What Is Right With Scully Estimates of a Player's Marginal Revenue Product: Reply

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Abstract

The author responds to an article in this edition by Bradbury (in press), which suggests that the free-market approach to estimating a player's marginal revenue product (MRP) is limited. The author begins by reviewing a number of empirical issues that potentially limit the Scully approach, then turn to Bradbury's concerns about the free-market approach. The author close by noting that these two methods are not competing nor is one necessarily superior to the other—each method has its own merits in terms of answering different types of questions related to a player's value.

What is a professional athlete player worth? One answer to this question is to look at what teams are paying free agents (FAs) because competition forces owners to pay at least what the player is worth to the team. An alternative approach would be to reassemble the player's marginal revenue product (MRP) by combining estimates of the team's marginal revenue (MR) with the player's marginal product (MP). Neither of the approach is superior to the other, and each estimates very different aspects of a player's value. For example, if one is interested in modeling the determinants of wages, then it is important that the analyst replicates the conditions under which salary negotiations took place. That is, the model should consider the bargaining

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positions of each side and explicitly recognize that salaries are determined ex ante, not ex post. If, on the other hand, one is interested in looking at whether the player "earned" his salary, then one might want to calculate his MRP using the player's actual, realized performance. In a nutshell, this distinction between the ex ante determination of salary versus the ex post evaluation of value is at the heart of what distinguishes the free-market approach from the Scully approach.

In the article, "What's Wrong with the Scully-Estimates of a Player's Marginal Revenue Product?" (Krautmann, 1999), I addressed a number of empirical issues associated with the Scully decomposition approach to estimating a player's MRP.[1] I then went on to introduce an alternative approach based on the assumption that salaries determined in a competitive market for labor should reflect an FA's *expected* MRP.[2]

Since this article first appeared over a decade ago, a number of subsequent studies have appeared in the literature that would improve the applicability of the free-market approach. For example, when there is a thin market for a superstar FA, the final determination of his salary may be more appropriately modeled by some type of Nash bargaining agreement (Solow & Krautmann, 2011). The Nash bargaining model suggests that the equilibrium salary negotiated between a team and the superstar will end up somewhere between the FA's alternative salary offer and the team's surplus generated from its next best alternative player. Of course, as the number of close substitutes for the player increases, this gap would shrink and the final outcome would converge to the competitive equilibrium.

Burger and Walters (2008) suggested that a winner's curse may arise as the result of teams bidding for a player's talent. Here it is the stochastic nature of production which introduces uncertainty into the bidding process. While Burger and Walters were concerned that the team which wins the bid would overestimate the FA's MRP, they ignore the converse possibility that the player (and his agent) may underestimate his MRP. To the extent that overestimates of MRP are as likely as underestimates, we have no reason to conclude that the winning bid is systematically above (or below) the player's marginal value.

Finally, hiring an elite superstar may be just enough to propel a near-contending team into the play-offs. Given that the (expected) extra revenues of making the play-offs is in the neighborhood of $10–$12 million, a team may be willing to pay an elite player a wage premium above his "regular-season-only" MRP (Krautmann & Ciecka, 2009). In this regard, the free-market estimate of MRP may need to be adjusted upward to reflect these play-off rents. In light of these many recent innovations, we see that a modern application of the free-market approach may need to be modified to incorporate these new innovations in the literature.

Shortcomings of the Scully Approach

Whether or not the limitations of the free-market approach expressed by Bradbury renders this approach inefficient or biased is an important epistemological question.

While Bradbury does a commendable job of pointing out potential shortcomings of the free-market approach (these concerns will be addressed more fully below), he spends too little time outlining my article's original concerns with the Scully approach. To briefly review these concerns, look at the decomposition of MRP into its two component parts: MR_j—the value to the jth team of winning one more game—and MP_{ij}—the extra wins of team j generated by adding the ith player to its roster.

1. *Difficulty in estimating a team's MR:* In order to implement the Scully approach, one first needs an estimate of MR_j. The jth team's MR, equal to $(\partial TR_j/\partial W_j)$ and interpreted as the extra revenues generated by winning one more game, is ultimately derived from some estimate of the team's total revenue (TR) function. To get the TR function, the analyst must first obtain reliable data on team revenues. Since most professional teams are privately held, the accuracy of any reported financial data is difficult to ascertain. A very common procedure found in the literature is to use financial data appearing in annual publications of *Forbes* (which took over this task from the defunct *Financial World* periodical). As noted by one sabermetrician, however, the reliability of these data is far from ideal: "*Forbes'* valuation numbers haven't been terribly accurate as compared to actual team-sales prices, and you'd figure revenue and net income numbers would be even harder to guess ... they really shouldn't be used for any kind of rigorous analysis at the team level" (Shawn Hoffman in the *Baseball Prospectus*, 2010).[3]

