WHAT'S WRONG WITH SCULLY-ESTIMATES OF A PLAYER'S MARGINAL REVENUE PRODUCT

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Estimates of baseball players' marginal revenue product, derived from the methodology introduced by Gerald Scully over 20 years ago in the American Economic Review, *suggest that even the highest-paid players are grossly underpaid. But given the fiercely competitive bidding process for free agents, it is hard to believe that owners can maintain salaries significantly below marginal revenue product. In this paper, an alternative approach for estimating a player's economic value is proposed. It uses market information gleaned from free agent contract negotiations. When applied to the less-mobile segment of the player market, this method yields much more reasonable estimates of players' marginal revenue products.* (*JEL* L83)

> One needs to be cautious about the results, since the estimates of player marginal products are crude (Scully [1989, 168]).
>
> Our MRP estimates do not have a particularly impressive correlation with player salaries (Zimbalist [1992, 190]).

I. INTRODUCTION

People often wonder how professional athletes could be worth the mega-dollar salaries they receive. For example, Michael Jordan was paid about $35 million last season by the Chicago Bulls, while Albert Belle was paid $10 million last season by the Chicago White Sox. Economic explanations have focused primarily on the amount of revenue generated by the player, especially as it pertains to labor market structure and the bidding process. One possibility is that team owners pay younger players less than they are worth in order to cross-subsidize the superstars. This would help explain why most professional sports leagues display a very definite two-tiered salary structure, distinctly split between younger indentured players and veteran free agents. Another possibility is that the superstars command such high salaries simply because they are able to generate large amounts of revenues for their team owners. In either case, most attempts at explaining this phenomenon begins with some type of estimation of the athlete's marginal revenue product (MRP). Professional baseball is used more often than other sports primarily because baseball players' marginal products are fairly independent, making it easier to isolate a particular player's contribution to his team. The seminal work on the pay versus performance of Major League Baseball players was provided by Scully [1974]. While the approach outlined by Scully has undergone much scrutiny, it remains one of the primary methods of estimating a player's MRP. It has even been used in arbitration hearings, including those involving the alleged collusion by owners to control free agent salaries in the mid-1980s.

A number of studies have applied the Scully method to investigate monopsonistic exploitation of "reserve clause" players. The reserve clause is a collective bargaining arrangement which reduces a young player's mobility by restricting him to a particular team. Under the current bargaining agreement in Major League Baseball, there are two types of players constrained by this clause. The most restricted are called apprentices. These are players with less than three years of Major League experience, and under the current agreement, have no recourse to salary arbitration. Journeymen are players with more than three years, but less than six years, of

* I would like to thank an anonymous referee for comments on an earlier draft, Paul Novak for valuable research assistance, and Sue Schoeben for her editorial advice.

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Economic Inquiry
(ISSN 0095-2583)
Vol. 37, No. 2, April 1999, 369–381

experience (as well as the top 17% of second-year players). These players are still restricted to their teams, but are eligible for salary arbitration. While studies have shown that the average apprentice earns less than half of his MRP, the evidence regarding journeymen is less clear (Scully [1989]; Zimbalist [1992]; Vrooman [1996]).

Applications of the Scully method have led to confusing, and sometimes conflicting, conclusions as to the extent to which players are compensated. For example, Scully [1989] reported that a typical free agent was paid only about 28% of his MRP; yet Zimbalist [1992] concluded that the average free agent received 23% *more* than his marginal value. Zimbalist reported that the typical journeyman receives only about 60% of his MRP, while Krautmann et al. [1997] found these players are actually slightly overpaid.

In this paper, we revisit the Scully technique for estimating the MRP of professional baseball players. Using a sample of free agents, we show that the Scully technique is extremely sensitive to the manner in which marginal product is measured. Dissatisfaction with the robustness of this technique leads us to search for an alternative approach which is less sensitive to the measures used. The approach proposed here estimates the market return on performance from a regression of free agent wages on performance. These market returns are then applied to the performance of reserve-clause players, giving estimates of their market values. Our results indicate that the average apprentice receives about 25% of his MRP, while the typical journeyman receives a salary that is essentially commensurate with his value.

II. THE SCULLY APPROACH

The Scully method estimates a player's value by imputing his MRP from the following three equations:

$$(1) \qquad TR_J = \alpha_0 + \alpha_1 X_J + \alpha_2 WPCT_J$$

$$(2) \qquad WPCT_J = \beta_0 + \beta_1 PERF_J$$

$$(3) \quad PERF_J = f(PERF_{IJ}, Z_J) \quad \forall \; I \text{ on team } J$$

where TR_J is the Jth team's total revenues, $WPCT_J$ is the Jth team's winning percent, X_J is a vector of other team-specific factors affecting the team's revenues, $PERF_J$ is the Jth team's performance measures, $PERF_{IJ}$ is the Ith rostered-player's performance on the Jth team, and Z_J is a vector of other inputs which determine the team's performance (e.g., the Minor League system, the managerial staff).

