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# An Economic Evaluation of the *Moneyball* Hypothesis

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In his 2003 book *Moneyball,* financial reporter Michael Lewis made a striking claim: the valuation of skills in the market for baseball players was grossly inefficient. The discrepancy was so large that when the Oakland Athletics hired an unlikely management group consisting of Billy Beane, a former player with mediocre talent, and two quantitative analysts, the team was able to exploit this inefficiency and outproduce most of the competition, while operating on a shoestring budget.

The publication of *Moneyball* triggered a firestorm of criticism from baseball insiders (Lewis, 2004), and it raised the eyebrows of many economists as well. Basic price theory implies a tight correspondence between pay and productivity when markets are competitive and rich in information, as would seem to be the case in baseball. The market for baseball players receives daily attention from the print and broadcast media, along with periodic in-depth analysis from lifelong baseball experts and academic economists. Indeed, a case can be made that more is known about pay and quantified performance in this market than in any other labor market in the American economy.

In this paper, we test the central portion of Lewis's (2003) argument with elementary econometric tools and confirm his claims. In particular, we find that hitters' salaries during this period did not accurately reflect the contribution of various batting skills to winning games. This inefficiency was sufficiently large that knowledge of its existence, and the ability to exploit it, enabled the Oakland Athletics to gain a substantial advantage over their competition. Further, we find

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that, even while various baseball interests denounced Beane and Lewis as charlatans in a stream of media reports, market adjustments were in motion (for discussion, see Lewis, 2004; Craggs, 2005). These adjustments took place around the time Lewis's book was published, and with sufficient force that baseball's labor market no longer exhibits the *Moneyball* anomaly.

Because sports often embody situations where choices are clear and performance and rewards are measurable, they generate useful conditions for studying the behavior of market participants. There are many examples. McCormick and Tollison (1986) use variation in fouls from basketball games to illustrate how the likelihood of punishment affects crime. Brown and Sauer (1993a, 1993b) used point spreads for professional basketball games to consider the influence of psychology and information on market prices. Studies find that the behavior of soccer players conforms well with game-theoretic predictions of equilibrium behavior in penalty kick situations (Chiappori, Levitt and Groseclose, 2002). Moreover, in laboratory experiments that are analytically similar to penalty-kick situations (but not described in a soccer context) soccer players act as predicted, whereas students from the general population do not, highlighting the relevance of experience in natural settings to results in the lab (Palacios-Huerta and Volij, 2006).

The present paper depicts a particularly clear case of mispricing in the baseball labor market, accompanied by successful innovation and subsequent adjustment in market prices. Although reasons for the failure of efficient pricing are not fully understood, it seems clear that the correction in market prices was tied to the diffusion of knowledge, as competing franchises mimicked the Athletics' strategy, in part by hiring Beane's chief assistants away from the Oakland organization.

## Measures of Offensive Productivity in Baseball and their Contribution to Winning

### Measures of Batting Skill

A Major League Baseball game consists of nine scheduled innings, in which each team has an opportunity to score runs on offense in its half of each inning. The team on offense is limited to three outs per inning, after which play and scoring cease. Play then resumes with the opponent taking its turn at bat. The limit on outs is crucial. Scoring runs is the objective of the team at bat, and this is accomplished by a combination of skills: in particular, skill at hitting the ball and the ability to avoid making an out.

The most common measure of batting skill is the *batting average*, which is the ratio of hits to total at-bats. The batting average is a crude index. By weighting singles and home runs the same, it ignores the added productivity from hits of more than a single base. Much better is the *slugging percentage*, which is total bases divided by at-bats, so that doubles count twice as much as singles, and home runs twice as much as doubles.

Nevertheless, both the batting average and slugging percentage ignore potentially relevant dimensions of batter productivity. When baseball statistics are calculated, sacrifices and walks are not counted as official at-bats, and so they do not figure into either batting average or slugging percentage. In particular, since a fundamental element of batting skill is the ability to avoid making an out, the failure to account for walks is a serious omission. Hitting a single leads to a higher batting average, and receiving a walk doesn't show up in batting average, but in both cases the batter ends up at first base. The statistic that takes walks into account is called *on-base percentage*, which is defined as the fraction of plate appearances (including both official at-bats as well as walks) in which the player reached base successfully through either a hit or a walk.

