NORTH-HOLLAND

The Journal of Socio-Economics

Journal of Socio-Economics 31 (2002) 191–214

Instrumental versus bounded rationality: a comparison of Major League Baseball and the National Basketball Association

David J. Berri [a,*], Martin B. Schmidt [b,1]

[a] *Department of Economics, California State University-Bakersfield, 9001 Stockdale Highway, Bakersfield, California 93311, USA*

[b] *Department of Economics, Portland State University, P.O. Box 751, Portland, OR 97207-0751, USA*

Abstract

The professional team sports industry is characterized by an abundance of information, defined objectives, and clear consequences. Given these characteristics, researchers have generally assumed that economic actors follow the dictates of instrumental rationality. The purpose of this research is to present evidence that in professional baseball, where player statistics have historically been tabulated and utilized, information is employed efficiently. However, economic agents in professional basketball, where player statistics are less intuitive and not historically tabulated, fail to process information in a fashion consistent with the precepts of instrumental rationality.

Keywords: Major League Baseball; National Basketball Association; Instrumental Rationality

1. Introduction

In recent years the professional team sports industry has attracted an increasing amount of attention from economists. The interest in this industry does not stem from its relative importance to the aggregate economy, but in the data the industry accumulates to evaluate its firms and workers. Such data have allowed economists to examine a variety of issues such as the impact alternative institutional arrangements have on worker compensation and mobility[1] and the possible existence of both employer and consumer racial discrimination.[2]

* Corresponding author. Tel.: +1-319-399-8714; fax: +1-319-399-8830.
E-mail addresses: dberri@csub.edu (D.J. Berri), schmidtm@pdx.edu (M.B. Schmidt).
[1] Tel.: +1-661-664-2027.

1053-5357/02/$ – see front matter © 2002 Published by Elsevier Science Inc.
PII: S1053-5357(02)00117-8

In general, these studies have followed in the neoclassical tradition by employing the assumption that economic actors follow the dictates of instrumental rationality.[3] Given that this industry is characterized by an abundance of information (i.e., team and player statistics), clear objectives (i.e., wins and/or profit maximization), and discernible consequences (i.e., losing games and/or loss of employment); it is generally expected that decision-makers in this industry will utilize information efficiently. The purpose of this paper is to examine whether this expectation is valid for both Major League Baseball (MLB) and the National Basketball Association (NBA).

The presented evidence is based upon the MLB managers' and coaches' selection of the Silver Slugger award[4] and the NBA head coaches' voting for the All-Rookie Team.[5] Each of these awards presents a direct statement of the managers' and coaches' evaluation of playing talent.[6] The question this inquiry will address is whether this evaluation is consistent with the available empirical evidence. In other words, are decision-makers in these two industries processing information in a fashion consistent with the precepts of instrumental rationality?

The organization of this inquiry will be as follows: the inquiry will begin with a brief review of the concepts of instrumental rationality, bounded rationality and the work of the Prospect school of cognitive psychology. Section 3 will examine both the quantity and quality of the information currently and historically available in both professional baseball and professional basketball. Section 4 will examine the baseball managers' and coaches' selection of the Silver Slugger award. This discussion will be followed by an examination of the NBA coaches' voting for the All-Rookie Team. Section 6 will offer concluding observations.

2. Instrumental rationality, bounded rationality and cognitive psychology

Economists who venture into the world of sports typically explain events in this industry in terms of economics. Occasionally economists reverse this relationship and utilize sports analogies to explain economics. Perhaps the most famous example comes from the work of Friedman (1953). Friedman hypothesized that a researcher could explain the shots of an expert billiard player by assuming the player understood the complex physical relationships underlying his/her actions. However, one would not expect that billiard players to be experts at physics, rather a researcher would be successful in his/her predictions simply because it would not be possible for billiard players to excel in this sport if the shots taken were not consistent with said physical relationships (p. 21).

A similar analogy, according to Friedman, can be offered with respect to economic agents. Although one may not expect the average economic actor to understand complex economic relationships, a successful player in the economic world cannot obtain his/her status without behaving in a fashion consistent with the dictates of economic data. In other words, economic agents must process information efficiently if the agent is to survive (pp. 21–22).

Critics of Friedman's position note that this analogy is likely applicable in an economic environment where consequences are clear and relatively simple to analyze. Friedman's story depends heavily upon an economic agent being able to obtain and interpret sufficient information so that the agent understands why observed outcomes occurred. As the economic actor's environs becomes increasingly complex, the ability to understand why outcomes were achieved becomes less likely.

