugging averages seriously underestimate the productivity of many players and is not a consistently significant variable in affecting winning percentage at the team level. Other critics claim that our preferred offensive measure, runs scored, undervalues RBI hitters. However, empirical analysis shows that RBI leaders also score many runs. Experiments with combined RBI and runs scored measures added virtually nothing to the MRP measure for RBI hitters, seriously detracted from the MRP of most MLB hitters, whose runs scored exceed their RBIs, and is plagued with double counting runs. Another objection to individual runs scored is that it is a 'situation-dependent' statistic, an objection which applies to RBI too (aside from solo home runs), but not to hits, batting average, or slugging average. Baseball researchers have proposed 'runs created' measures to remove situation dependency (e.g. James, 1987), but is it doubtful that this should be done on theoretical grounds. Top players bat higher in the order and get into more scoring situations because they are more productive. That is, if we assume that players are assigned in a quasi-efficient fashion, as suggested by theory and experience, then actual runs scored is a superior productivity index to an index of runs created. Further, mean career runs scored removes much chance variation, correlates well with more complex 'runs created' measures, and is not an experimental statistic. Another question concerns the choice of career MRP, a more recent performance measure, or a speculative measure purporting to predict next season's performance. To test this proposition, we substituted the last three year's MRP for career MRP and found no significant differences. An explanation for the lack of impact is that the data change little because performance is relatively flat over careers, aside from a slight upward trend in the first three years of MLB experience when players are learning the 'book' on other players.[17]

For pitchers, *ERA* is the most popular index of pitching prowess and we concur. A pitcher can only prevent the opposition from earning runs against him. The lowest possible *ERA* is zero and an *ERA* of zero implies that a team's winning percentage (*WP*) would equal the intercept (461.42 in Eqn (1a) above) plus any offensive production. Intuitively, pitchers and defense cannot win a game, but, at best, can hold the opponent scoreless until the offense scores. To form an equation for pitchers analogous to that for hitters, note that a one-point increase in winning percentage (*WP*) is worth \$27 217 according to Eqn (2a) above and each one-point decline in team *ERA* raises *WP* by 86.37. However a team's *ERA* is not simply the sum of individual pitcher performances: it si a weighted average of individual ERAs—weighted by each pitcher's share of team innings pitched (*IP%*). Therefore, following Medoff (1976, p. 177), each pitcher's *ERA* productivity function is multiplied by personal *IP%* to obtain the following:

$$\begin{aligned}\text{MRP pitcher}_i &= \$27\,217 \times (461.42 - 86.37\,ERA_i) \\ &\quad \times IP\% \\ &= (\$12\,558\,468 \times IP\%) \\ &\quad + (\$2\,350\,732 \times IP\%)\ ERA_i \qquad (4)\end{aligned}$$

Equation (4) shows that each pitcher has a unique, linear value function, with a higher personal intercept as share of innings pitched rises but with a steeper *ERA* slope too. The equation implies that all pitchers with a career *ERA* of 5.34 have a zero MRP and a negative MRP for *ERA*s above 5.34. To aid intuition, note that a star pitcher would have a career *ERA* of 3.0 and pitch about 13% of his team's innings in an average season, implying a 1986–7 MRP of \$715 815.

In contrast, Scully (1974), Bruggink and Rose (1990), and others claim that a pitcher's career strikeout-walk ratio is the best measure of pitching effectiveness. We disagree. The purpose of a pitcher is to stop the other team from scoring. The method of stoppage does not matter: by blazing fast balls for strikeouts, say, a Nolan Ryan, or by low pitches for ground outs, say, Tommy John. Also, team equations show that strikeout-walk ratio is not significantly related to winning percentage, while *ERA* is highly significant. (Zimablist, 1992, agrees with this view but does not estimate pitcher MRPs.)

SALARY DETERMINATION

Salary regressions offer a convenient way to test whether baseball players are paid their estimated MRPs, to explore *RUNS* scored and *ERA* as indexes of individual productivity, to investigate the pattern of salary–productivity relations in baseball, and to test the superstars model of Rosen (1981) and MacDonald (1988).

If baseball players are paid their marginal revenue products, then a regression of individual salaries on estimated MRPs should 'accept' (fail to reject) the joint hypothesis that the intercept equals zero and the slope equals one. Table 1 presents overall salary regression results with pooled 1986 and 1987 data excluding first- and second-year players (called rookies) because they have little or no track record and generally receive the minimum salary of $60 000 in 1986 and $62 500 in 1987.[18] Pooling is appropriate because separate equations for 1986 and 1987 were not statistically different.