Members of the Society for American Baseball Research (SABR) have studied a variety of combinations of on-base percentage and slugging percentage in the hope of generating a single statistic that will capture a batter's contribution. It has long been known among this group, dubbed sabermetricians, that linear combinations of these two percentages are very highly correlated with runs scored, the primary objective of an offense. The essence of the *Moneyball* hypothesis is that the ability to get on base was undervalued in the baseball labor market.

**Contribution to Winning**

We use linear regression analysis to confirm that on-base percentage is a powerful indicator of how much a batter contributes to winning games. In Table 1, the dependent variable in the regression is the team's winning percentage. The data for these calculations are performance data over five seasons from 1999 to 2003. Column 1 of Table 1 shows that looking only at a team's own on-base percentage and the on-base percentage of its opponent can explain 82.5 percent of the variation in winning percentage. Column 2 shows that looking only at a team's own slugging percentage and the opponent's slugging percentage can explain 78.7 percent of the variation in winning percentage. Column 3 incorporates both measures of batting skill, which improves the explanatory power of the regression to 88.5 percent of variance. The coefficients on skills for a team and its opponents are quite close to each other, as would be expected in a two-sided symmetric game.[1] This is to be expected given the well-documented high correlation between runs scored and linear combinations of on-base and slugging percentage.

The final column of Table 1 is used to assess *Moneyball's* claim (Lewis, 2003, p. 128) that, contrary to then-conventional wisdom, on-base percentage makes a more important contribution to winning games than slugging percentage. To facilitate the comparison, the "on-base" and "on-base against" coefficients are restricted to be the same, as are the "slugging" and "slugging against" coefficients. The coefficients in this regression for on-base percentage are more than twice as large as the coefficients for slugging, which supports Lewis's claim. A one-point

[1] Similar results are obtained using a team's Earned Run Average, a measure of the runs given up by a team's pitchers, as a measure of the quality of a team's pitching and its defensive ability.

*Table 1*
**The Impact of On-Base and Slugging Percentage on Winning**

| | Model | | | |
|---|---|---|---|---|
| | *1* | *2* | *3* | *4* |
| Constant | 0.508 | 0.612 | 0.502 | 0.500 |
| | (0.114) | (0.073) | (0.099) | (0.005) |
| On-Base | 3.294 | | 2.141 | 2.032 |
| | (0.221) | | (0.296) | (0.183) |
| On-Base against | −3.317 | | −1.892 | $-2.032^R$ |
| | (0.196) | | (0.291) | |
| Slugging | | 1.731 | 0.802 | 0.900 |
| | | (0.122) | (0.149) | (0.106) |
| Slugging against | | −1.999 | −1.005 | $-0.900^R$ |
| | | (0.112) | (0.152) | |
| Number of observations | 150 | 150 | 150 | 150 |
| $R^2$ | .825 | .787 | .885 | .884 |
| Hypothesis test of model 4, $H^0$: On-Base = Slugging | | | | |
| $F(1, 147) = 16.74$, $p$-value = 0.0001 | | | | |

*Source:* Retrosheet Game Logs, ⟨http://www.retrosheet.org⟩. The data were obtained free of charge from, and are copyrighted by, Retrosheet, 20 Sunset Rd., Newark, DE 19711.
*Notes:* Data are aggregate statistics for all 30 teams from 1999–2003. Coefficient estimates were obtained using ordinary least squares. Coefficients for annual 0/1 dummy variables are suppressed. Standard errors are in parentheses. Superscript "R" indicates that the coefficient was restricted to equal its counterpart in the regression. The $p$-value for the null hypothesis that restrictions are valid is 0.406 ($F$ = 0.52).

change in a team's on-base percentage makes a significantly larger contribution to team winning percentage than a one-point change in team slugging percentage.