In general, critics of the rationality assumption note the limits of the human mind's ability to decipher increasingly complex information. A leading voice among the dissenters has been Herbert Simon[7] who introduced the concept of 'bounded rationality' into the economists' dictionary in an effort to

> "focus attention upon the discrepancy between the perfect human rationality that is assumed in classical and neoclassical economic theory and the reality of human behavior as it is observed in economic life. The point was not that people are consciously and deliberately irrational . . . but that neither their knowledge nor their powers of calculation allow them to achieve the high level of optimal adaptation of means to ends that is posited in economics." (Simon, 1992, p. 3)

The limits of the human mind have been noted in the work of both Simon and the cognitive psychologists who introduced Prospect theory.[8] In essence, Prospect theory states that people utilize various heuristic devices to simplify incoming information in an effort to overcome the limited ability of the human mind to process complex information. However, such simplification tools bias a person's computations in a fashion that renders subsequent decisions inconsistent with the precepts of instrumental rationality (Etzioni, 1988, p. 118).

An example of such a systematic bias is anchoring and adjustment. Experiments have shown that people tend to be overly tied to initial estimates (the anchor). As new information is introduced, people either fail to adjust,[9] or significantly under-adjust.[10] Such results have not only been shown experimentally, but also in real-life situations[11] (Etzioni, 1988, pp. 118–119).

The evidence of people being unwilling to adjust to new information leads one to question how decision-makers in professional sports adjust to new information. The answer to this inquiry begins with an examination of the data currently and historically available in the two sports focused upon in this research.

3. The current and historical data of professional baseball and basketball

To understand how information is processed in professional baseball and professional basketball, one must first establish what information has been and is available. Given that the focus of this paper is on the Silver Slugger award in baseball and the All-Rookie Team in basketball, only data relevant to these honors will be discussed. For the former, only a player's batting prowess is considered, hence defensive and base-running statistics do not need to be examined. In contrast, the All-Rookie Team is not simply about offense or defense, but rather a player's total productivity. Hence, virtually every player statistic in basketball needs to examined.

3.1. Team and player statistics in professional baseball

Baseball has historically been a game obsessed with numbers. From the inception of the National Association in 1871, people in this industry have tracked a variety of factors designed to measure the productivity of both the individual player and team. The list of factors utilized in 1871 to measure the productivity of a batter includes singles, doubles, triples, home runs, walks, strike outs, runs and runs-batted-in.[12] Of the statistics listed by Blass (1992) as being the primary causal factors of runs scored, only hit-by-pitch, grounded into double plays and sacrifice flies were not tabulated in the National Association at its inception.

The work of Blass ascertained the value of each of the aforementioned statistics in terms of the primary offensive objective, scoring runs. Although this work will be discussed in more detail below, a perusal of the econometric evidence is unnecessary if one simply wishes to determine which factors are likely to have the greatest impact on runs scored. Given that runs are scored by moving players around the bases, factors that move players around the fastest are likely to have the largest value. Hence, the most valuable statistics in terms of runs scored is likely to be home runs, followed by triples, doubles, and then singles. Each of these factors, which are capable of advancing base runners more than one base towards home, are likely to be more valuable than walks or stolen bases.

3.2. Team and player statistics in professional basketball

The utilization of statistics in the NBA also began with the inception of the league. However, unlike professional baseball, several significant factors were not tabulated initially. For the 1946–1947 season, the first in the NBAs history, only assists, personal fouls and factors associated with scoring were tracked. Rebounds were not added as a statistic until the 1950–1951 campaign, and factors such as steals, turnovers and blocked shots were not tracked for teams until the 1973–1974 campaign. The 1977–1978 season marked the first time turnovers were tabulated for individual players (The Sporting News: Official NBA Guide, 1998–1999).

A perusal of the head coaches' playing and coaching records reveals that the majority of individuals whose votes are considered in this study were first introduced to the game of basketball prior to the 1973–1974 season. Consequently, these people first learned how to evaluate playing talent from individuals who reached conclusions without the assistance of the varied statistics utilized today. Given this training, one may wonder how coaches today have learned over the course of their careers to utilize this information?

Hampering this learning process is the diverse nature of the information gathered. In baseball, one does not need advanced econometrics to understand the basic ordering of the data. The data collected for basketball, though, is likely much more difficult to interpret. For example, which factor has the greatest impact on wins, rebounds, turnovers, points scored, or assists? To properly evaluate players who offer a heterogenous collection of these factors, this question needs to be answered.

In sum, relative to baseball, basketball has a shorter history collecting and analyzing player productivity statistics. Additionally, the collected data is much more difficult to interpret and evaluate. Given these differences, should we ultimately see differences in how information is utilized in the two sports?