   In the final analysis, it is unclear how close the Forbes' data are to the team's actual revenues, and more importantly, how close these data come to reflecting the underlying win elasticity. Perhaps, some notion of the accuracy of these data can be gleaned from two independent sources of audited financial records that have been made public: the recent disclosure of team financial data by Deadspin.com (2010) and the audited books used in 2001 by the Blue Ribbon Panel (BRP; 2001). The website, Deadspin.com, published confidential, independently audited reports on the finances of the following six teams: Los Angeles Angels, Texas Rangers, Seattle Mariners, Tampa Bay Rays, Florida Marlins, and Pittsburgh Pirates. Assuming that the audited data are accurate, a comparison of these audited data to that reported by *Forbes/Financial World* gives us reason for concern. For example, *Forbes* reports the Mariners's TR in 2008 as $189 million; Deadspin.com gives the audited value to be $216 million (a 14% understatement). *Forbes* also reported the Rangers's TR as $176 million in 2008; Deadspin.com reports the number as $149 million (a 15% overstatement). The audited financial data used by the BRP give yet another glimpse into the quality and accuracy of the *Forbes/Financial World* data. For example, *Financial World* reported the TR of the New York Yankees in 1996 as $133 million; the BRP gave the value as $108 million (a 23% overstatement).

While such a disparity between the *Forbes* and audited data should give us reason for concern, one might still argue that the *Forbes* data are the best information available. But since these data provide a critical link in the construction of a player's MRP, we should check how to see how close the *Forbes* data come to estimating the team's MR. To this end, we estimated the MR function using the revenue data appearing in both the BRP report and in various editions of *Forbes*.[4] The results of this analysis are again rather disturbing. Using the *Forbes* and BRP data, we get following estimates of MR:

- *Forbes* data: $MR_F = 1.296 + 0.002 \times WINS$
- BRP data: $MR_{BRP} = 4.938 - 0.045 \times WINS$.

Counter to our theoretical expectations, the *Forbes* data yield a *rising* (rather than falling) MR function—although the estimated slope is not statistically significant. The estimate of MR function derived from the BRP data, on the other hand, is negatively sloped (and significant). More critical to the issue at hand, we used these two sets of estimates to impute the MRs at various levels of team performance. For mediocre teams winning about 65–70 games, the estimated MR using the *Forbes* data <u>underestimated</u> the BRP estimate by about $500,000. Yet, for division-leading teams winning about 95–100 games, the *Forbes* estimate <u>overestimated</u> the BRP estimate by almost 1 million dollars! Thus, using the *Forbes* estimates of MR in a Scully model might lead us to systematically underestimate the MRP of players on mediocre teams and overestimate the MRP of players on good teams!

2. *Difficulty in estimating a player's MP:* There are two major difficulties associated with estimating a player's MP. The first deals with the team's replacement player. Zimbalist (1992) pointed out long ago that the proper measure of MP should be one that includes a consideration of the marginal contribution of the replacement player the team would have chosen in place of the FA (Zimbalist called this "the counterfactual"). Would the FA's replacement player have been an average player *or* an average player at his position *or* perhaps the team's best Minor League player at that same position? In short, the analyst faces the nearly impossible task of identifying the relevant replacement player that the team would have used as an alternative to the FA in question.[5] Ignoring the output of the replacement player, Zimbalist warned, will result in an overestimate of the player's MP (and hence MRP).

The second difficulty that arises is how one calculates the player's marginal contribution to his team from his individual performance statistic. While it is an easy task to connect team performance statistics to team wins, it is not so clear as to how one allocates these team statistics to each individual player. Again, the empirical devil lies in the details. The most common type of performance

measure used by analysts is some type of "rate" statistic, such as batting average (BA) or slugging average (SA), which is relative to the player's at-bats (AB). For example, consider using SA as the performance measure (as was done by Scully, 1974). The Scully approach would impute the ith player's contribution to team j's SA by multiplying his SA by w_{ij}, his proportion of team AB; that is, the individual's contribution to his team's SA is $(w_{ij} \times SA_{ij})$, where $w_{ij} = (AB_{ij})/AB_j$. This procedure almost certainly overstates the player's marginal contribution, as it implies the counterfactual that the replacement player either had an SA of zero or was expected to have zero AB! Now consider what happens when one uses this weighting scheme to assign a player's OPS to his team (as was done by Zimbalist, 1992). The OPS statistic adds together the player's slugging average (SA) with his on-base-percentage (OBP). His SA equals his total bases (TB) divided by his at-bats (AB): SA = TB/AB. His OBP is equal to his hits (H) plus walks (BB) plus hit-by-pitches (HBP) plus sacrifices (S), divided by his plate appearances (PA): OBP = (H+BB+HBP+S)/PA. Should the weight, w_{ij}, used to impute the player's contribution to his team be his proportion of team AB or his proportion of team plate-appearances (PA)? Since PA is about 25% larger than AB, arbitrarily choosing one over the other will surely affect the estimate of the player's MP.