## The Labor Market's Valuation of Skill and the Athletics' Management Strategy

### Wages in Major League Baseball

We now turn to the question of the labor market's valuation of batting skills. Table 2 presents summary statistics on wages for position players (nonpitchers) during the five seasons spanning 2000–2004. The average wage for position players increased over the sample period, from $2.56 million to $3.32 million, with the figure for 2004 slightly lower than the prior year. Home run hitters, defined as those with more than 25 homers in a season (roughly one standard deviation above the mean), earn $3 million to $4 million more than the average player.

### Valuation of Batting Skill in Baseball

An efficient labor market for baseball players would, all other factors held constant, reward on-base percentage and slugging percentage in the same propor-

*Table 2*
**Major League Baseball Salaries 2000–2004**
*(millions of current dollars)*

| *Summary Statistic* | *2000* Salaries | *2000* N | *2001* Salaries | *2001* N | *2002* Salaries | *2002* N | *2003* Salaries | *2003* N | *2004* Salaries | *2004* N |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 2.56 | 354 | 3.02 | 358 | 3.16 | 346 | 3.46 | 344 | 3.32 | 340 |
| 10th percentile | 0.25 | | 0.25 | | 0.26 | | 0.32 | | 0.32 | |
| Median | 1.45 | | 1.61 | | 1.80 | | 1.56 | | 1.25 | |
| 90th percentile | 6.40 | | 7.50 | | 8.00 | | 9.12 | | 9.00 | |
| *Sample Means* | *Salaries* | *N* | *Salaries* | *N* | *Salaries* | *N* | *Salaries* | *N* | *Salaries* | *N* |
| HR > 25 | 5.57 | 60 | 6.43 | 62 | 7.34 | 53 | 8.12 | 50 | 7.96 | 53 |
| HR < 14 | 1.46 | 202 | 1.53 | 200 | 1.77 | 211 | 1.96 | 204 | 1.78 | 197 |
| Catchers | 1.88 | 46 | 2.13 | 48 | 2.16 | 50 | 2.73 | 45 | 2.46 | 48 |
| Infielders | 2.19 | 126 | 2.69 | 130 | 2.67 | 126 | 2.78 | 120 | 2.61 | 116 |
| First basemen/ DHs | 3.15 | 55 | 3.94 | 48 | 4.65 | 50 | 4.44 | 50 | 4.00 | 52 |
| Outfielders | 2.93 | 127 | 3.34 | 132 | 3.48 | 120 | 3.98 | 129 | 4.03 | 124 |

*Source:* Performance and position from the Lahman database v. 5.1, ⟨http://www.baseball1.com⟩. Salaries and labor market status from Doug Pappas, ⟨http://roadsidephotos.sabr.org/baseball/data.htm⟩.
*Notes:* Salary data for all position players with more than 130 at-bats in a season. HR stands for home runs, thus 60 players hit more than 25 home runs in 2000. DHs stands for designated hitters.

tions that those statistics contribute to winning. We assess this proposition by estimating earnings equations for position players (which means that we exclude pitchers) for the 2000–2004 seasons. The dependent variable is the logarithm of annual salary. All productivity variables are calculated based on performance in the prior year, because salary is generally determined prior to performance, and based on expected productivity given observed performance in previous years.[2]

All players with more than 130 at-bats in the previous season are included in the regressions, which is a fairly low hurdle since during a 162-game season, many players will have at least 500 official at-bats (not counting plate appearances that lead to walks and sacrifices).[3] The regression specification holds a number of other

[2] This approach economizes on data collection at the potential expense of precision. Since salary is a function of expected performance, variation in performance from the expected level is likely to increase as time passes from the contract date. Not knowing the date at which long-term contracts were signed is problematic when performance varies from its expected level. This concern is reduced to the extent that good hitters, sluggers and so on perform similarly from year to year. Note also that as long-term contracts introduce inertia to salary corrections, our regressions will tend to understate shifts in the returns to skill. Changes in returns to a particular skill dimension across time would occur more slowly in our sample than in a counterfactual sample populated exclusively with one-year contracts.