Of particular interest in this paper is equation (3), which summarizes how the inputs employed by the team produce the team's performance. While one would expect to derive the player's marginal product from this relationship, it may be difficult to separate out his contribution from that of his teammates and the other inputs. If equation (3) were separable, we would be able to measure a player's contribution in the typical fashion by simply looking at his performance statistics.[1] Those who have used the Scully method typically disregard Z_J and implicitly assume equation (3) is separable, then proceed to measure the player's marginal product by using some measure of his individual performance. But if equation (3) is not separable, we may be assigning too large of a marginal contribution to the player, resulting in an upward bias in our estimates of the player's MRP. That is, we are essentially giving the rostered players full credit for the wins of the team, ignoring the contributions of such factors as managerial quality and cross-player complementarities.[2]

From equations (1) and (2), the MRP of the Jth team is given by:

$$MRP_J = (\partial TR_J / \partial WPCT_J)(\partial WPCT_J / \partial PERF_J)$$

$$= (\alpha_2)(\beta_1).$$

Since neither equation (1) nor (2) involves the

1. For a detailed discussion of functional separability, see Leontief [1947], Berndt and Christensen [1973], or Russell [1975].

2. This technique will systematically overestimate players' marginal revenue products by assigning all of the team's MRP to its rostered players. For example, if strategic moves by the manager results in a couple of extra wins per season, then the Scully technique will inappropriately assign the manager's marginal contribution to his players. For a discussion of role of the managerial input, see Ruggiero, et al. [1996].

Ith player, standard regression techniques can be applied to team-specific data to get estimates of α_2 and β_1. For example, when offense is measured using the slugging average, we find that a team hitting one standard deviation above the sample mean (equal to an additional 0.022, or "22 points") results in additional team revenues of about $4.6 million (see Appendix A for more details).

To derive the player's MRP, one must first determine how the placement of the Ith player on the Jth team (here denoted ΔI_J) impacts the team's performance, and therefore its revenues. Denoting the Ith player's marginal product on the Jth team as

$$(\Delta PERF_J / \Delta I_J), \text{ then}$$

$$MRP_{IJ} = (MRP_J)(\Delta PERF_J / \Delta I_J)$$

$$= \alpha_2\beta_1 \ (\Delta PERF_J / \Delta I_J).$$

Spelled out in this fashion, we see that our estimate of a player's MRP depends critically on the manner in which his marginal product is measured.

The two primary methods used to measure a hitter's marginal product are based on the following proportional and incremental concepts:

1. *Proportional Method:* This method, pioneered by Scully [1974], credits the player with some proportion of his individual performance. Scully measured a player's marginal product by multiplying his Slugging Average (SA) by the percentage of team at-bats accounted for by the player. For example, if a player accounted for 11% of his team at-bats, and slugged .400, then assign (0.11)(.400) = 0.044 as the player's marginal product.

2. *Incremental Method:* This approach, proposed by Zimbalist [1992], is based on the difference in the team's performance *with versus without* the player on its roster. Zimbalist's mistake, however, is that he measured productivity using the player's slugging average. The problem with using this statistic is that the team's performance will necessarily rise when deleting a below-average player, yielding an imputed marginal product which is negative.[3] As negative values of marginal product are not allowed by second-order conditions, this method of implementing the incremental method cannot be correct. A more promising approach would be to use a statistic based on a player's total performance, such as total bases, home runs, or runs-batted-in. As the total product equals the marginal product for the first unit, this approach guarantees positive marginal products. For example, if a player creates 200 total bases, then adding him to the roster (and cutting a non-productive player) will increase the team's total bases by 200.

Included in the task of identifying and measuring a player's marginal product is an issue dealing with the timing of salary negotiations. When a player and his team open contract negotiations, the talks take place prior to season t. As such, the salary agreed upon by both sides is clearly based on expectations of the player's upcoming contribution. Scully measured a player's contribution in the *ex ante* sense by using a player's career statistic up to season (t–1); Zimbalist, on the other hand, used the player's end-of-season (or *ex post*) contribution.[4] While there are times when one might want to compare the *ex post* measure of performance to wages (e.g., if one were interested in investigating possible shirking or other disincentive problems of long-term contracts), the use of the *ex post* realization of performance is clearly inappropriate when one is relating a player's salary to his MRP. For such purposes, a measure of the player's *ex ante* performance is needed. To illustrate the sensitivity of the Scully approach to the definition of productivity, we calculated players' MRPs using both their *ex ante* and *ex post* performances.

In this study, we confine our attention to the estimation of the MRPs of position players

3. This may help explain why Zimbalist's estimates of marginal revenue products, averaged over his sample, were so low.

4. The manner is which a player's expected contribution is measured is always somewhat arbitrary. While Scully's use of career performance is promising, it may not be a very good measure of a player's *ex ante* contribution. For example, it is doubtful that the expectation used in contract negotiations takes into account those performances associated with a player's first couple of years in the Majors (especially if he is approaching the end of a long career).