The first equation of Table 1 regresses reported salary for experienced hitters on four variables: career MRP, and three binary variables for winning final-offer salary arbitration that season, losing salary arbitration that season and signing as a free agent. The estimated MRP coefficient is 0.97, which is significantly positive and different from zero, with a t-ratio of 25. The career MRP coefficient is not signficantly different from one, suggesting that experienced hitters receive a dollar in marginal earnings per dollar of marginal revenue product. This initial result suggests that the method we used to independently estimate MRPs is sound. By comparison, the pitchers' MRP coefficient of 1.26 in the second equation of Table 1 is significantly different from zero (t-18) and significantly exceeds one at the 5% level, suggesting that pitchers are 'overpaid' at the margin and thus raising the ironic possibility that pitchers 'exploit' MLB owners, hitters, and/or customers rather than being exploited. The hitters' intercept of $77 598 is significantly negative in equation 1 of Table 1, suggesting a constant, annual underpayment of hitters, while the pitchers' estimated intercept is significantly positive, suggesting some overpayment of pitchers relative to their estimated MRP.

The first two equations of Table 1 yield mixed results on arbitration decisions: winning salary arbitration is positive for both hitters and pitchers but only significant at the 5% level for pitchers, while losing salary arbitration is negative for both groups but not significant for pitchers. Signing as a free agent is not a significant variable in the first two equations in Table 1.

Overall, equations 1 and 2 in Table 1 suggest that we cannot reject the hypothesis that MLB players are paid approximately in accord with (discounted) MRP and do not suffer from monopsony exploitation. The equations account for 44–50% of salary variation among hitters and pitchers (log and semi-log specifications added to new information to these results).

Table 1. Salary Regression Results Excluding 1 – 2 year Rookies, 1986–7

	Hitters	Pitchers	Hitters	Pitchers
n	652	443	652	443
Intercept	−77 598[a]	90 631[a]	−627 674[a]	−477 565[a]
	(2.95)	(3.63)	(13.54)	(11.15)
Career	0.97[a]	1.26[a]	0.84[a]	1.08[a]
MRP	(25.35)	(18.11)	(23.40)	(17.64)
W Arb.	72 238	156 659[b]	132 480[a]	226 221[a]
	(0.81)	(2.08)	(1.70)	(3.74)
L Arb.	−170 099[b]	−55 181	−103 516[c]	−16 881
	(2.30)	(0.76)	(1.60)	(0.29)
Free agent	−485	−81 186	−140 963[a]	−202 969[a]
	(0.01)	(1.42)	(3.46)	(4.22)
Years	—	—	131 559[a]	133 583[a]
			(13.18)	(14.65)
Years sq.	—	—	−5 174[a]	−5 140[a]
			(11.04)	(11.66)
F-ratio	161	86	178	134
R^2	0.50	0.44	0.62	0.65

[a]Significant at the 1% level.
[b]Significant at the 5% level.
[c]Significant at the 10% level.
Absolute t-ratios in parentheses.

In accord with traditional wage regressions, the last two equations in Table 1 introduce years of MLB experience and years squared to explore the impact of experience on baseball salaries. Years and years squared are highly significant for both hitters and pitchers, suggesting a significant concave experience-earnings profile despite controlling for average MRP differences. Lazear and Moore (1984) argue that this familiar concave relation is not as steep for the self-employed as for salaried employees because only salaried employees need a steep career earnings profile to induce sustained productive effort. Career MRP coefficients drop from the 0.97–1.26 range to the 0.84–1.08 range, though both remain significantly different from zero. The hitters' MRP coefficient of 0.84 is significantly different from one and the pitchers' MRP coefficient of 1.08 is not. The hitters' intercept in equation 3 and the pitchers' intercept in equation 4 of Table 1 are significantly negative, suggesting partial support for exploitation in this overall specification. R^2 increases from the 0.44–0.50 range to the 0.62–0.65 range with the inclusion of experience variables.

Winning arbitration is significantly positive in equations 3 and 4 and losing arbitration is not significant, confirming the general impression that players eligible for salary arbitration have little downside risk and good upside potential from arbitration.[19] The significant negativity of free agency may seem surprising because free agency should reflect a competitive market for skilled services, but it lends itself to many interpretations: some free agents are in the twilight of their career, or are considered 'damaged goods', or perhaps were overpaid in earlier auctions, or the owners acted together as arbitrators Roberts and Nicolau ruled in the controversial baseball collusion cases. Evidence from grouped regressions reported below show free agency is significantly negative for pitchers and hitters.[20]

The results in Table 1 led us to group the data by experience and institutional class. There is a remarkable correspondence between baseball's labor market structure and payment in accord with marginal product, although it also may reflect explanations based on a time lag for salaries to rise to career productivity or a cost recovery period for teams to capture general player development costs. Model 1 in Table 2 has a highly significant intercept of \$54 553 for first- and second-year hitters and a small but significant MRP coefficient of 0.05. Rookies basically receive the salary minimum while high productivity rookies begin their climb up the salary ladder; career MRP variation only accounts for 21% of rookie salary variation. More experienced players (models 2 and 3 in Table 2) have smaller and less