[3] A minimum of 130 at-bats is required for a player to qualify for honors as rookie of the year. This provides an objective cutoff so that we employ productivity measures exclusively for players with a relatively large sample of at-bats.

factors constant, following the categories used by Kahn (1993). The base category is for younger players who have limited power to negotiate for higher salaries under the collective bargaining agreement that governs baseball, and effectively face a monopsony employer of their labor. Players with more experience become eligible for salary arbitration, in which the team and player each propose a salary and the arbitrator must choose one of the positions, without splitting the difference. Players also eventually become eligible for free agency, which allows them to offer their services to all teams. The regression also includes a variable for playing time, as measured by plate appearances. It also adjusts for the fact that defensive skills are more important at certain positions by including indicator variables for players at the more demanding defensive positions of catcher and infielder (by which we mean second base, third base, or shortstop).[4]

The first column of results in Table 3 reports coefficient estimates from the log salary regression when all five years of data are pooled. All significant coefficients have the expected signs. Relative to younger players who have limited ability to negotiate their pay, players who are eligible for arbitration earn more, with an additional increment for players eligible to become free agents. We also obtain positive and statistically significant returns to expected playing time. The returns to on-base percentage and slugging are both positive, as expected. However, the coefficient for slugging on the income of a player is considerably larger than the coefficient for on-base percentage, which is the reverse of their importance to team success. This is consistent with *Moneyball's* claim that on-base percentage is undervalued in the labor market.

Columns 3 through 7 of Table 3 display parameter estimates for the same equation for each individual season. These results indicate that pooling is inappropriate, as labor market returns to player attributes differ across seasons. Figure 1 shows how the estimated returns to on-base percentage and slugging percentage evolve over this period. In the first four years of data, the slugging coefficients are all statistically significant and of similar magnitude, ranging between 2.05 and 3.10. In contrast, the on-base percentage coefficients are smaller than their slugging counterparts in each of these years, ranging between −0.13 and 1.36, and are not statistically significant.

Column 2 of Table 3 presents coefficient estimates when the first four seasons are pooled. The coefficient for slugging percentage is 2.45 and statistically significant, and the coefficient for on-base percentage is 0.84, and not statistically significant. A sense of the absolute magnitude of the premium for sluggers can be obtained for each year by evaluating the effect on salary of one-standard-deviation

[4] Productivity and positional data were obtained from the Lahman baseball database at the Baseball Archive at ⟨http://baseball1.com⟩. Data on salaries and labor market status were obtained from Doug Pappas' Business of Baseball data archive at ⟨http://roadsidephotos.sabr.org/baseball/data.htm⟩. We lack measures such as speed and fielding ability in our data. These are likely relevant in specific cases, but prior research results imply that our set of regressors accounts for the bulk of salary variation that can be systematically explained.

*Table 3*
**The Baseball Labor Market's Valuation of On-Base and Slugging Percentage**

| | *All Years* | *2000–2003* | *2000* | *2001* | *2002* | *2003* | *2004* |
|---|---|---|---|---|---|---|---|
| On-Base | 1.360 | 0.842 | 1.334 | −0.132 | 0.965 | 1.351 | 3.681 |
| | (0.625) | (0.678) | (1.237) | (1.230) | (1.489) | (1.596) | (1.598) |
| Slugging | 2.392 | 2.453 | 2.754 | 3.102 | 2.080 | 2.047 | 2.175 |
| | (0.311) | (0.338) | (0.628) | (0.613) | (0.686) | (0.850) | (0.788) |
| Plate appearances | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 | 0.003 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Arbitration eligible | 1.255 | 1.242 | 1.293 | 1.106 | 1.323 | 1.249 | 1.323 |
| | (0.047) | (0.048) | (0.102) | (0.100) | (0.100) | (0.111) | (0.115) |
| Free agency | 1.683 | 1.711 | 1.764 | 1.684 | 1.729 | 1.663 | 1.575 |
| | (0.044) | (0.185) | (0.096) | (0.092) | (0.097) | (0.107) | (0.105) |
| Catcher dummy | 0.152 | 0.185 | 0.137 | 0.065 | 0.208 | 0.343 | 0.059 |
| | (0.056) | (0.061) | (0.124) | (0.116) | (0.122) | (0.134) | (0.133) |
| Infielder dummy | −0.029 | −0.007 | 0.060 | 0.069 | −0.087 | −0.054 | −0.100 |
| | (0.040) | (0.044) | (0.087) | (0.083) | (0.086) | (0.095) | (0.098) |
| Intercept | 10.083 | 10.429 | 10.078 | 10.347 | 10.490 | 10.289 | 9.782 |
| | (0.170) | (0.178) | (0.360) | (0.321) | (0.358) | (0.387) | (0.414) |
| Observations | 1736 | 1402 | 353 | 357 | 344 | 342 | 340 |
| $R^2$ | 0.675 | 0.687 | 0.676 | 0.728 | 0.695 | 0.655 | 0.635 |
| *Value of one-standard-deviation increase (in millions of dollars)* | | | | | | | |
| On-Base | | | 0.14 | 0.16 | 0.17 | 0.19 | 0.49 |
| Slugging | | | 0.52 | 0.61 | 0.64 | 0.70 | 0.61 |

