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

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Abstract

Krautmann contends that Scully's method for estimating the marginal revenue products of baseball players using team revenues is flawed. Krautmann suggests an alternate method that uses free-agent salaries to impute players' revenue contributions. The Scully method has its weaknesses; however, its flaws are not as serious as Krautmann claims. Though Krautmann's free market returns method offers a useful approach for estimating players' marginal revenue products, it suffers from deficiencies that the Scully method avoids; thus, it is not necessarily superior to revenue-based estimates.

Keywords

marginal revenue product, baseball, salary

Introduction

In 1974, Gerald Scully published his seminal paper "Pay and Performance in Major League Baseball," which presented a method for estimating the marginal revenue products of baseball players. The paper was novel not only for its valuing of professional athletes but also for providing the first actual estimates of worker marginal

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revenue products in any field. The Scully technique employs a multiple-step method for calculating player marginal revenue products: estimate the relationship between team performance and revenue, estimate the impact of individual performance on team performance, and then use the estimates from the first two steps to produce marginal revenue product estimates for individual players. The framework of this simple and straightforward approach has been used by economists on many occasions.[1]

In 1999, Anthony Krautmann published a paper titled "What's Wrong with Scully-Estimates of a Player's Marginal Revenue Product," which presents a critique of Scully's model and offers an alternate method for estimating marginal revenue products. Krautmann states that "Applications of the Scully method have led to confusing, and sometimes conflicting, conclusions as to the extent to which players are compensated" (p. 370). He argues that Scully estimates are too high and weakly correlated with free-agent salaries. However, Krautmann's main contribution is presenting an alternative estimation technique, which he calls the "free market returns approach."

The free market returns approach uses the free-agent market to price player performance based on the salaries that free agents receive upon signing contracts. The values are then applied to other players' performances according to the measured impact of metrics included in a regression model to generate marginal revenue product estimates. Krautmann explains that "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" (p. 373). If the market is efficient, then the outcomes should contain information about the value of players, including nonpublic information regarding club finances that are a closely guarded secret. This is an important advantage over the Scully model, which must rely on unofficial estimates of team revenue.

The Krautmann method is not without its own problems nor is it necessarily superior to the Scully method. This article notes the advantages and disadvantages of both methods. In particular, I highlight the disadvantages of the Krautmann method, which has not received a formal critique since its initial publication. In this article, I use the term "Scully method" to refer to all revenue-based estimation methods and the term "Krautmann method" to refer to any method that uses free-agent salaries to estimate marginal revenue products. Though the original models may suffer from some flaws, I concentrate the analysis on the general methods in order to serve as a guide for future researchers who may employ versions of these techniques.

What Is Wrong With Scully Estimates

Krautmann's first indictment of the Scully method is that its marginal revenue product estimates are too large—five to six times the wages of free agents—relative to actual salaries earned by free agents. The disparity between his estimates and

free-agent salaries was not unnoticed by Scully (1989), but he interpreted the spread as evidence of owner collusion to suppress salaries. This was a reasonable conclusion considering that at the time of Scully's writing, Major League Baseball was in the midst of losing several arbitration cases for colluding to depress salaries.[2]

Krautmann roughly replicates Scully's method to examine players in the early 1990s, when collusion was not the problem it was in the mid-1980s when Scully last employed his technique. Because the spread persists in an era in which there was no documented collusion, Krautmann argues that a flaw in the model is the likely explanation for the disparity instead of collusion. In an attempt to rescue the Scully model, Krautmann correctly suggests that using total revenue as a dependent variable overstates individual player revenue contributions. A portion of team revenues are derived from centrally shared league revenue—most of which comes from national television contracts—that are unaffected by individual team performance; therefore, differences in player performances do not affect this revenue stream and should not be used to calculate marginal revenue products. Krautmann finds that estimates based on turnstile revenue reduce the spread between salaries and Scully estimates; however, the remaining difference is still too large to be consistent with competitive pressure offered by the free-agent market. In addition, even if the correction erased the disparity, teams do generate team-specific revenue from contributions beyond ballpark attendance through local broadcast rights, sponsorships, and so on. Marginal revenue product estimates ought to measure such contributions; and thus, it is a bad sign that the model continues to produce such high estimates.