Table 2. Salary Regressions for Hitters, Grouped by Experience, 1986–7

		Player group	
	Years 1–2	Years 3–6	Years 7 +
n	140	275	377
Eligible for:			
Min. salary?	Y	Y	Y
Salary arbitration?	N	Y	Y
Free agency?	N	N	Y
Intercept	54 553[a]	−43 337[c]	−11 890
	(12.04)	(1.99)	(0.29)
Career	0.05[a]	0.58[a]	1.06[a]
MRP	(6.05)	(15.70)	(19.75)
W Arb.	—	288 132[a]	124 411
		(4.70)	(0.57)
L Arb.	—	37 514	−141 409
		(0.63)	(1.20)
Free agent	—	—	−119 520[a]
			(2.57)
F	37	103	105
R^2	0.21	0.53	0.53

[a–c]As Table 1.
Absolute *t*-ratios in parentheses.

significant intercepts and much larger MRP coefficients. In years 3–6 players whose contracts have expired are eligible for salary arbitration and the career MRP coefficient rises to 0.58, significantly different from both zero and one. Winning final-offer salary arbitration adds $288 132 to annual compensation ($n = 13$), significant at the 1% level, while losing salary arbitration ($n = 19$) has no statistical impact. In years 7+ players whose contracts have expired are eligible for either arbitration or free agency; the MRP coefficient rises to 1.06, the intercept is significantly different from zero and not significantly different from one and arbitration decisions have no significant impact on salary. However, signing as a free agent significantly reduces salary by $119 520 per season ($n = 52$), *ceteris paribus*. This represents a 17% loss in salary relative to the salaries received by free agents. Bruggink and Rose (1990) found a 28% loss for free agents in 1985–6 versus 1984.

Many offensive players must contribute defensively too. How does defense affect the regression estimates for hitters reported above? To test for this potential distortion we classified all hitters by defensive position and inserted a 1 for all players classified as catchers, shortstops, second basemen, and third basemen (the most skilled defensive positions) and a 0 for first basemen and outfielders. The result was that skilled defensive positions command a premium of $46 000 per season (usually significant at the 6% or 7% level for a two-tail test) in regression models like those reported in Tables 1 and 2, but the variable had no impact on other coefficients of interest.

Table 3 shows results for pitchers equivalent to those in Table 2 for hitters. Intercpets are significantly positive for rookie pitchers, but in contrast to hitters intercepts remain significantly positive in years 3–6 and 7+. Career MRP coefficients are significantly different from zero in all three experience groups, rising from 0.08 for rookies to 0.86 for 3–6 years and 1.22 for 7+ years. Winning salary arbitration is significantly positive for pitchers in both 3–6 years and 7+ years ($n = 14$), while losing arbitration is not statistically significant at conventional levels ($n = 15$). Signing as a free agent is associated with a $239 270 salary decline ($n = 25$), *ceteris paribus*. This is a 33% loss based on salaries actually paid to the 7+ year cohort. While this result certainly can be interpreted as evidence for owner collusion against free agent pitchers, also note that pitchers have shorter careers than hitters and have some tendency to be overpaid relative to hitters. In equation 3 of Table 3, for example, the

Table 3. Salary Regressions for Pitchers, Grouped by Experience, 1986–7

	Player group		
	Years 1–2	Years 3–6	Years 7+
n	129	219	224
Eligible for:			
Min. salary?	Y	Y	Y
Salary arbitration?	N	Y	Y
Free agency?	N	N	Y
Intercept	61 875[a]	38 588[b]	263 723[a]
	(17.94)	(2.50)	(5.89)
Career	0.08[a]	0.86[a]	1.22[a]
MRP	(5.34)	(17.06)	(11.03)
W Arb.	—	260 927[a]	202 893[c]
		(5.19)	(1.69)
L Arb.	—	47 607	−11 692
		(1.07)	(0.09)
Free agent	—	—	−239 270[a]
			(3.87)
F	28	130	34
R^2	0.18	0.64	0.38

[a–c]As Table 1.
Absolute *t*-ratios in parentheses.

$239 270 loss for signing as a free agent is offset by an intercept 'overpayment' of $263 723.

SUPERSTARS

Now we consider a superstars model for major league baseball players' salaries. Rosen (1981) has observed that in certain kinds of economic activity there is concentration of output among a few individuals, marked skewness in the associated distributions of income and very large rewards at the top. In Rosen's model the joint consumption technology provided by the media and mass audiences combines with the imperfect substitution features of preferences to yield compensation differences among producers that greatly exaggerate their talent differences. Rosen (1981) also presents a theory of assignment of buyers and sellers which explains the differential skew between the distribution of income and talent, a condition that has been an important problem in the literature on the distribution of income. MacDonald (1988) extends the Rosen (1981) model and considers an occupation (like baseball) characterized by uncertainty in individual performance and where past performance is highly correlated with future performance. In equilibrium only the young enter the profession, success is rare and highly rewarded. The superstars model of Rosen and MacDonald is characterized by convex returns, although Rosen remarks (1981, p. 845) that it will be 'virtually impossible to obtain systematic data in this field'.