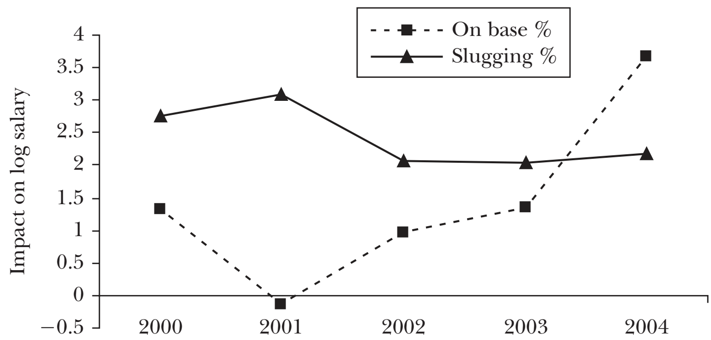
*Source:* Same as Table 2.
*Notes:* The dependent variable is ln(Salary) for year $t$, and performance variables are from year $t - 1$. 0/1 dummies for each year are included in the pooled regressions. Standard errors in parentheses. The sample includes all players with at least 130 plate appearances during the relevant season.

increases in slugging percentage and on-base percentage. These figures are listed in the last two rows of Table 3. The incremental salary impacts for slugging percentage in the first four years range from $0.52 million to $0.70 million and are three to four times as large as the incremental impact of a standard deviation increase in on-base percentage.

This finding contrasts with the evidence from Table 1, which indicates that swapping a small increment of slugging percentage in return for a small increment of on-base percentage would increase a team's winning percentage. The lack of a market premium for hitters with superior skill at the patient art of reaching base through walks validates the systematic approach taken by the Oakland Athletics in identifying such players, and thereby winning games at a discount relative to their competition.

The relative valuation of on-base and slugging percentage is abruptly reversed for the year 2004—and this result exists despite the inertia produced by long-term contracts. The salary returns to slugging are similar in 2004 to prior years, but 2004

*Figure 1*
**Labor Market Returns to On-Base and Slugging Percentage Over Time**




*Source:* Coefficient estimates from Table 2.

is the first year in which on-base percentage becomes statistically significant. The labor market in 2004 appears to have substantially corrected the apparent inefficiency in prior years, as the coefficient of on-base percentage jumps to 3.68, and the ratio of the monetary returns to reaching base and slugging is very close to the ratio of the statistics' contributions to team win percentage.