Both of these empirical difficulties are inherent in the estimation of MRP using the Scully approach. One attraction of the free-market approach is that the analysis does not require direct estimates of the player's MP nor the team's MR. One simply uses the observed wages of those players who negotiated their salaries in the competitive FA market and assume that this observed wage approximates the player's (expected) MRP. Furthermore, errors in this approximation are harmless as they simply become part of the regression stochastic term.

How Limited Is the Free-Market Approach?

Bradbury's primary concern is with the maintained assumption of the free-market approach—namely, that the FA labor market is efficient and sufficiently competitive so that teams are forced to pay a FA his expected marginal value. Rather than rendering the free-market approach ineffective and/or biased, we believe that many of his concerns actually suggest ways to strengthen its legitimacy.

1. Bradbury is correct in pointing out that run-of-the-mill FAs may be competing with those restricted players whose wages are unduly affected by such things as the reserve clause and the arbitration process. For sure, ignoring this aspect of a segmented labor market would undoubtedly depress the imputed marginal return to performance and hence impose a downward bias on the resulting estimate of MRP. This problem could be easily addressed by including controls for

part-time FAs in the wage regression. In fact, most subsequent studies using the free-market approach have included controls for utility/part-time players.[6]

2. Bradbury states that the free-market approach ignores the fact that players are willing to trade-off longer contract length for smaller wages. But the literature overwhelmingly concludes that longer contracts are associated with larger, rather than smaller, salaries (see Krautmann & Oppenheimer, 2002; Maxcy, 2004). Furthermore, it is debatable as to whether there exists any economic trade-off between wages for nonpecuniary benefits. Other than the occasional instance of some player exercising his short-lived popularity (e.g., witness the recent LeBron James circus announcing his signing with the Miami Heat), perhaps, the most convincing evidence of a compensating wage differential in sports labor markets appeared in a recent article dealing with National Basketball Association (NBA) players (Michaelides, 2010). In any case, if compensating differentials are found to be significant, then the free-market approach could easily incorporate these location- or team-specific amenities into the FA wage regression.

3. It is not clear how the *Moneyball* (Lewis, 2003) ''mispricing problem'' is pertinent to the issue at hand. While Billy Beane did value his players on the basis of OBP (rather than other more common metrics like SA or OPS), this appears to matter only for the Oakland Athletics and what they paid their FAs. It is unclear how the free-market approach is affected by including the Oakland FAs in the sample, but surely one could control for such team-specific idiosyncrasies using standard panel-data techniques. Furthermore, if the other 29 teams were pricing their FAs on the basis of some other metric (e.g., OPS), and the free-market approach used OPS as the players' performance metric, then this approach is correctly pricing players according to what those 29 teams felt determined marginal value. This should not be seen as an indictment on the free-market approach (for the wage still reflects what the teams believe their players are worth) but rather a result of the technical inefficiency of teams.

4. It is not clear why Bradbury is concerned about a nonlinear relationship between team performance and team revenues. While the Scully approach surely requires the analyst to specify the functional form of the revenue function, the free-market approach does not directly estimate a revenue function—and hence does not make any assumption about the functional form. If the author's concern is that the return to performance is increasing at a nonconstant rate, then the free-market approach could handle this by allowing performance to enter the wage equation in a quadratic (or higher order) form. I would certainly agree with Bradbury's assertion that assuming linearity is problematic for the Scully approach, '' . . . care should be taken to account for the nonlinear relationship between winning and revenue.'' But this caution should be directed toward those using the Scully approach.

5. In terms of the surplus derived from arbitration-eligible players in Krautmann, Gustafson, and Hadley (KGH, 2000) - one needs to also consider the precision