The MLB data permit a systematic test of a superstars model, however, and the results are presented in Table 4. Salaries are regressed on career MRP and MRP squared to test for convex returns, and two binary variables controlling for contractual environment, namely, 'Arb. eligible' for players in years 3–6 and 'Free eligible' for players beyond 6 years in MLB. These two variables reflect the threat effect on salary of eligibility for arbitration or free agency, as well as the impact of the actual arbitration rulings and free agent signings reflected in the regression models above. Since we intend to search for evidence of disproportionate returns to talent in the upper tail, we do not believe that it is appropriate to suppress outliers in the upper tail by log or semilog transformations of the data.

The results reported in Table 4 support the superstars model: the squared MRP coefficient is positive and statistically significant at the 1% level in both hitter and pitcher equations. This result was foreshadowed in the data because they show the highest paid players systematically paid more than their econometrically-estimated MRP. Fans may find a home run by Juan Gonzalez (the 1992–3 home-run leader) more satisfying than a home run by an obscure rookie. In addition, the

Table 4. Superstars model. 1986–7

	Hitters	Pitchers
n	792	572
Intercept	−115 287[a]	−35 640
	(3.41)	(1.50)
MRP	0.09	0.51[a]
	(0.83)	(3.97)
MRP Sq'd	0.005[a]	0.005[a]
(× 10 000)	(5.80)	(3.12)
Arb. elig.	163 738[a]	127 192[a]
	(5.86)	(5.13)
Free elig.	481 808[a]	454 451[a]
	(17.41)	(17.05)
F	305	257
R^2	0.61	0.64

[a] Significant at the 1% level.
Arb. eligible — 1 if 3–6 years; — 0 otherwise.
Free eligible — 1 if 7 + years; — 0 otherwise.
Absolute t-ratios in parentheses.

market eligibility variables in the superstars equations of Table 3 are positive and significant at the 1% level for both hitters and pitchers. Variation in all four variables accounts for nearly two-thirds of variation in MLB salaries.

Our superstar results are contrary to Frank (1984) who finds that the most productive members within organizations appear to be paid less than their MRP while the least productive appear to be paid substantially more. Frank argues that workers seem to care about their relative standing in the specific pay hierarchy to which they belong. Our superstar results also stand in contrast to those of Lazear and Moore (1984), who argue that the steepness of employee's experience–earnings profiles are accounted for by the desire to provide incentives for sustained productivity rather than reward players for expected productivity. Both of these hypotheses do not appear to apply to major league baseball

CONCLUSION

Previous researchers found that baseball players under the reserve clause had been paid considerably less than their contributions to club revenues. Under the contemporary regime of free agency and 'final offer arbitration' (FOA), however, we find substantial evidence that experienced players are paid in accord with their estimated career marginal revenue products; young players, however, tend to be paid less than their marginal revenue products. This pattern closely coincides with their eligibility and ineligibility for FOA and free agency in the baseball labor market.

Another interesting feature of our results is the evidence for senior pitchers to be somewhat overpaid relative to their statistical marginal product, a tendency not observed for hitters. While we have no solid explanation at this point, potential hypotheses include a customer premium for pitchers undetected by the mechanical productivity measure (*ERA* weighted by innings pitched), as in high-pressure or 'clutch' appearances by relief pitchers, or a systematic overbidding in a world of injuries and short careers as suggested by Cassing and Douglas (1980), or perhaps a disequilibrium phenomenon in the structure of baseball salaries which will be eliminated over time, i.e. overbidding by owners not yet efficiently adjusted to the new bargaining environment. Independent data on revenue variation by starting pitchers during the season could shed light on questions surrounding pitchers' pay and productivity.

Finally, the baseball data allow us to conduct the first systematic test of the Rosen–MacDonald superstars model. The regression analysis confirms the superstars model: salary differences between first- and second-rank performers greatly exaggerate talent differences, that is, returns to talent are convex.

Acknowledgements

This research was supported in part by a grant from the summer interim faculty research fund of Northeast Louisiana University. A preliminary version of this paper was presented at the meetings of the Western Economic Association, Lake Tahoe, Nevada, 18–22 June, 1989. We gratefully acknowledge comments by Raymond Battalio, Haeshin Hwang, and Robert Reed, and the statistical assistance of Paul Puccioni, Shan Guo, Rajiv Gupte and Jasvinder Singh.
The data set and additional results are available from Don N. MacDonald, Department of Finance, University of North Texas, Denton, Texas 76203-6677, USA.