(i.e., non-pitchers). Our rationale for this is that while a hitter's job is simply to create runs, the marginal product of a pitcher varies depending on his role. Starting pitchers are valued primarily for their ability to pitch a lot of innings and win games; hence the relevant statistics for measuring their contribution would include the earned-run average, number of wins, and winning percentage. Short relievers, on the other hand, are valued primarily for their ability to get a few tough outs, often when the opponent is in a position to tie or win the game. Clearly, the most relevant statistics for measuring a stopper's contribution is his number of saves and percentage of blown save opportunities. Finally, middle relievers are needed to hold a team's lead so that the short reliever can close out the game. This suggests that a middle reliever's performance should be measured using something like the percentage of leads preserved. Because of this wide variety in performance measures (depending on the type of pitcher), together with the fact that there is no apparent reason why the shortcomings of the Scully approach would differ between pitchers and hitters, we confined our attention to estimating the marginal revenue products of hitters.

Using a sample of 215 position players eligible for free agency between 1990 and 1993, players' marginal revenue products are estimated using both the proportional and incremental methods. For the proportional method, a player's marginal product is defined in the same manner as that used by Scully. For the incremental method, a player's marginal product is measured using his total bases created, TBASES.[5] Each method is calculated using both the player's *ex ante* and *ex post* performances, where the *ex ante* contribution of the player is obtained by averaging his performance over the previous three seasons and the *ex post* contribution is defined as the player's end-of-season performance statistics (i.e., those statistics associated with season t). Player data was obtained from various sources, while the team data was obtained from *Financial World* magazine. Table I contains the descriptive statistics of the variables used in the analysis.

Table II summarizes the Scully-estimates of these players' marginal revenue products, delineated by the method used in calculating $(\Delta PERF_J / \Delta I_J)$. For additional insight into the implications of these estimates, Table II also includes the implied ratio of estimated MRP to real salary, denoted MRP*/W, as well as the correlation coefficients between the estimated values and actual wages.

A couple of important conclusions can be drawn from Table II. First, the estimates of MRP are very large—some five to six times larger than the average free agent's salary. It is difficult to believe that a bidding process as competitive as that associated with free agency could result in such large deviations between wages and MRP. Furthermore, a gap of this magnitude implies a nearly vertical labor supply curve, a near impossibility given the degree of mobility enjoyed by free agents.[6] That is, if wages were determined by a monopsony, then setting marginal factor costs to MRP implies that

$$W = \{\varepsilon^S / (1 + \varepsilon^S)\}\, MRP$$

where ε^S is the elasticity of labor supply. Thus, ratios of $MRP / W > 5.0$ imply $\varepsilon^S < 1/4$. Finally, as noted by Zimbalist, the Scully technique does not lead to very impressive correlations between the estimates and actual player salaries.

One possible reason for such large estimates of MRP* is the use of total revenues (TR) as the dependent variable in equation (1). While turnstile revenues are surely connected to a team's performance, other types of revenues (especially those arising from stadium arrangements and national broadcasting sources) are more likely tied to non-performance factors such as league-wide appeal or super-station programming.[7] If so, then the teams marginal revenue component,

5. TBASES measures the total number of bases created by the player, obtained by adding the number of walks (BB) to the product of slugging average (SA) and at-bats (AB): TBASES = BB + (SA)(AB).

6. We would like to thank an anonymous referee for pointing out the implication of the large estimates given in Table II.

7. Furthermore, unless one has first-hand knowledge of the actual venue contracts, it is difficult to trust the stadium revenues reported in *Financial World.*

TABLE I
Summary Statistics of Variables

Variable	Mean	Std. Error	Maximum	Minimum
Team's Real Total Revenue (TR_J)	55,600,000	15,660,000	98,000,000	34,000,000
Team's Real Gate Revenue (GR_J)	18,790,000	6,832,000	43,230,000	8,000,000
Team's Slugging Average (SA_J)	0.388	0.022	0.436	0.338
Team's Total Bases ($TBASES_J$)	2672	174	3204	2229
Team's Earned Run Average (ERA_J)	3.91	0.413	4.90	3.06
Population (POP_J)	6,166,000	5,211,000	19,740,000	1,583,000
Team's Winning Percent ($WPCT_J$)	0.501	0.062	0.642	0.352
Free Agents' Real Salary (W_I)	1,287,000	1,096,000	5,678,000	98,553
Free Agents *Ex Ante* At-Bats/Year: ($ABYEAR_I$)	383.05	132.2	631.3	83.0
Free Agents *Ex Ante* Slugging Average (SA_I)	0.386	0.058	0.570	0.240
Free Agents *Ex Ante* Total Bases ($TBASES_I$)	190.8	81.1	402	30.1
Free Agents *Ex Post* Slugging Average (SA_I)	0.371	0.082	0.726	0.171
Free Agents *Ex Post* Total Bases ($TBASES_I$)	159.8	101.6	491	10
Journeymen *Ex Ante* Slugging Avg. (SA_I)	0.391	0.056	0.535	0.253
Journeymen *Ex Ante* At-Bats/Year. ($ABYEAR_I$)	373	126	617	9
Journeymen Real Salary (W_I)	1,172,800	934,950	4,658,000	168,100
Apprentices *Ex Ante* Slugging Average (SA_I)	0.368	0.059	0.577	0.176
Apprentices *Ex Ante* At-Bats/Year. ($ABYEAR_I$)	314	131	605	39
Apprentices Real Salary (W_I)	230,090	136,320	1,251,000	95,990