An alternate explanation for Krautmann's identified spread is that it is the product of a unique sample or the regression is not properly specified. Using an updated Scully-inspired approach, Bradbury (2007a) estimates that free-agent hitters earned salaries 8% less than their estimated marginal revenue products at the median. Bradbury (2010) uses a more detailed approach to find hitters earning 13% less than their estimated marginal revenue product at the median.[3] Bradbury's Scully estimates do not differ significantly from free-agent salaries, and the disparity is much smaller than the disparity measured by Krautmann. Krautmann's specification choice differs considerably from Scully's and Bradbury's models; therefore, it appears that Krautmann's estimated spread is not an inherent problem of the Scully method.

The second alleged failure of the Scully model is that the estimates do not square with free-agent salaries. Citing Zimbalist (1992), Krautmann notes the correlation between free-agent wages and his marginal revenue product estimates—generated using the Scully method as a guide—is not strong. Zimbalist describes the correlation as not being "particularly impressive;" however, this conclusion is wrong for two reasons.

First, as Krautmann correctly notes, Zimbalist's "incremental method" for estimating player marginal products is seriously flawed because it erroneously assigns negative marginal products to players. Therefore, it is unclear how useful the correlation is between Zimbalist's revenue-based estimates and salaries.

Second, Zimbalist finds that his marginal revenue product estimates and service time explain between 42% and 54% of the variance in salaries across players. Krautmann's own Scully estimates explain between 40% and 53% of the variance in salaries across free agents.[4] Explaining half or less of the variance may seem unimpressive; however, when compared to the stability of player performance, the fit is acceptable. Teams sign free agents with ex ante expectations about how players will perform. Bradbury (2008) reports that the season-to-season performance correlation explains between 43% and 45% of the variance from one season to the next—a magnitude similar to the percentage variance in salaries that is explained by performance.[5] Teams sign free-agent players after forming expectations about how a player will perform over the contract term based on past performance. Because performance fluctuates considerably, pegging salaries to actual future performance is difficult; thus, performance should not be expected to be perfectly correlated with salaries.[6] It turns out that the correlation between salary and marginal revenue product that Krautmann observes is consistent with the expected variance in player performance. In this light, contrary to the assertions of Zimbalist and Krautmann, the correlation between Scully estimates and salaries is impressive.

A final weakness of the Scully method that Krautmann does not specifically emphasize is that it relies on team revenue data, which Major League Baseball teams do not openly share. In few instances, some financial data have been released; however, accounting practices likely distort the financial reality. Therefore, revenue-based marginal revenue product estimates must rely on unofficial revenue estimates. The Krautmann method offers a way to estimate invisible revenue streams; therefore, even if the Scully method survives Krautmann's critique, the free market returns approach may still be a superior alternative.

What Is Wrong With Krautmann Estimates

The key assumption that underpins the Krautmann method is that competition in the free-agent market will cause wages to approximate marginal revenue products. Indeed, Krautmann acknowledges that the lack of competition means that salaries will not equate marginal revenue products.

> If, on the other hand, the market structure determining free agent salaries 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, [the predicted value] should be interpreted as what the player could have received if he were not indentured by the reserve clause—that is, and estimate of his market value. (p. 374–375)

Krautmann states that the lack of collusion and growth of player salaries indicates that free-agent market appears to be competitive, and thus free-agent wages should approach player marginal revenue products.[7] But even in a market for free agents that does not explicitly restrict salaries, economists studying baseball's labor market

have argued that player salaries may fall below the revenue that players generate due to the availability of substitutes. Scully (1974) states that "Certain factors, such as the availability of close substitute players, affect the outcome of the negotiation" (p. 916). In his seminal article on baseball's labor market, Rottenberg (1956) argued that the existence of substitute players affects teams' willingness to pay for players:

> while each player has a monopoly to his own services, he is not truly unique, and there are more or less good substitutes for him. His salary is therefore partially determined by the difference between the value productivities and the costs of other players by whom he may be replaced. (p. 253)

Similarly skilled free agents likely compete against one another for slots on desirable teams to depress wages. But, the most important feature of baseball's labor market is that below-market wages earned by players with less than 6 years of service create a talent pool of cheap substitutes for free agents. Even though some major league free agents may be superior to replacements available at monopsony-depressed wages, lower salary costs make the replacements desirable to teams. For example, a marginal everyday outfielder might have to compete with a platoon of top-tier minor league players who would take turns batting against opposite-handed pitchers.[8] The added production of the free-agent outfielder might be worth more revenue to the team—and justify a commensurate salary—but the wages earned by replacements being paid artificially restricted salaries may be more attractive to the team. Therefore, even though the free agent might be superior to the replacement platoon, the availability of low-wage substitutes gives teams bargaining power to dampen free-agent wages. While the best free agents have few substitutes, less-skilled free agents may have their salaries significantly impacted by the availability of reserved players. Thus, competition between players may cause free-agent salaries to underestimate the revenue contribution of free-agent players.