NOTES

1. Salary data for the 1986 and 1987 seasons were obtained from the 8 October 1986, 9 October 1986, 11 November 1987, and 12 November 1987 issues of *USA Today*. The salary data are based on documents filed with the Players Relations Committee, Players Association and information obtained from team officials or player agents. Base salaries include deferred payments and prorated signing bonuses. Incentives include clauses for weight, attendance, performance and awards. The data are excellent and widely used in baseball.
2. Final-offer salary arbitration was agreed to by player and owner representatives on 23 February 1973 and 756 players had filed for final-offer salary arbitration by the end of 1987. Arbitrators are given a set of criteria to base their awards on, which are either the last offer of the club or the last demand of the player. See Dworkin (1981, 1987) and Frederick *et al.* (1992) for details on the final-offer salary arbitration process.
3. See Dworkin (1987) and Sommers (1992) for details of the present compensation schemes. Considerable controversy exists in the literature on whether such restrictions on player movements have actually effected the allocation of playing talent across teams (compare Hunt and Lewis, 1976; El Hodiri and Quirk, 1971; Demmert, 1973; Demsetz, 1973; and Rottenberg, 1956, against Daly and Moore, 1981, and Cymrot 1983). In salary regression mod-

els not reported here but similar to those reported in Tables 1–3 below, variables for urban population and urban population squared had no significant independent effect on player salaries, supporting the proposition that the market assignment of MLB players is approximately in accord with highest valued use. In 1986 and 1987 the National Football League (NFL) and National Hockey League (NHL) had punitive compensation schemes which allegedly restrict the movement of players among teams relative to baseball and the National Basketball Association (NBA).

4. *Wall Street Journal*, 20 March 1990, p. A6.
5. *USA Today*, 7 September 1988.
6. AP dispatch, *Houston Chronicle*, 5 December 1991, p. 3B, and AP dispatch, *Houston Chronicle*, 6 December 1991, p. 4B.
7. The Scully (1974) profit-maximization model is an adequate static formalization if it is amended to allow each team to be a price-setter in its product market rather than a competitive price-taker as Scully assumes. Empirically there is substantial variation in ticket prices across teams.

The desirability (quality) of the games to consumers is assumed to be measured by the team's winning percentage W, which depends on two general classes of inputs: (1) a vector of player skills A_i, and (2) a vector of nonplayer inputs I_j. Thus,

$$W = W(A_i; I_j) \qquad (N1)$$

Teams earn revenue R from tickets sold T, broadcasting fees B, and concessions C including parking; subtracting total cost from total revenue we have profit:

$$\max_{A,I} \pi = p(T)T[W(A_i, I_j), POP] + B(T) + C(T) - [E_i A_i S_i(A_i) + E_j r_j I_j + FC] \qquad (N2)$$
$$A,I$$

where ticket price is a function of W and *Population*, $S_i(A_i)$ are player supply functions and nonplayer input r_j prices are competitively determined. First-order conditions are

$$\partial\pi/\partial A_i = 0 = p(\partial T/\partial W)(\partial W/\partial A_i) + T(\partial p/\partial W)(\partial W/\partial A_i) + (\partial B/\partial W)(\partial W/\partial A_i) + (\partial C/\partial W)(\partial W/\partial A_i) - A_i \partial S_i/\partial A_i - S_i \qquad (N3)$$

$$\partial\pi/\partial I_j = 0 = p(\partial T/\partial W)(\partial W/\partial I_j) + T(\partial p/\partial W)\partial W/\partial I_j) + (\partial B/\partial W)(\partial W/\partial I_j) + (\partial C/\partial W) \times (\partial W/\partial I_j) - r_j \qquad (N4)$$

The first four terms on the right-hand side of Eqn (N3) constitute the MRP of player skills and the last two terms in (N3) is the marginal factor cost which exceeds average factor cost under monopsony. The question in this paper is whether final-offer salary arbitration and free agency have effectively closed the mfc (A_i), afc(A_i) gap.

8. A variable for championship (0–1) is insignificant in revenue Eqn (2) below. Baseball performance data are obtainable from many public sources, notably the *Official Baseball Guide* and the *Baseball Registry*, both published by the Sporting News.
9. We explored a number of alternative measures of offensive and defensive performance including RBIs, slugging averages, fielding averages, strikeout to walk ratios, games, games won, earned runs and unearned runs. We do not claim that 'no other wheel will roll', but believe that our indexes chosen equal or exceed others in simplicity, stability and explanatory power. Moreover, alternate functional forms to allow for diminishing marginal productivity failed to improve the fit of the model.