$$(\partial TR_J / \ \partial WPCT_J) = \alpha_2,$$

will systematically overestimate the impact of winning percent on total revenues (and hence the team's MRP). In Table III, we address this possibility by recalculating the Scully marginal revenue products using just the team's *turnstile* revenues. As suspected, the imputed value of a typical free agent's MRP fell (by nearly 25%). Yet even making this adjustment yields estimates that are still four to five times larger than the wage. As such, it would not appear that the Scully technique can be remedied by simply adjusting the manner in which revenues are measured.

It is also interesting to note that, regardless of how one measures the player's contribution or the team's revenues, the *ex ante* estimates of MRP are about 20% larger than the *ex post* estimates. This may be due to measuring the *ex ante* expectation by the player's three-year average in the presence of a concave productivity-experience relationship, as discussed in Vrooman [1996]. If performance rises with experience, but at decreasing rate, then using productivity data from the player's prior three years may overestimate the *ex ante* expectation used in negotiations, leading to an upward bias in our estimates of MRP. Alternatively, *ex post* performance may fall short of *ex ante* expectations because of some type of disincentive problem associated with the signing of (typically multi-year) free agent contracts (Lehn [1982]; Krautmann [1990]).

III. FREE MARKET RETURNS APPROACH

The results presented in Tables II and III suggest that, regardless of how a player's marginal product is measured, the Scully method yields large and varied estimates of players' marginal revenue products. As a result, we propose a simple alternative for imputing a player's value to his team. Our method is based on the intuitive notion that the intense bidding process that determines free agent salaries should align wages to marginal revenue products, allowing us to estimate the competitive return to performance. By applying these

TABLE II
Average MRP* of Free Agents
(Using *Total* Revenues)

	Ex ante			Ex post		
	MRP*	$\frac{MRP*}{W}$	cor (MRP*, W)	MRP*	$\frac{MRP*}{W}$	cor (MRP*, W)
Proportional Method	5,689,000	6.83	0.73	4,711,000	5.27	0.63
Incremental Method	5,303,000	6.36	0.73	4,441,000	4.96	0.65

Note: The entries are the mean values of the variables for the sample of 215 hitters who were potential free agents from 1990 through 1993.

market returns to the performances of players restricted by the reserve clause, we can impute the market value of these indentured players.

An estimate of the free market return is obtained by regressing free agents' wages on their performance. With a sufficiently large panel of data spanning numerous free agent signings per team, we are able to control for team-specific factors which affect wages by viewing teams as cross-sectional units in a fixed-effects model. This fixed-effects model is given by:

$$(4)\quad W_{IJ} = \delta_J + \delta_1\, PERF_I + \delta_2\, TREND + \varepsilon_{IJ}$$

where $PERF_I$ is an *ex ante* measure of the *I*th free agent's performance,[8] *TREND* is included to control for any time trend in the data, and δ_J is the fixed-effects parameter for team *J*. The gain involved in using a fixed-effects specification is that it allows δ_J to control for team-invariant factors, including managerial quality, which are difficult to measure and would otherwise be ignored.

These regression estimates are then used to impute the value of a young player restricted by the reserve clause. Using player-specific performance information, an estimate of the *I*th reserve-clause player's market value ($VALUE^*$) is computed as:

$$(5)\quad VALUE^*_{IJ} = \hat{\delta}_J + \hat{\delta}_1\, PERF_I + \hat{\delta}_2\, TREND$$

where $\hat{\delta}$ is the vector of regression estimates obtained from equation (4) and $PERF_I$ is the reserve-clause player's *ex ante* performance. Essentially this method imputes a young player's market value by applying the same returns to performance he would have received if he had access to competitive labor markets. One attraction of this method is that it uses market information to impute a player's value. Furthermore, it enables us to calculate the economic value of indentured players, a cohort whose MRP is usually difficult to ascertain.[9]

Whether one chooses to interpret $VALUE^*$ as the player's MRP or his market value depends largely on the degree of competition in the free agent market. The term "MRP" refers to the marginal benefits accruing to the team, measured by the extra revenues generated by the player, while the term "market value" is what someone is willing to pay to purchase a player's services. If the market structure determining free agent wages is reasonably competitive, then the equilibrium bid for a free agent will converge to his MRP. In this case, $VALUE^*$ produced by our method will provide a reasonable estimate of the reserve-clause player's MRP. If, on the other hand, the mar-

8. If the baseball production function (which relates player talent to team wins) exhibits diminishing returns to hitting, then a good hitter will have a higher marginal product on a weaker team. In this case, one would need to allow for some interaction between a player's performance and the quality of his team. But Krautmann and Oppenheimer [1994] could not reject constant returns to hitting, implying that a hitter's contribution to winning is identical on all teams, i.e., $PERF_{IJ} = PERF_{IK} = PERF_I \ \forall\ J, K$. This assumption, commonly made in the pay versus performance literature, is why the variable *PERF* in equation (5) does not have a team-specific subscript.