Another problem with using free-agent contracts to estimate marginal revenue products is that players often agree to contracts below their expected revenue-generating potential in return for in-kind compensation or insurance. Players frequently sacrifice pecuniary wages to play for a hometown or winning team. For example, Chris Bosh, LeBron James, and Dwyane Wade all accepted below-market offers to play for the Miami Heat in order to form a core of All-Star players capable of winning a National Basketball Association (NBA) championship.

A similar common discount occurs when players accept long-run contracts that pay them less than their expected annual worth as a form of insurance against injury. For example, a free agent who is expected to be worth $10 million a year might accept a guaranteed 3-year $21 million deal, as opposed to three successive 1-year $10 million deals, because he is risk averse. Such discounts in market prices will cause the Krautmann's method to impute marginal revenue products below their true level.

The use of market salaries to value performance is also problematic in light of recent research identifying the mispricing of professional athletic talent. In his

popular book, *Moneyball*, Lewis (2003) uses anecdotes to explain how the Oakland A's exploited labor market inefficiencies to win games on a small budget. Hakes and Sauer (2006) verify one hypothesis put forth in *Moneyball* that teams were undervaluing on-base percentage relative to slugging average (SLG). Economists have also identified pricing mistakes in basketball. Berri, Schmidt, and Brook (2006) identify that NBA teams overpay players for scoring. The Krautmann method is unable to identify such inefficiencies and will incorporate them into the estimates. The Krautmann method is tautological in respect to prices—it assumes that market prices are correct—therefore, it is problematic to evaluate the accuracy market prices using this method. Without estimates based on objective fundamental values, economists do not have a benchmark to identify mispricing of athletic talent.

All the above factors are exacerbated by the small size of the free-agent market. Most labor markets include thousands of employers hiring from a labor pool that includes many more thousands of potential employees. Thirty teams typically sign just over 100 players to free-agent contracts each year.[9] This may seem like a sufficient number of observations until considering the different roles players have and the few slots each team has available. There are eight fielding positions, a designated hitter, starting pitchers, and relief pitchers. In addition, there are roster spots for pinch hitters, exceptional fielders, and left-handed specialists. Player roles are not clearly defined and may change over time. It is often the case that there are only a few teams chasing after a particular free agent. The regression equation Krautmann employs uses only a few control variables; therefore, the coefficients may be capturing information from important omitted variables.[10] And because the factors that connect players and teams may be unique, capturing their impacts in an expanded regression estimation with so few degrees of freedom may be difficult.

Several studies that have employed the Krautmann method have measured a linear relationship between performance and revenue, such as Krautmann (1999), Krautmann, Gustafson, and Hadley (2000, 2003). However, Bradbury (2007a) and Bradbury (2010) find an increasing relationship between performance and revenue. The increasing relationship likely reflects two factors: the demand to watch a winning team and that high-win teams typically collect a share of postseason revenue.[11]

The nonlinear relationship has profound implications for estimating player marginal revenue products for both the Krautmann and the Scully methods. Both the methods have been used to estimate the impact of performance on revenue as linear functions, but the increasing returns have a greater impact on the Krautmann method. If winning teams sign the top free agents—and they have the incentive to do so because they earn higher returns than losing teams—then linear translations to value less-skilled players or teams on inferior teams will overvalue player contributions. For example, Bradbury (2010) demonstrates that 2008-2009 free agent C. C. Sabathia was worth 50% more to the New York Yankees—who won 89 games in 2008—than to the average major league team. Conversely, if the market is dominated by less-skilled players being signed by weak teams, then linear imputations for excellent players will undervalue their marginal revenue products. Though linear

Scully estimates will also improperly value performance, any bias to the estimates is less severe, because the estimates are not tied to free-agent contracts, which are signed by teams on different portions of the revenue function. No matter the method, care should be taken to account for the nonlinear relationship between winning and revenue when estimating marginal revenue products.