CONT and *OUT* pick up performance relative to the division winner, not absolute winning percentage, uncaptured by total runs and *ERA*. While their exact interpretation may be debatable, they are intended to capture differences in late-season intensity, holding constant absolute runs and *ERA*. Certainly winning percentage partially determines *CONT* and *OUT*, but we do not believe that more complex models designed to explain *CONT* and *OUT*, especially in a small sample, would be repaid. It most likely would impair our aim of achieving reliable estimates of *RUNS*, *ERA* and *WP* coefficients. Another alternative is to redefine *CONT* and *OUT* to be less endogenous (adding results from the two preceding seasons) but it produces no significant difference in marginal value of *WP* on *REV* (\$26 911 versus \$27 217). That *CONT* and *OUT* or suitable counterparts like a team's win percentage relative to the division winner, *ceteris paribus*, improves estimation of the marginal impact of *RUNS*, *ERA*, and *WP*, may be best illustrated by the results of dropping *CONT* and *OUT* from Eqn (1) yielding:

$$\underset{}{WP} = \underset{(9.34)}{430.52} + \underset{(12.35)}{0.69RUNS} - \underset{(12.21)}{107.74ERA}$$

$$\text{DF} = 49,\ F = 115,\ R^2 = 0.82$$

$$REV = \underset{(1.20)}{8.47} + \underset{(1.94)}{0.027583WP} - \underset{(3.25)}{9.79POP} + \underset{(3.75)}{0.75Y} - \underset{(5.67)}{8.40LOSER} - \underset{(1.91)}{4.04TT}$$

$$\text{DF} = 46,\ F = 28,\ R^2 = 0.75$$

The absolute value of *RUNS* and *ERA* coefficients increase about 25%, R^2 falls slightly from 0.86 to 0.82, and the *WP* coefficient decreases by 10% in the second equation. This model implies a modest increase in estimated MRP's of hitters in Eqn (3) and a substantial decline in the estimated MRP's of pitchers in Eqn (4). In fact, a majority of pitchers would have negative estimated productivity because zero productivity occurs at a relatively low

ERA of 4.00. This result and extensive regression analysis convinces us that the seminal paper by Scully (1974) hit on the best available measure (*CONT* and *OUT*) for team morale, timing, and other intangibles, and that Scully's model handled it properly.

10. Costs include spring training costs net of receipts from spring training games; team costs including hotel and meal expenses, transportation expenses, manager, coaches', scouts', and trainers' salaries; medical expenses; uniform and equipment expenses; stadium operation costs; ticket publicity and promotional expenses; and general and administrative costs. Scully (1974) estimated these costs per player at \$128 300 in the 1968–9 seasons. Lacking precise nonplayer cost data we updated Scully's estimates by CPI inflation and compared the figures with Markham and Teplitz (1981). The two measures were virtually identical. Therefore, nonplayer costs for the 1986–7 seasons were estimated at \$386 422 per player, approximately \$9.6 million per team excluding farm system costs.
11. In 1986 and 1987 ABC and NBC were entering their third and fourth years of a six-year pact with Major League Baseball (MLB) worth a total of \$1.2 billion. ABC paid \$94 million in both 1986 and 1987 to MLB for national braodcasting rights while NBC paid \$80 million in 1986 and \$95 million in 1987. CBS Radio Network entered its third (1986) and fourth years (1987) of a \$32 million pact with MLB worth \$6 million in 1986 and \$6.5 million in 1987. These national revenues are divided equally among the 26 major league teams, producing \$6.96 million in 1986 and \$7.56 million in 1987. Local broadcast revenue were obtained from 3 March 1986 and 2 March 1987 issues of *Broadcasting*.
12. The OLS estimates of MRP in Eqn (2) are biased downward by 19% for pitchers and 10% for hitters; naturally use of OLS estimates of MRP would lower the odds of finding monopsony exploitation (MRP > Salary) because MRPs would be underestimated.
13. Scully (1989, p. 155) estimates the *WP* coefficient at a higher value of \$31 696 in 1984 data; since his OLS regression includes only *WP* and population as regressors and the dependent variable is estimated gross revenues without subtraction of nonplayer expenses, the coefficient estimate probably exaggerates the independent effect of *WP* on revenues for 1984. Bruggink and Rose (1990 provide an even higher OLS estimate of \$53 070 for the *WP* coefficient for 1984–6 data in an equation similar to our (2a) above except that they use estimated gross revenues as a dependent variable, exclude urban income and 'loser' as regressors, and include a binary variable for older stadiums, an insignificant variable. We can obtain observationally equivalent results (a coefficient of \$54 315) if we use OLS estimation, drop income and *LOSER* from the revenue equation, but this model fails to properly isolate the marginal value of *WP*, all else equal. For example, adding income to the model drops the *WP* coefficient to \$44 618 and adding *LOSER* drops it to \$22 081. The potency of *LOSER* (three straight seasons below 0.500) is especially credible because season ticket sales drop off drastically for the handful of teams that chronically lose. Parity and contest uncertainty are vital to the popularity and financial success of professional sport. Neither Scully (1989) nor Bruggink and Rose (1990) adjusted *REV* downward for nonplayer team costs, they used (arguably) inferior performance variables of slugging average and strikeout-to-walk ratio, both used OLS estimation, and neither controlled for income and *LOSER*. Also, Scully (1989) did not control for substitute teams in the same market-variables that theory and empirical results indicate are important variables—and excluded Houston and Minnesota because of a lack of revenue data. Nevertheless, the fact that Scully's estimate is close to ours and that Bruggink and Rose's result can be nearly duplicated in our data provides some reassurance that our preferred model provides reasonable estimates from which to estimate MRP's and compare with salaries.
    Zimablist (1992, p. 117) specified yet another two-equation OLS model, arguing that coefficients on current *WP* and previous season's *WP* must be added to obtain a discounted, two-season revenue effect of team performance on revenue of \$63 026.
14. For example, to test the linearity of the revenue function we estimated the log elasticity between gross revenues and winning percentage at 1.1, which is not significantly different from 1 ($t = 0.44$, d.f. = 51, $P < 0.05$). Although diminishing marginal returns to victories might be expected, Scully (1974, 1989) argues that a linear revenue relation holds in baseball as a result of the age and stability of the game and the high uncertainty in each contest so that additional victories do not significantly reduce marginal attendance.
15. Scully's (1974) specification of the production function estimated via OLS in the 1986–7 data yields (t-ratios):