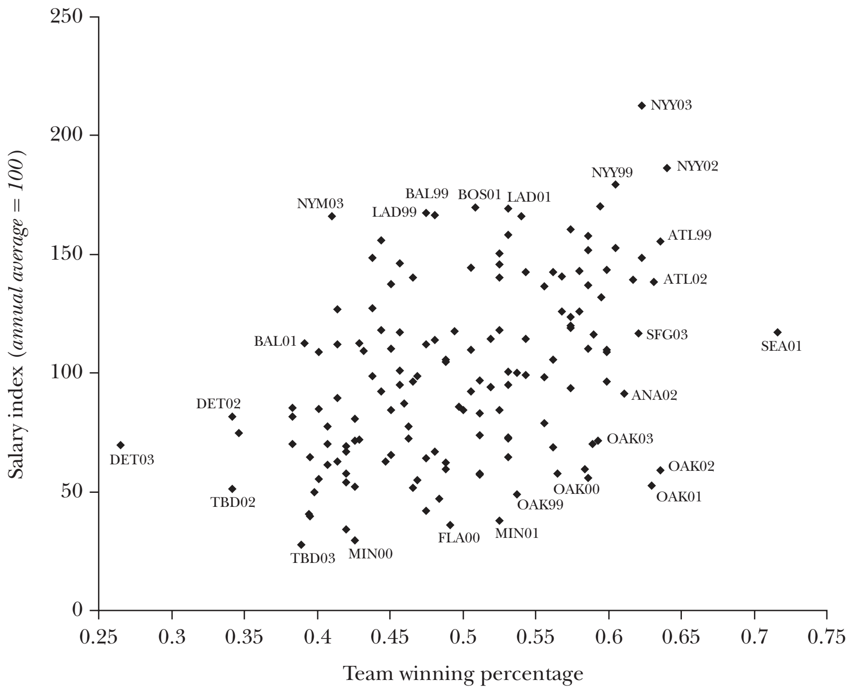
We have thus verified a central claim in *Moneyball* by showing that on-base percentage was undervalued at the beginning of the 2000–2004 period in Major League Baseball. There are two obvious caveats which should be addressed before accepting Lewis's argument completely. First, it might be that fans prefer watching sluggers, and that the allegation of mispricing confuses the ability to "win ugly," but unprofitably, with profit maximization. Second, the analysis thus far does not link the Oakland A's success to an explicit strategy capitalizing on the alleged mispricing of skill. We turn to these questions now.

**Efficiency and Management Strategy in the Oakland A's Personnel Decisions**

The Oakland Athletics' management strategy, as reported by Lewis (2003, p. 124) was to minimize the payroll required to build a team which would successfully contend for a playoff spot. Figure 2 is a scatterplot of team salaries and winning percentage which demonstrates the Athletics' ability to win "on the cheap." Because Major League Baseball salaries were increasing rapidly during this period, each team payroll is indexed to the league-wide average for that season. The points in the scatterplot which represent the Athletics teams (OAK99–OAK03) are tightly clustered in the bottom right corner of Figure 2, which is consistent with the Athletics' stated optimal combination of high winning percentage and low indexed team salaries.[5] Other teams along the "frontier" of efficiently converting payroll

[5] As discussed in Lewis (2003, xiii), the late Doug Pappas (at that time chairman of SABR's Business of Baseball Committee) was one of the first to examine the efficiency with which the Oakland A's went

*Figure 2*
**Frontier for Efficient Conversion of Team Salary into Team Winning Percentage, 1999–2003**




*Source:* Won-loss records from www.baseball-reference.com. Team salaries from SABR, ⟨http://businessofbaseball.com/data.htm⟩.
*Notes:* Teams near the frontiers of efficient and inefficient conversion are given a team–year label, with the last two digits indicating the year. Teams near the frontiers are Atlanta (ATL), Anaheim (ANA), Baltimore (BAL), Boston (BOS), Detroit (DET), Florida (FLA), Los Angeles Dodgers (LAD), Minnesota (MIN), Oakland (OAK), New York Mets (NYM), New York Yankees (NYY), Seattle (SEA), San Francisco Giants (SFG), and Tampa Bay Devil Rays (TBD). All years for Oakland are included.

into wins usually either failed to have enough on-field success to make the playoffs (like the 2003 Tampa Bay Devil Rays, 2000 Florida Marlins and 2001 Minnesota Twins), or, like the 2001 Seattle Mariners, were far better on the field than their nearest competition during the regular season. As the baseball labor market corrected in 2004, the Athletics remained near the frontier of salary efficiency, but their advantage was narrowed. Despite increasing their payroll to 86 percent of league average, they finished just behind the California Angels (now called the Los

about their business. Pappas calculated the incremental cost of winning a game during this period. Only two teams spent less than $1 million to win a game. The A's cost of about half a million dollars was the lowest, and about one-sixth the cost of the least efficient teams. Pappas (2002) discusses the calculation and provides cost estimates for all teams during the 2001 season.

Angeles Angels of Anaheim) in 2004, missing the playoffs for the first time since 1999.