All but one of the factors above suggest that using free-agent salaries to estimate marginal revenue products likely underestimates the financial worth of players. Some evidence of downward bias exists in Krautmann's imputed estimates of arbitration-eligible players. Krautmann (1999) finds that arbitration-eligible players earn salaries roughly commensurate with their marginal revenue products. Krautmann et al. (2000) finds that arbitration-eligible players actually earn more than their marginal revenue products. These findings violate the fundamental assumption of the free market returns approach that teams are managed by rational and knowledgeable agents. No team should offer arbitration to a player whom it could release and sign as a free agent at a lower wage. The collective bargaining agreement explicitly disallows comparisons to players with no more than one additional year of service time in arbitration hearings.[12] A 6-year arbitration-eligible player can compare himself to free agents, but the comparison is tempered by below-market nonfree–agent salaries to whom his team will no doubt compare him. Fifth-, fourth-, and "super-two" third-year players can only compare themselves to players who have their salaries restricted by the collective bargaining process. Thus, the arbitration rules make it unlikely that arbitration-eligible players would typically earn salaries approaching or exceeding their marginal revenue products.

Furthermore, if teams do pay arbitration-eligible players salaries equal to or greater than their revenue-generating potential, this contradicts the notion that teams rationally value players according to their marginal revenue products. This result undermines the entire Krautmann approach because rational valuation of player performance by teams is the key assumption that justifies the free market returns approach. Thus, it appears likely that past studies using the Krautmann method underestimate the value of free agents as expected.

In summary, though the Krautmann method avoids having to rely on team revenue estimates by using market-determined free-agent wages, the market prices on which the Krautmann model depends may not properly reflect players' true marginal revenue contributions. The availability of cheap substitutes, players' willingness to accept discounts for nonpecuniary wages and reduce risk, past evidence of inefficiency in professional sports labor markets, limited competition for player services, and the nonlinear relationship between performance and revenue call into question the assumption that the free-agent market can be used to estimate marginal revenue products. The fact that the Krautmann method yields estimates far lower than Scully estimates does not mean that they are necessarily more correct. In fact, there are reasons to believe that the Krautmann method underestimates players' marginal revenue products.

Discussion and Conclusion

Krautmann (1999) provides a useful method for estimating players' marginal revenue products. Rather than being a superior alternative to the Scully method, it should be acknowledged that it possesses some advantages over Scully's revenue-based method. The most attractive feature of the Krautmann method is that it captures the private information of decision makers in baseball front offices, who have the knowledge and incentives to properly value baseball talent. In this sense, the free-agent market possesses a characteristic similar to prediction markets that economists are using with increasing frequency to capture hidden information. However, players' willingness to accept wages less than their marginal revenue products, the potential lack of competitiveness of the free-agent market, and the nonlinear relationship between winning and revenue means that player salaries may not properly mirror marginal revenue products.

One particularly useful aspect of the Scully method is that it can spot market inefficiencies, which are known to exist in professional sports labor markets. The Krautmann method is less capable of spotting pricing mistakes, especially in a market where consistent mistakes can generate bubbles. As a practical matter, general managers, player agents, and arbitrators must use revenue-based estimates to estimate the fundamental value of player performance separate from market value.

Though the analysis presented in this essay has been mostly critical of the Krautmann method, I do not believe that the free market returns approach is impotent. To the contrary, connecting marginal revenue products and free-agent salaries is a novel approach to valuing players, which may help capture nonpublic information regarding how teams value players. Furthermore, Hakes and Sauer (2006) and Bradbury (2007b) find that baseball's labor market is largely governed by rational and informed decision making; therefore, the estimates do contain useful information that should be used by researchers seeking to better understand baseball's labor market.

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Notes

1. Sommers and Quinton (1982), Zimbalist (1992), Bradbury (2007a, 2010).
2. The owners would also later agree to settle collusion allegations for 2002 and 2003 as a part of the 2006 Collective Bargaining Agreement.