$$\begin{aligned} WP = {} & \underset{(2.88)}{347.77} + \underset{(0.85)}{0.23TSA} + \underset{(1.56)}{0.39TSW} - \underset{(1.20)}{14.95NL} \\ & + \underset{(4.15)}{59.72CONT} - \underset{(3.94)}{52.69OUT} \end{aligned}$$

$$R^2 = 0.65, \mathrm{DF} = 51$$

where *WP*, *CONT* and *OUT* are as previously defined and *TSA* = team slugging average (total bases divided by official number of at bats), *TSW* = team strikeout to walk ratio and *NL* equals one if the team is National League and zero if the team is American League. The estimated coefficients for *TSA* and *TSW* are not significant at conventional levels. By contrast, the production function proposed here is stable in the period 1968–87. Further results are available from the authors.
16. The American League allows a designated hitter DH to bat in place of the pitcher. This substitution, not allowed in the NL regular season, increases the slugging averages and runs scored in the AL.

17. We consider the defensive contributions of offensive players below.
18. Data for rookies are reintroduced in Table 2.
19. In recent analyses of final-offer arbitration, Ashenfelter and Bloom (1985) found that arbitrators impartially applied the same standards and most often chose the final union demand; Bazerman and Farber (1985) found that arbitrators were influenced by reasonable rather than unreasonable offers and avoided naive split-the-difference decisions; Farber and Bazerman (1986) found that final-offer arbitrators chose the offer closest to the appropriate reward and there was no difference between conventional arbitration and final-offer arbitration outcomes.
20. Lehn (1984) argues that baseball's free agent market has been characterized by asymmetric information among clubs. He claims that clubs for which players have performed have superior information with which to estimate a player's future performance compared to clubs which merely bid on a particular player. Lehn presents evidence that free agents spend more time on the disabled list that non-free agents and that club owners have revised their expectations of free agent performance downward over time. By contrast, Krautmann (1990) finds no evidence for shirking due to signing long-term contracts in baseball, instead attributing productivity changes to chance rather than disincentive problems.

REFERENCES

American League of Professional Baseball Clubs and National League of Professional Baseball Clubs and Major League Baseball Players Association, Basic Agreement effective 1 January 1976.

O. Ashenfelter and D. E. Bloom (1985). Models of arbitrator behavior: theory and evidence. *American Economic Review*, **74,** No. 1, March, 111–24.

The Baseball Register (1987). St Louis, MO: The Sporting News Publishing Co.

M. H. Bazerman and H. S. Farber (1985). Arbitrator decision making: when are final offers important? *Industrial and Labor Relations Review*, **39,** No. 1, October, 76–89.

T. H. Bruggink and D. R. Rose, Jr (1990). Financial restraint in the free agent labor market for major league baseball: players look at strike three. *Southern Economic Journal*, **57,** No. 4, April, 1029–43.

J. Cassing and R. Douglas (1980). Implications of the auction mechanism in baseball's free agent draft. *Southern Economic Journal*, **47,** No. 1, July, 110–21.

D. J. Cymrot (1983). Migration trends and earnings of free agents in major league baseball. *Economic Inquiry*, **21,** No. 4, October, 545–556.

D. J. Cymrot and J. A. Dunlevy (1987). Are free agents perspicacious peregrinators? *Review of Economics and Statistics*, **69,** No. 1, February, 50–58.

G. Daly and W. J. Moore (1981). Externalities, properties rights and the allocation of resources in major league baseball. *Economic Inquiry*, **19,** No. 1, January, 77–95.

H. G. Demmert (1973). *The Economics of Professional Team Sports*, Lexington, MA: Lexington Books.

H. Demsetz (1967). Toward a theory of property rights. *American Economic Review, Papers and Proceedings*, **57,** No. 2, May, 347–53.

J. Dworkin (1981). *Owners Versus Players: Baseball and Collective Bargaining*, Boston, MA: Auburn.

J. Dworkin (1986). Salary arbitration in baseball: an impartial assessment after ten years. *Arbitration Journal*, **41,** No. 1, March, 63–9.