In effect, the A's were able to purchase a successful team less expensively by focusing on players with a higher on-base percentage, chiefly players who excelled at receiving walks. Disciplined hitters avoid swinging at balls, forcing a pitcher to throw strikes to get an out. A team of disciplined hitters is rewarded in several ways. More walks occur, raising on-base percentage. A reputation for discipline causes pitchers on the other team to throw more pitches in the strike zone, which are easier to hit. Finally, patient hitters cause pitchers to throw a greater quantity of pitches, which raises the chance that a tiring pitcher will start to throw pitches that are easier to hit successfully.

The emphasis on taking walks is apparent in the Oakland A's aggregate batting statistics. They led the American League in walks in 1999 and 2001, were second or third in 2000, 2002 and 2004, and fifth in 2003 (as shown at ⟨http://www.baseball-reference.com/leagues/AL.shtml⟩). Coupled with the emphasis on walks in player development, this success suggests that an explicit strategy was being followed.[6]

Although the interpretation of the regression coefficients in Table 3 treats player skills as strictly fixed, observed skill is a combination of innate skill with team investment in player development. The A's strategy was carried out both in signing players and in coaching. In signing position players, Oakland looked for hitters who did not appear outstanding in batting average or slugging percentage, and thus who commanded only moderate salaries, but who made a substantial contribution to winning baseball games when on-base percentage and the ability to draw walks were taken into account. At the same time, the Oakland coaching staff preached the virtues of disciplined hitting and not swinging at bad pitches (or even at certain strikes that cross the plate in a way that would be hard to hit solidly). Third baseman Eric Chavez said: "The A's started showing me these numbers . . . how guys' on-base percentages are important. It was like they didn't want me to hit for average or for home runs, but walks would get me to the big leagues" (Lewis, 2003, p. 151). Miguel Tejada, who won the 2002 American League Most Valuable Player Award, was quoted as saying (presumably half-joking): "If I don't take twenty walks, Billy Beane send me to Mexico."

Personnel movements during these years illustrate that the Athletics were able to substitute new players to maintain team success when individual players became too expensive to keep. As one example, the A's had a player named Jason Giambi who won the Most Valuable Player award in the American League in 2000 for his hitting prowess. After the 2001 season, Giambi had enough major league experi-

[6] Although this article focuses on the valuation of batting talent, Oakland's quantitative strategy extended to pitchers as well. The current ace of the Oakland staff, Barry Zito, was passed over by both the Texas Rangers and San Diego Padres, who told him that he "didn't throw hard enough to make it in the big leagues" (Lewis, 2003, p. 221). Oakland's scouting department agreed, but Beane drafted Zito anyway, obtaining six years of excellent work at a bargain price from a pitcher who would win the Cy Young award as the best pitcher in the league.

*Table 4*
**Records, Attendance and Ticket Prices of the Oakland Athletics, 1997–2004**

| | | | *attendance* | | *Ticket Prices* | |
|---|---|---|---|---|---|---|
| *Year* | *Win–Loss record* | *League rank* | *Total attendance* | *Ratio to league avg.* | *$ per seat* | *Ratio to league avg.* |
| 1997 | 65–97 | 14 | 1,264,218 | 0.566 | 10.53 | 0.805 |
| 1998 | 74–88 | 10 | 1,232,343 | 0.536 | 10.58 | 0.713 |
| 1999 | 87–75 | 5 | 1,434,610 | 0.627 | 10.10 | 0.623 |
| 2000 | 91–70 | 2 | 1,603,744 | 0.764 | 11.35 | 0.631 |
| 2001 | 102–60 | 2 | 2,133,277 | 0.909 | 14.07 | 0.754 |
| 2002 | 103–59 | 2 | 2,169,811 | 0.983 | 14.94 | 0.779 |
| 2003 | 96–66 | 2 | 2,216,596 | 1.011 | 15.65 | 0.780 |
| 2004 | 91–71 | 5 | 2,201,516 | 0.941 | 16.49 | 0.804 |