9. A reserve clause player could be paid less than his MRP if he is perceived as a more risky input than a free agent. That is, since a young player has a shorter history, his productivity may be viewed as more uncertain. If so, then our method of applying free agent returns to reserve clause performances will introduce an upward bias in the estimates of MRP. Table I suggests, however, that this is not likely a problem because the performance statistics of reserve clause players are no more variable than that of free agents (i.e., the standard errors of the productivity measures are essentially identical between free agents and non-free agents).

TABLE III
Average MRP* of Free Agents
(Using *Turnstile* Revenues)

	Ex ante			Ex post		
	MRP*	$\frac{MRP*}{W}$	cor (MRP*, W)	MRP*	$\frac{MRP*}{W}$	cor (MRP*, W)
Proportional Method	4,486,000	5.40	0.73	3,718,000	4.17	0.63
Incremental Method	4,183,000	5.03	0.73	3,506,000	3.92	0.65

Note: The entries are the mean values of the variables for the sample of 215 hitters who were potential free agents from 1990 through 1993.

ket structure determining free agent salaries is imperfectly competitive (e.g., a bilateral monopoly, a winner's curse problem), then the correspondence between a free agent's wage and his MRP is less clear. In this case, $VALUE^*$ should be interpreted as what the player could have received if he were not indentured by the reserve clause—that is, an estimate of his market value.

To compare the Free Market Returns (FMR) approach to the Scully method, we estimated equation (4) using a sample of 273 free agent position players who signed new contracts between 1990 and 1994.[10] In particular, we estimated the free agent return on performance in the following fixed-effects model:

$$(4') \quad W_{IJ} = \delta_J + \delta_1 SA_I + \delta_2 SA_I \cdot CAT_I + \delta_3 SA_I \cdot SS_I + \delta_4 ABYEAR_I + \delta_5 TREND + \varepsilon_{IJ}.$$

For simplicity, we measured the hitter's performance using his slugging average (SA), and included cross-terms with dummy variables for catcher (CAT) and shortstop (SS) to allow for differences in the returns to performance for those players who are used primarily for defensive purposes. To control for differences between starters and part-time players, we included the player's at-bats per season (denoted ABYEAR). The trend variable (TREND) is included to account for the increase in real wages between 1990 and 1994. All monetary variables are measured in constant 1990 dollars.

Table IV reports the fixed-effects estimates of (4′). As expected, the results imply that starters and better players are paid more. While shortstops receive a $1.2 million premium for their defensive skills, we were somewhat surprised to find that catchers do not. Finally, our estimates imply that real wages have been rising at about $100,000 per year.

To get the free market values of reserve-clause players, these regression coefficients were applied to the *ex ante* performances of a sample of 702 reserve-clause players (391 apprentices and 311 journeymen) playing on Major League teams between 1990 and 1994. As rookies do not have a long enough work history upon which to base an *ex ante* expectation, we deleted all first-year apprentices from the sample. Table V summarizes these estimated values, together with the implied ratio of market value to salary and the correlation coefficients between the imputed value and actual salaries. The Scully estimates of the marginal revenue products of these reserve-clause players are also included in Table V.

Both methods imply that the average reserve-clause player generates more revenue for his team than he is paid. In comparing across the two types of reserve-clause players,

10. As we are using *ex ante* estimates of players' performance, the effects of the 1994 labor strike (which prematurely ended the season in August) would not affect the contract negotiations of free agents (which took place in January). The reason the 1994 free agents were excluded in the analysis which generated Tables II and III is that *ex post* productivity measures were included in that analysis.

TABLE IV
Fixed-Effects Estimates Of Real Wages

Variable	Coefficients
Slugging Average (SA)	7,491,300 (7.2)*
(Slugging Average) x (Catcher) (SA · CAT)	199,980 (0.5)
(Slugging Average) x (Shortstop) (SA SS)	1,198,000 (2.6)*
At-Bats per Year (ABYEAR)	3913 (8.8)*
Time (TREND)	101,980 (3.0)*
Fixed Effect	–3,393,000
R^2	0.61

Note: t-statistics in parentheses.
*Significant at the 5% level.

it is not surprising to find that apprentices are relatively more underpaid than journeymen. This is consistent with the fact that arbitration eligibility yields journeymen more negotiating power, making them less susceptible to monopsonistic exploitation. It is also consistent with the internal labor market literature which suggests that employees would be willing to accept lower wages early on because they will be rewarded with higher wages in their later years (Lazear [1979]).