J. Dworkin (1987). Professional sports. In David Lipsky and Clifford Donn, eds., *Collective Bargaining in American Industry* (edited by D. Lipsky and C. Donn), Lexington, MA: Lexington Books, pp. 187–224.

M. El Hodiri and J. Quirk (1971). An economic model of a professional sports league. *Journal of Political Economy*, **79,** No. 6, November/December, 1302–19.

H. S. Farber and M. H. Bazerman (1986). The general basis of arbitrator behavior: an empirical analysis of conventional and final-offer arbitration. *Econometrica*, **54,** No. 6, November, 1503–28.

R. H. Frank (1984). Are workers paid their marginal products? *American Economic Review*, **74,** No. 4, September, 549–71.

D. M. Frederick, W. H. Kaempfer and R. L. Wobbekind (1992). Salary arbitration as a market substitute. In *Diamonds Are Forever: The Business of Baseball* (edited by P. M. Sommers), Washington, DC: Brookings, pp. 29–49.

J. Hill (1985). The threat of free agency and exploitation in professional baseball: 1976–1979. *Quarterly Review of Economics and Business*, **25,** No. 4, Winter, 68–82.

J. Hill and W. Spellman (1983). Professional baseball: the reserve clause and salary structure. *Industrial Relations*, **22,** No. 1, Winter, 1–19.

I. Horowitz (1974). Sports broadcasting. In *Government and the Sports Business* (edited by R. G. Noll), Washington, DC: Brookings, pp. 275–324.

J. W. Hunt, Jr and K. A. Lewis (1976). Dominance, recontracting, and the reserve clause: major league baseball. *American Economic Review*, **66,** No. 5, December, 936–43.

W. James (1987). *The Bill James Baseball Absract*. 1987, New York: Ballantine.

J. Johnston (1984). *Econometric Methods*, 3rd edn., New York: McGraw Hill.

G. G. Judge, W. E. Griffiths, R. Carter Hill, H. Lutkepohl and T. -C. Lee (1985). New York: John Wiley.

J. Kmenta (1986). *Elements of Econometrics*, 2nd edn., New York: Macmillan.

A. C. Krautmann (1990). Shirking or stochastic productivity in major league baseball? *Southern Economic Journal*, **57,** No. 4, April, 961–8.

E. P. Lazear and R. L. Moore (1984). Incentives, productivity, and labor contracts. *Quarterly Journal of Economics*, **94,** No. 2, May, 275–96.

K. Lehn (1984). Information asymmetries in baseball's free agent market. *Economic Inquiry*, **22,** No. 1, January, 37–44.

G. MacDonald (1988). The economics of rising stars. *American Economic Review*, **78,** No. 1, March, 155–66.
J. Markham and P. Teplitz (1981). *Baseball Economics and Public Policy*, Lexington, MA: Lexington, Books.
M. Medoff (1976). On monopsonistic exploitation in professional baseball. *Quarterly Review of Economics and Business*, **16,** No. 3, Summer, 113–21.
M. Miller (1991). *A Whole Different Ball Game*: *The Sport and Business of Baseball*, Secaucus, NJ: Birch Lane Press.
H. J. Raimondo (1983). Free agents' impact on the labor market for baseball players. *Journal of Labor Research*, **4,** No. 2, Spring, 183–93.
S. Rosen (1981). The economics of superstars. *American Economic review*, **71,** No. 5, December, 845–58.
S. Rottenberg (1956). The baseball players' labor market. *Journal of Political Economy*, **64,** *No.* 3, *June*, 242–58.
J. Scoville (1974). Labor relations in sports. In *Government and the Sports Business* (edited by R.G. Noll), Washington, DC: Brookings, pp. 185–220.
G. W. Scully (1974). Pay and performance in major league baseball. *American Economic Review*, **64,** No. 5, December 915–30.
G. W. Scully (1989). *The Business of Major League Baseball*, Chicago, IL: University of Chicago Press.
P. M. Sommers (ed.) (1992). *Diamonds Are Forever*: *The Business of Baseball*, Washington, DC: Brookings.
P. M. Sommers and N. Quinton (1982). Pay and performance in major league baseball: the case of the first family of free agents. *Journal of Human Resources*, **17,** No. 3, Summer, 426–36.
Statistical Abstract of the United States (1890, 1984, 1987). US Department of Commerce.
Official American League Red Book (1986, 1987, 1988). St Louis, MO: The Sporting News Publishing Co.
Official Baseball Guide (1986, 1987, 1988). St Louis, MO: The Sporting News Publishing Co.
Official National League Green Book (1986, 1987, 1988). St Louis, MO: The Sporting News Publishing Co.
A. Zimbalist (1992). Salaries and performance: beyond the Scully model. In *Diamonds Are Forever*: *The Business of Baseball* (edited by P. M. Sommers), Washington, DC: Brookings, pp. 109–33.