In an effort to answer this question, the voting record for the aforementioned post-season awards will each be analyzed according to two methodologies designed to interpret player performance data. The characteristics of the first chosen method will be (1) historically available, (2) relatively simple to calculate and understand, and (3) empirically inferior to more advanced methods of analysis. The second method of analysis will have the opposite characteristics.

Each method will be examined from two perspectives. First we will explore how consistent each measure is with either runs scored or team wins. After ascertaining this relationship we will examine how consistent each measure is with the selection of the aforementioned post-season awards. If the instrumental rationality thesis is supported, the measure most consistent with runs scored or team wins will also be most consistent with the managers' and coaches' voting record.

4. Measuring player productivity in professional baseball

4.1. Connecting player productivity statistics to runs scored

Table 1 lists each of the factors, along with corresponding summary statistics,[13] that will be employed in the study of MLB. The data utilized in this study will come from four years, beginning with the 1995 campaign and concluding with the 1998 season. Baseball's labor strife reduced the size of the 1995 regular season, therefore each statistic is utilized on a per game basis. Finally, post-season statistics are not considered since the Silver Slugger award is solely based on regular season performance.

The two methods utilized to examine the voting record for the Silver Slugger award will be slugging percentage and a method we will entitle, runs manufactured. The former has a significant history not only in baseball, but also in the sports economics literature. Gerald Scully, in his seminal study of the worker exploitation under baseball's reserve clause, utilized slugging percentage to measure the productivity of MLB hitters.

The calculation of slugging percentage is as follows:

$$\text{slugging percentage} = \frac{\text{total bases}}{\text{official at-bats}} \tag{1}$$

Table 1
Team performance variables, baseball (per game)[a] (sample: 1995–1998)

Team statistics	Notation	Mean	Standard deviation	Maximum	Minimum
Runs	RS	4.858	4.797	6.168	3.830
Slugging percentage	SLG	.421	.028	.485	.373
Singles	1B	6.200	6.164	7.028	5.380
Doubles	2B	1.763	1.762	2.302	1.290
Triples	3B	.193	.191	.321	.070
Home runs	HR	1.043	.997	1.630	.650
Base on balls	BB	3.477	3.448	4.310	2.430
Hit-by-pitch	HBP	.315	.296	.617	.140
Stolen bases	SB	.711	.704	1.319	.330
Ground into double play	GIDP	.774	.753	1.062	.59
Caught stealing	CS	.315	.310	.528	.110
Sacrifice flies	SF	.298	.301	.469	.170
Outs	OUTS	25.20	25.190	25.880	24.400

[a] The source of the team performance variables, with the exception of GIDP, was http://homes.arealcity.com/baseballstats/statistics/teambatting.html [accessed: June 15 2000]. GIDP was found at ESPN StatSearch (2000), with web address http://espn−mlb.factcity.net/factcity/factcity [accessed: June 15].

Table 2
White heteroskedasticity—consistent standard errors and covariance (sample: 1995–1998)

Independent variables	Coefficient	Standard error	*t*-statistic	*p*-value
Constant	−2.247	.317	−7.097	0
SLG	16.894	.753	22.443	0
Observations: 114	*R*-squared	.803	Adjusted *R*-squared	.801
	F-statistic	456.62	*p*-value: *F*-statistic	0
	Standard deviation of the dependent variable	.523	Standard error of regression	.2330

OLS estimates for Eq. (3). Dependent variable: *R*.

where

$$\text{total bases} = \text{singles} + \text{doubles} \times 2 + \text{triples} \times 3 + \text{home runs} \times 4 \quad (2)$$

As noted, the data required to calculate slugging percentage has been tabulated since 1871. Although the measure is also fairly simple to calculate and interpret, slugging percentage may be a flawed appraisal of a batter's productivity since it excludes such factors as walks, hit-by-pitch, grounded into double plays and sacrifice hits. How much does the exclusion of these factors impact the ability of slugging percentage to explain runs scored?

The answer to this question is offered *via* the estimation of Eq. (3). The results of this estimation are reported in Table 2.

$$Y_{1n} = A_{1n} + \alpha_1 X_{1n} + \epsilon_{1n} \quad (3)$$

where $Y_1 = \text{RS}$, $X_1 = \text{SLG}(+)$, $n = 1, \ldots, z$ with $z = 114$. The theorized impact of SLG is listed in parentheses.

Table 2 indicates that slugging percentage is statistically significant at the 1% level. Furthermore, this factor is capable of explaining 80% of runs scored per game. Further exploration of these results indicates that a one unit increase in total bases per game results in an additional .49 runs scored per contest. Each additional at-bat results in a corresponding decline in the dependent variable of .21.