In a comparison between the two methods, Table V shows that the Scully estimates are consistently four to five times larger than those produced by the FMR method. Why are the Scully estimates so much larger than those generated from the FMR approach?

One possibility is that the FMR method systematically underestimates players' market values. If owners successfully discipline themselves, they might be able to depress free agent wages below MRP. In this case, the FMR method will underestimate the return to performance, and hence understate the value of reserve-clause players. While owners were found guilty of this type of collusive behavior back in the mid-1980s, recent trends in the industry suggest such behavior has stopped. For one, players' salaries have been rising at 10% to 15% per year over the past decade. Furthermore, league expansion over this same decade has diluted talent on the typical team, intensifying the bidding process for all free agents (even the most mediocre ones). If this market is as competitive as it appears to be, the wages of free agents likely reflects marginal revenue products.

The other possibility is that the Scully technique systematically overestimates players' marginal values. Allocating the team's performance to its rostered players in proportion to the player's percentage of team at-bats means that the marginal products of non-player inputs (e.g., coaches and managers) will be inappropriately apportioned to rostered players. To the degree that these other inputs contribute to team performance, the Scully technique will overestimate players' marginal products, and hence, marginal revenue products. We suspect that this is the primary reason for the large estimates produced by the Scully technique seen in Table V.[11]

11. One possible test of the accuracy of the FMR method is to compare the correlation between actual wages and the estimates generated by each method. Unfortunately, this goodness-of-fit test will not be particularly helpful in distinguishing between the two methods simply because the innate uncertainty underlying both techniques arises from the same source (namely, variations in players' marginal product). That is, both approaches simply multiply a player's marginal product by regression coefficients derived from some auxiliary regression(s). The likely reason why the FMR method yields slightly higher correlation coefficients is that it controls for the defensive positions (CAT and SS) believed to be an important determinant of a player's value.

TABLE V
Average Value of Reserve-Clause Players
(Using *Ex Ante* SA as Measure of Performance)

	Scully Method			Free Market Return Method		
Type of Player	MRP*	$\frac{MRP^*}{W}$	Cor (MRP*, W)	VALUE*	$\frac{VALUE^*}{W}$	Cor (VALUE*, W)
Apprentice (n=391)	$4,451,000	21.03	0.53	$810,200	3.64	0.54
Journeyman (n=311)	$5,619,000	4.79	0.65	$1,080,800	1.17	0.67

Notes: The figures in Table V are from a sample of 702 reserve-clause hitters in 1990–1994. To allow for sufficient work histories, we deleted any apprentice with less than one year of Major League experience.

Given the institutional structure of the arbitration process, one would not expect to find differences between the salaries of journeymen and free agents as large as those implied by the Scully estimates. For one, both the owner and the player must approve of a potential arbitrator before the case is heard, meaning that any arbitrator who regularly over- or under-pays players will not hear many cases. Furthermore, the collective bargaining agreement specifically outlines the method to be used by arbitrators in making their decision. A player is ranked relative to other players at his position, where this ranking is based on his performance in the preceding year. The arbitrator compares the player's salary bid and the team's offer to the wages paid to similar players, and chooses either the bid or the offer. Since less than one-half of all roster players are bound by the reserve clause, many of the player's neighbors in this ranking are former or current free agents. Furthermore, well over 75% of all arbitration-eligible players reach an agreement without going through the painful arbitration process. For both of these reasons, one would not expect the salaries of journeymen to deviate much from the wages paid to free agents. The FMRs method implies that the average journeyman is paid about 85% of his value. The Scully approach, on the other hand, suggests that such a player is paid only about 25% of his marginal revenue product.

One reason team owners extract a surplus[12] from their reserve-clause players is that it allows them to recoup some portion of their investments in general training associated with the Minor Leagues (see Krautmann and Oppenheimer [1994]). While teams do not typically divulge confidential information as to the exact amount spent developing its players, spotty evidence suggests that Major League Baseball teams spend between $3 million and $6 million per year developing their players (see Ernst & Young [1991]; Zimbalist [1992]; U.S. House of Representatives [1994]; Vrooman [1996]). Given that an average team carries about six apprentices and five journeymen (pitchers and hitters together), the FMRs method implies that an average team extracts a surplus of about $4.5 million from its contingent of reserve-clause players—about enough to pay for the team's training expenses. The Scully method, on the other hand, implies that owners extract a surplus of over $57 million from these players. If this were correct, one would expect to see evidence of these monopsony rents showing up in terms of large franchise profits. This does not seem to be the case in Major League Baseball. Between 1990 and 1996, the real (accounting) profit of an average baseball franchise is only about $4 million, with about 40% of the franchises claiming to have lost money (see *Financial World* magazine).