of these point estimates. Bradbury is correct in stating that a negative surplus does imply that arbitration-eligible ("Journeyman") players are paid more than their FA counterparts.[7] But the values presented in that study are averages and are quite small—on the magnitude of only about 5% of the typical Journeyman's wage. While KGH did not test for the statistical significance of the Journeymen's surpluses, these very small point estimates are almost certainly not significantly different from zero. In fact, one of the main points of the KGH study was the conclusion that the arbitration process results in a much more competitive salary process than that facing arbitration-ineligible players ("Apprentices"). To check the statistic significance of the average surplus of Journeymen, we updated the KGH study using a sample spanning the 2009-2011 seasons. In this update, we ran a wage regression on a sample of 183 (potential) FA hitters to get the marginal returns to the wage factors.[8] Applying these estimated marginal returns to a sample of 209 arbitration-eligible hitters, we found the average surplus for Journeymen to be a little over $300,000. A couple of interesting observations arise from this update. One, the point estimate of the average surplus in this recent period is positive. In other words, the average Journeyman is underpaid by about $300,000 (rather than overpaid as found in KGH). This $300,000 underpayment implies that a typical Journeyman receives about 90% of his MRP. In addition, while this point estimate is indeed positive, it is not significantly different from zero. This suggests that a typical Journeyman receives a wage that does not differ significantly from that which he would have received had he signed an FA contract with his team. Finally, since the confidence interval for the surplus includes zero, the finding of a negative surplus estimate in the original KGH study is not particularly surprising.

6. Bradbury's contention that Journeymen should only be compared to those players with at most one extra year of Minor League (ML) experience is not entirely relevant nor entirely correct. Fourth-year Journeymen are compared to fifth-year players, while fifth-year Journeymen are compared to sixth-plus players, and so on. Since arbitration-eligible players constitute about a quarter of all active players, these comparables become transitively interlinked, making this stipulation in the collective bargaining agreement (CBA) only weakly relevant. Furthermore, Bradbury may be giving this 1-year-difference clause a bit more importance than what is implied by the CBA. The 2007 CBA does not explicitly disallow longer comparisons—but rather it simply states that "particular attention" should be given to those within 1-year's experience.

7. In terms of the contention that the FA market is too thin to legitimately apply the competitive results, one might look to the Industrial Organization literature to see how many agents it takes for a market to be considered "sufficiently competitive." While there may be some disagreement over the exact number, once you get past 15–20 firms, the equilibrium converges to the competitive outcome. Bradbury is correct to note that toward the end of the negotiation process for a particular FA, it is typical that only one or two teams remain in the hunt.

But the threat of another team coming into the negotiation process at the ele-
venth hour suggests that competitive forces continue to lurk in the background
up to the final inking of the contract.

8. Continuing with the issue about smallness of number discussed in #7 above, it is
    not clear that Bradbury is accurately accounting for all of the available FAs,
    both in total and at each position. Bradbury posits that the FA market is typified
    by only about 100 FAs who sign new contracts with the 30 teams. In fact, the
    proper supply in this FA market is all "potential" FAs not just those who ulti-
    mately signed new contracts. Many potential FAs re-sign with their teams
    before hitting the FA market, while many others are left behind to reenter the
    market via Minor League contracts. Using the more proper designation "poten-
    tial FAs," the numbers are quite a bit thicker than that reported in Bradbury. For
    example, in 2010, there were 177 potential FAs spread across the different posi-
    tions in the following manner: 13 first basemen, 14 second basemen, 11 short-
    stops, 11 third baseman, 21 catchers, 26 outfielders, 8 designated hitters, 31
    starting pitchers, and 42 relief pitchers. When looked at in this context, the scope
    and depth of this labor market is quite a bit more competitive than that implied
    by Bradbury.

Concluding Remarks

On the surface, it appears that our discipline has two diametrically opposed methods of
estimating the value of a player: the Scully approach (which meticulously reassembles
MRP from its component pieces) and the free-market approach (which simply
assumes efficient and competitive labor markets). In point of fact, these two methods
are not competing nor is one necessarily superior to the other. Each method has its own
merits in terms of answering different types of questions related to a player's value. If
one is interested in understanding what determines a player's salary or whether the
arbitration process is racially blind—then the free-market approach is warranted. But
if one is interested in the efficiency consequences of a new long-term contract or
whether a player "earned" his salary—then the Scully approach is warranted.

The distinction between ex ante and ex post determinants of salary goes a long
way helping us understand many of the controversial player signings debated in the
sports media. For example, in 2010, the New York Mets signed Jason Bay to a
4-year, $66 million contract. According to the *Baseball Prospectus*, Bay was pro-
jected to hit 28 homeruns and 95 runs-batted-in (RBIs) in 2010, for a Wins Above
Replacement Player (WARP) of 3.2. Given these expectations, Bay appeared to
merit the $16.5 million he was to be paid in 2010. Completely unforeseen, however,
was that Bay's season came to an abrupt halt in late July due to a concussion. Not
surprising, his ex post performance statistics were rather dismal—6 homeruns, 47 RBIs,
and a WARP of only 0.7. While the Bay signing was applauded by the New York media
when he signed the contract in February, by the end of August, the media characterized
his signing as just another bust in the long and tortured history of Mets.

Declaration of Conflicting Interests

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