The results reported in Table 2 offer some justification for Scully's original choice of productivity measures. However, the aforementioned research of Asher Blass offers a superior model of runs scored. Blass's model is reported in Eq. (4) with the results of its estimation listed in Table 3.

$$Y_{2n} = A_{2mn} + \sum_{k=1}^{10} \alpha_{2k} X_{2kn} \quad (4)$$

where $Y_2 = \text{RS}$, $X_{21} = \text{1B}(+)$, $X_{22} = \text{2B}(+)$, $X_{23} = \text{3B}(+)$, $X_{24} = \text{HR}(+)$, $X_{25} = \text{BB}(+)$, $X_{26} = \text{HBP}(+)$, $X_{27} = \text{SB}(+)$, $X_{28} = \text{GIDP} + \text{CS}(-)$, $X_{29} = \text{SF}(+)$, $X_{30-} = \text{OUTS}(-)$, $n = 1, \ldots, z$ with $z = 114$. The theorized impact of each factor is listed in parentheses.

The estimation of Blass's model indicates that a 93% of runs scored can be explained *via* an expanded set of offensive statistics. Of this list of explanatory variables Blass considers, only GIDP + CS is not significant at the 5% level.[14] Clearly Blass's model offers a superior measure of a players productivity than a model based solely on slugging percentage.

Table 3
White heteroskedasticity—consistent standard errors and covariance (sample: 1995–1998)

Independent variables	Coefficient	Standard error	*t*-statistic	*p*-value
Constant	.622	1.356	.458	.648
1B	.546	.044	12.330	0
2B	.597	.086	6.882	0
3B	.827	.366	2.257	.026
HR	1.386	.069	2.028	0
BB	.352	.042	8.357	0
HBP	.434	.128	3.392	.001
SB	.185	.062	2.989	.004
GIDP × CS	−.241	.164	−1.467	.145
SF	.602	.271	2.218	.029
OUTS	−.127	.051	−2.482	.015
Observations: 114	*R*-squared	.937	Adjusted *R*-squared	.931
	F-statistic	152.86	*p*-value: *F*-statistic	0
	Standard deviation of the dependent variable	.5240	Standard error of regression	.138

OLS estimates for Eq. (4). Dependent variable: RS.

4.2. Examining the Silver Slugger award

Blass's model considers several factors that baseball did not track in either the late 19th century or early 20th century. For example, grounded into double plays was not kept as an official statistic in the National League (NL) until 1933, with the American League following the NLs lead in 1939. Furthermore, a sacrifice fly was only occasionally included as a sacrifice hit till it was finally adopted by MLB as a separate statistic in 1954.[15] How well do decision-makers in professional baseball incorporate this relatively new information into their measures of player performance?

The answer to this question is offered *via* an examination of the manager and coaches' selection of the Silver Slugger award. The players were ranked at each position according to both slugging percentage and Blass's method, which we have entitled runs manufactured.[16] The player selected for the Silver Slugger award is then listed in Table 4, along with each player's corresponding ranking by each measure.[17]

Eight Silver Slugger teams are examined in terms of both slugging percentage and runs manufactured. The results offer credence to the hypothesis that baseball managers and coaches not only utilize the available player information, but that this information is also utilized correctly. Of the 68 players named, 50% finished first in runs manufactured. Another 25% ranked second at their position by Blass's measure. For 31 players, the ranking offered by slugging percentage and runs manufactured was identical. Of the 37 players where the rankings differ, though, the listed player was ranked higher in runs manufactured 24 times, or in 65% of the reported cases. This rudimentary evidence suggests that runs manufactured, rather than slugging percentage, is more consistent with the managers' and coaches' evaluation of playing talent. To see how decision-makers perform in a more complex environment, we now turn to the case of professional basketball.

Table 4
Examining the Silver Slugger award winners, slugging percentage, runs manufactured