12. The surplus refers to the excess of $VALUE^*$ over wages; i.e., $SURPLUS = (VALUE^* - W)$.

IV. CONCLUDING REMARKS

Economic explanations of the exorbitant salaries paid to professional athletes have traditionally focused on some estimate of players' marginal revenue products. Much of the work done in this direction has concentrated on explaining the salaries of Major League Baseball players using a technique pioneered by Scully. This paper calls into question the validity of the traditional Scully method for imputing players' MRPs. We propose a simple alternative approach which uses information gleaned from the free agent market. In short, our proposed method estimates the free market return to performance which, when applied to the contribution of a reserve-clause player, allows us to impute his market value. Such estimates could be valuable in analyzing a number of important issues pertaining to this labor market. For example, this approach would allow one to analyze monopsony exploitation between different classes of players. Not only could this yield us valuable insight into possible discriminatory practices in this labor market, but it might also provide us with a better understanding of the long-standing tension between owners and players which has led to a number of recent work stoppages.

APPENDIX A

Estimating MRP Using the Scully Approach

The standard approach used in Scully [1974, 1989] and updated by Zimbalist [1992] is given by equations (1)–(3) above. Zimbalist noted that Scully missed the importance of the *previous season's* winning percent to this season's revenues, implying that a lagged value of WPCT needs to be added to equation (1), giving:

$$\text{(A1)} \quad TR_{Jt} = a_0 + a_1\, POP_{Jt} + a_2 WPCT_{Jt} + a_3\, WPCT_{J(t-1)}$$

The dependent variable, TR_{Jt}, is the *J*th team's total real revenues (in 1990 dollars) in season *t*, and includes those revenues derived from turnstile attendance, season ticket holders, broadcasting rights, and other sources (e.g., concessions, parking). The variable $WPCT_{Jt}$ denotes the winning percentage of the *J*th team in season *t*, and $WPCT_{J(t-1)}$ denotes its winning percentage in the previous season. While $WPCT_{Jt}$ reflects the effects of winning on this season's revenues (primarily through turnstile attendance and concessions), $WPCT_{J(t-1)}$ reflects the impact on this season's revenues of last year's success (primarily through season ticket sales and local broadcasting appeal). The size of the market from which the team derives its fans is represented by the variable POP_{Jt} , defined as the population of the metropolitan area in which the team is located.[13]

To estimate equation (A1), we used the total revenues reported in the annual editions of *Financial World* for the 1990 through 1993 seasons. This time frame was used because *Financial World* only began providing these estimates in 1990, and we did not want to include the 1994 nor 1995 seasons in our sample, given the strike of 1994–1995. All dollar variables are measured in constant 1990 dollars. We dropped observations corresponding to the two expansion teams, giving us four seasons of data covering 26 teams.

The ordinary least squares estimates of the revenue function are reported in Table A1. All of the estimates have the expected signs and are significant at reasonable levels. Using an interest rate of 7% to discount the coefficient on lagged winning percent, these estimates imply that one additional game won (raising winning percent by 0.0062) increases a team's real discounted revenues by $647,954. This suggests that if Albert Belle was "worth" the $10 million he was paid in 1997 (or $8.17 million in 1990 dollars), he needed to create an additional 13 wins for the White Sox! The coefficient on population implies that the effect of the additional 5 million people in New York City over Los Angeles (the second largest market) results in additional real revenues of $10.6 million.[14]

When estimating equation (2), one is forced to specify the relevant performance variables, $PERF_J$. Surely the most important factors determining a team's success are its ability to score runs (offense) and its ability to prevent runs from being scored (defense). But what constitutes the best measures of offense and defense always creates a lively debate. Previous experience with this issue leads us to agree with Zimbalist in that one of the best proxies of a team's defense is the quality of its pitching staff, as measured by its earned run average (ERA_J). On the offensive side, however, a number of statistics have been proposed to measure a team's ability to score runs. Among the most popular is the *average* number of bases created per at-bat—the team's slugging average (SA_J). An alternative measure of offensive performance is provided by the team's *total* number of bases, $TBASES_J$. The appeal of this measure is its ability to capture the importance of the number of bases created (similar to slugging average) as well as getting on base via walks (like OBP, or the on-

13. There is some disagreement in the literature as to the proper manner of measuring the market size of cities with 2 teams. While Scully divided the population in two (i.e., 0.5*POP) for those metro areas with two teams, Zimbalist argued that the proper specification is to include the total population for these cities (he also tried a middle ground: 0.75*POP). We estimated (1') using all three definitions of population, and since the results changed very little, just report those estimates with population included in its entirety.