*Source:* Attendance data from ⟨http://businessofbaseball.com⟩; ticket price data from ⟨http://teammarketingreport.com⟩.
*Notes:* Four teams make the playoffs each season: the division winners and the team with the next best record. The Oakland A's won the Western Division in 2000, 2002 and 2003, automatically qualifying for the playoffs.

ence to qualify for free agency. After making $4.1 million in 2001, Giambi signed a seven-year contract with the New York Yankees for $120 million dollars. Oakland made no serious effort to match this offer. However, by signing inexpensive players to replace the lost superstar with incremental improvements across several positions, the Athletics repeated as division champions in 2002, actually improving their season record by one win. The replacement of offensive production from a now-expensive Jason Giambi with an array of undervalued talent—notably high on-base percentage hitters Scott Hatteberg and David Justice—neatly encapsulates Lewis's argument, and ours.

### Winning the Oakland A's Way and Profit Maximization

Although a comprehensive analysis of revenues and costs for the Oakland franchise is beyond the scope of this paper, suggestive evidence is readily available that is consistent with the Athletics' strategy being both an on-field and financial success. Table 4 presents data on the Athletics' performance, attendance and ticket prices relative to the rest of the league from 1997 to 2004. In 1995, new ownership dismantled the team roster to cut costs, and performance declined. The low-budget strategy centering on on-base percentage was put in place at this time (Lewis, p. 58), and performance began to improve in 1999. The table makes it clear that the A's revenues were sensitive to performance: attendance increased sharply while average ticket prices rose as on-field success improved. Thus, while the Oakland organization focused on winning games cheaply, their improved performance increased demand. The evidence in Table 4 is fully consistent with our view that the Oakland strategy for winning games was a successful exploitation of a profit opportunity.

## Concluding Remarks

Our analysis supports the hypothesis that baseball's labor market was inefficient at the turn of the twenty-first century. Arguably, this mispricing of skill had been present for a sustained period of time, perhaps decades. Dodgers General Manager Branch Rickey—perhaps best-known for breaking the color barrier in baseball with Jackie Robinson—argued in print for the importance of on-base percentage during the 1950s, but he failed to win converts (Rickey, 1954; Schwartz, 2004, p. 59). Bill James, a pioneer among sabermetricians, published a series of statistical analyses of scoring beginning in the late 1970s, and came to a similar conclusion (Lewis, 2003, pp. 76–77; James, 1982).

Consistent with the vociferous objections of baseball insiders to the possibility that quantitative analysis could help guide team management, the sabermetric insights of Rickey, James and others were apparently ignored. James in particular grew frustrated that his careful work was dismissed by the game that was his passion: "'When I started writing I thought if I proved X was a stupid thing to do that people would stop doing X,' he said. 'I was wrong'" (Lewis, 2003, p. 93).

Apparently only Oakland executive Sandy Alderson read, absorbed and incorporated Bill James's analysis into an explicit organizational strategy (Lewis, 2003, p. 63, p. 142). To execute the strategy, Oakland reached outside baseball circles and hired two young Ivy League graduates with quantitative backgrounds to evaluate personnel.

Oakland's on-field performance, combined with their radical low-budget approach, exposed a flaw in the way personnel decisions were made in baseball. Once exposed (with the help of Lewis's best-seller), competitive forces were set in motion as teams sought to replicate or improve upon the A's formula. Oakland's competitors sought success by attempting to hire the personnel management team assembled by Alderson. The two Ivy Leaguers mentioned above were hired as General Managers (that is, as executives with authority over personnel decisions) by the Toronto Blue Jays and the Los Angeles Dodgers during and after the 2003 season (Saraceno, 2004). Although the Boston Red Sox failed in their attempt to hire both the Athletics' General Manager (Billy Beane) and Assistant General Manager, they followed Beane's advice by hiring the similarly inclined Theo Epstein, making him the youngest General Manager in baseball history (Shaughnessy, 2003). In addition, the Red Sox hired the dean of sabermetrics, Bill James himself, in an advisory capacity. The Red Sox proceeded to win the World Series in 2004.

This diffusion of statistical knowledge across a handful of decision-making units in baseball was apparently sufficient to correct the mispricing of skill. The underpayment of the ability to get on base was substantially if not completely eroded within a year of *Moneyball's* publication.

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