3. Bradbury (2007a) uses on-base percentage and SLG to estimate player marginal products. Bradbury (2010) uses linear weights, which weights individual baseball events according to expected run production, to more precisely measure players' offensive contribution. Both the models use revenue estimates from *Forbes* ''The Business of Baseball Report'' to estimate the nonlinear impact of output on revenue. The difference between the marginal revenue product estimates and free-agent salaries in both the models is within 1 *SD* of free-agent salaries.
4. Calculated by squaring the reported correlation coefficients.
5. Correlations were calculated using Krautmann's performance metric SLG and Zimbalist's metric on-base-plus-slugging, erroneously referred to as ''PROD.''
6. Though I do not examine the phenomenon in this article, if performance variance affects expectations of long-term performance, then players with more stable performances should sign longer term contracts.
7. ''If this market is as competitive as it appears to be, the wages of free agents likely reflects marginal revenue products'' (Krautmann, 1999, p. 376).
8. The common practice of rotating players according to whose hand dominance is the opposite of the pitcher is known as platooning. Because players hit better against opposite-handed pitchers, a platoon of inferior players may perform as well as a superior player who takes some plate appearances from same-handed pitchers. A disadvantage of platooning is that it requires two roster spots on the 25-man roster.
9. From 2006 to 2008, on average, 54 pitchers and 58 position players signed major league contracts as free agents. (Source: ESPN Free Agent Tracker, various years, http://sports.espn.go.com/mlb/features/freeagents).
10. Krautmann does attempt to control for different roles interacting position identifiers for catchers and shortstops with the SLG. He also uses a vector of team dummies (referred to as ''fixed effects'') in an attempt to capture aspects unique to each team.
11. While the increasing relationship does not level off within the range of the sample, it is likely that increasing returns will not go on forever. The maximum wins in the sample (the 2004 St. Louis Cardinals) had 105 wins. Diminishing returns to winning likely exist but above a level that teams rarely reach. For the purpose of estimating player marginal products, the hypothetical diminishing returns portion of the revenue function is not relevant because teams not experiencing diminishing returns will outbid teams that do.
12. ''The arbitration panel shall, except for a Player with 5 or more years of major league service, give particular attention, for comparative salary purposes, to the contracts of Players with major league service not exceeding one annual service group above the Player's annual service group'' (2007-2011 Basic Agreement, p. 18).

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Erratum

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The endnotes in Bradbury (2013) were inadvertently missed from the manuscript. Following are the endnotes, which are also available at http://jse.sagepub.com/supplemental.

ENDNOTES

1. In truth, a more appropriate title for this paper could have been "An Alternative to the Scully Approach to Estimating a Player's Marginal Revenue Product." Apologies to Gerald Scully (RIP).
2. The first-order condition of expected profit maximization specifies that the competitive firm equates expected MRP to the price of the input, hence the motivation for using the wage to approximate MRP. Unless there exist exists systematic bias in the models used to predict the player's marginal value, the forecast errors should be white noise.
3. While the actual method used by Forbes to estimate team revenues is proprietary, vague references to their methodology did appear many years ago when Financial World was publishing this data. Here it was implied that the estimates were derived from simple marketing models, with ad hoc adjustments made in recognition of legal and public commitments (e.g., lucrative stadium contract clauses, locally mandated financial stipulations).
4. The regression model run is $TR = \alpha + \beta 1 WINS + \beta 2\ WINS2 + \beta 3\ POP$, where WINS is total number of wins, and POP is the MSA population. The sample used corresponds to the 1999 and 2000 seasons. Other specifications tried included a dummy variable for teams making the playoffs. Empirical results are available from the author upon request.
5. Sabermetricians have gone to great length to devise metrics attempting to measure the value of a player relative to the alternative player who would have been hired instead (e.g., VORP, WARP, Batter-Fielder Win.). Many of these metrics assume that the replacement player is the average player at the same position.

6. Some studies control for the starter vs. utility player effect by including dummy variables for utility players; other times, this is achieved by segmenting the dataset according to starters vs. utility players. In Krautmann (1999), the wage equation includes AB per year to capture whether the player is a starter or utility player.
7. The surplus is defined as (MRP – WAGE), the difference between the player's (estimated) MRP and his wage.
8. These wage factors include a measure of the player's expected marginal product (above his replacement player), his age, the market size of his signing team, and controls for both primary position and whether he is a starter or utility player. The empirical results are available on request from the author.