14. Zimbalist is unclear as to the base year he used in his analysis. Assuming he used the first year of his sample [1984] as his base year, and converting his figures into comparable 1990 dollars, his estimates imply that an additional win increased real revenues by $491,550; while the additional 5 million people in New York City over Los Angeles is worth an extra $15.1 million.

base percent), while avoiding the double counting incumbent with Zimbalist's measure PROD (equal to SA + OBP).[15] In this study, we measure a team's offense (OFF_J) using SA_J when implementing the proportional method, and $TBASES_J$ when using the incremental method. As such, the team's winning percent is estimated by:

$$\text{(A2)} \qquad WPCT_{Jt} = \beta_0 + \beta_1\, OFF_{Jt} + \beta_2\, ERA_{Jt}.$$

The ordinary least squares estimates of (A2), using team data from 1990 through 1993, are reported below in Table A2.[16] Not surprising, all performance variables have the expected sign and are significant. These estimates imply that a team wins one extra game for every 23 additional bases achieved. Alternatively, it is necessary to increase a team's SA by 0.0031 in order for the team to win one additional game.

Using the results in Tables A1 and A2, we can impute a team's MRP attributed to its total bases as:

$$(\partial TR_J / \partial TBASES_{Jt}) = \{\hat{\alpha}_2 + [\hat{\alpha}_3 / (1+i)]\}\,(\hat{\beta}_1)$$

$$= \{57{,}490{,}000 + [50{,}310{,}000/(1.07)]\}\,(0.00027)$$

$$= 27.799$$

where the coefficient on the lagged value of winning percent, α_3, has been discounted by the prevailing Treasury Bill rate of 7%. This calculation implies that every extra base accumulated by a team results in additional revenues of $27,799. Alternatively, the team's MRP with respect to slugging average is

$$(\partial TR_J / \partial SA_{Jt}) = \{\hat{\alpha}_2 + [\hat{\alpha}_3 / (1+i)]\}\,(\hat{\beta}_1)$$

$$= \{57{,}490{,}000 + [50{,}310{,}000/(1.07)]\}\,(1.98)$$

$$= 206{,}910{,}000$$

implying that every "one point" (i.e., 0.001) increase in a team's SA increases its revenues by $206,910.

A player's MRP is derived by multiplying his marginal product by the team's estimated MRP. For the proportional method, the player's marginal product is his individual slugging average, SA_I, weighted by his proportion of team at-bats, i.e.,

$$(\Delta PERF_J / \Delta I_J) = (\Delta SA_J / \Delta I_J) = (AB_I / AB_J)\, SA_I.$$

For *ex ante* measures of a player's contribution, we used his average number of at-bats over the prior three seasons to measure AB_I, and his average slugging average over these same three seasons for SA_I. For the *ex post* measures, we used his end-of-season number of at-bats and slugging average. In both cases, we used the league-wide average number of team at-bats (equal to 5492) to measure AB_J.

For the incremental method, $(\Delta PERF_J / \Delta I_J)$ is calculated in the following manner:

$$(\Delta PERF_J / \Delta I_J) = (\Delta TBASES_J / \Delta I_J) = TBASES_I.$$

Again, the use of a player's total statistic is justified on the grounds that the total and margin are equivalent for the first unit applied. That is, if a player creates 200 total bases, then adding him to a team (and releasing an unproductive player) will raise the team's total bases by this same 200. We use the same criteria described above for defining the *ex ante* and *ex post* measures of performance.

Using Albert Belle's *ex ante* measures of slugging average equal to 0.671, total bases equal to 493, and proportion of team at-bats equal to 0.11, the Scully estimates of his 1997 MRP is about $14.4 million (in 1990 dollars). This implies that Albert Belle was paid only about 55% of his economic value.

15. Using total bases has the additional advantage of allowing one to use the bases created by a player as an incremental measure of his marginal product (because when one uses a total statistic, the player's marginal and total product are identical). When using an average statistic (e.g., SA, OBP), one is forced to contrive a rule for apportioning the player's performance to his team.

16. We estimated model specifications which allow for differences between the American and National Leagues. Running a Chow test on the null hypothesis, H_0: $\beta_{NL} = \beta_{AL}$, we found no evidence of any significant difference between the two leagues.

APPENDIX TABLE A1
Ordinary Least Squares Estimates of the Revenue Function
Dependent Variable: Real Revenues

Variable	Coefficient
Constant	−11,450,000 (−0.93)
Population (POP_J)	2.1187 (9.97)*
Winning Percent ($WPCT_{Jt}$)	57,490,000 (3.22)*
Lagged Winning Percent ($WPCT_{J(t-1)}$)	50,310,000 (2.70)*
$R^2 = 0.52$	
$n = 104$	

Note: t-statistics in parentheses. * Significant at the 5% level.

APPENDIX TABLE A2
Ordinary Least Squares Estimates of the Production Function
Dependent Variable: $WPCT_{Jt}$

Variable	Coefficient	Coefficient
Constant	0.242 (4.9)*	0.176 (2.84)*
Slugging Average (SA_J)	—	1.98 (12.0)*
Total Bases ($TBASES_J$)	0.00027 (14.2)*	—
Earned Run Average (ERA_J)	−0.115 (−14.6)*	−0.113 (−12.8)*
R^2	0.75	0.70

Note: t-statistics in parentheses. * Significant at the 5% level.

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