Position	National League			American League		
	Silver Slugger award winner	Rank SLG	Rank RM	Silver Slugger award winner	Rank SLG	Rank RM
1998						
1B	Mark McGwire	1	1	Rafael Palmeiro	5	2
2B	Craig Biggio	3	1	Damion Easley	1	4
3B	Vinny Castilla	2	2	Dean Palmer	1	1
C	Mike Piazza	1	2	Ivan Rodriguez	1	1
OF	Sammy Sosa	1	1	Ken Griffey	4	2
OF	Greg Vaughn	4	5	Albert Belle	1	1
OF	Moises Alou	6	3	Juan Gonzalez	2	3
SS	Barry Larkin	1	1	Alex Rodriguez	2	1
DH				Jose Canseco	6	4
Average		2.38	2.00		2.56	2.11
1997						
1B	Jeff Bagwell	2	1	Tino Martinez	4	2
2B	Craig Biggio	1	1	Chuck Knoblauch	8	1
3B	Vinny Castilla	1	1	Matt Williams	1	4
C	Mike Piazza	1	1	Ivan Rodriguez	2	1
OF	Larry Walker	1	1	Ken Griffey	1	1
OF	Tony Gwynn	7	3	David Justice	2	5
OF	Barry Bonds	5	2	Juan Gonzalez	3	10
SS	Jeff Blauser	2	1	Nomar Garciaparra	1	1
DH				Edgar Martinez	1	1
Average		2.50	1.38		2.56	2.89
1996						
1B	Andres Galarraga	1	2	Mark McGwire	1	3
2B	Eric Young	2	2	Roberto Alomar	2	2
3B	Ken Caminiti	1	1	Jim Thome	1	1
C	Mike	1	1	Ivan Rodriguez	6	1
OF	Ellis Burks	1	3	Ken Griffey	3	3
OF	Barry Bonds	3	2	Albert Belle	4	1
OF	Gary Sheffield	2	1	Juan Gonzalez	1	5
SS	Barry Larkin	1	1	Alex Rodriguez	1	1
DH				Paul Molitor	9	2
Average		1.50	1.63		3.11	2.11
1995						
1B	Eric Karros	2	2	Mo Vaughn	5	2
2B	Craig Biggio	1	1	Chuck Knoblauch	2	1
3B	Matt Williams	3	2	Gary Gaetti	3	4
C	Mike Piazza	1	1	Ivan Rodriguez	5	2
OF	Dante Bichette	1	2	Albert Belle	1	1
OF	Tony Gwynn	19	6	Tim Salmon	2	2
OF	Sammy Sosa	13	7	Manny Ramirez	3	3
SS	Barry Larkin	1	1	John Valentin	1	1
DH				Edgar Martinez	1	1
Average		5.13	2.75		2.56	1.89
All years (average)		2.88	1.94		2.69	2.25

5. Measuring player productivity in professional basketball

5.1. Connecting player productivity statistics to team wins

Table 5 lists each of the factors, along with corresponding summary statistics,[18] that will be employed in the study of professional basketball. Similar to the study of professional baseball, the data utilized in this study will come from 4 years, beginning with the 1994–1995 campaign and concluding with the 1997–1998 season. Given that the All-Rookie Team is based solely upon regular season performance, the players' and teams' post-season performance will not be considered.

As noted, two methodologies will be utilized to ascertain the ability of NBA coaches to evaluate NBA personnel. Each method is an index constructed to capture the varied facets of a player's production in a single measure.[19] The first method, titled "Points Created," was introduced by Bellotti (1988) and utilized by Jeffrey Jenkins in a recent examination of salary

Table 5
Team performance variables, basketball[a] (sample: 1994–1995 through 1997–1998)

Player and team statistics	Notation	Mean	Standard deviation	Maximum	Minimum
Assists	AST	1,846	167.83	2,281	1,533
Assist-to-turnover ratio	ASTO	1.44	.18	1.93	1.15
Blocked shots	BLK	414	79.14	663	277
Defensive rebounds	RBD	2,338	126.74	2,661	2,044
Field goal attempts	FGA	6,572	266.29	7,431	5,972
Free throw attempts	FTA	2,153	19.54	2,743	1,734
Free throw percentage[b]	FT	.74	.02	.78	.66
Free throws made	FTM	1,589	151.10	2,044	1,230
Missed field goal attempts	MFGA	3,560	21.31	4,307	3,086
Missed free throw attempts	MFTA	564	75.13	880	413
Offensive rebounds	RBO	1,053	125.60	1,514	829
Personal fouls	PF	1,865	133.01	2,203	1,591
Points	PTS	8,060	392.10	9,091	7,173
Points-per-shot[c]	PPS	.99	.04	1.08	.85
Steals	STL	673	79.68	987	503
Three point field goals made	3FGM	447	114.06	735	189
Turnovers	TO	1,290	89.68	1,544	1,041
Team Points Created	TPC	6,191	516.71	7,441	5,014
Two point field goals made	2FGM	2,565	171.52	2,942	2,144
Wins	WINS	41	14.42	72	11

D. . . represent the opponents' accumulation of the factor, i.e., the opponent's total scoring: DPTS.

[a] The sources of the player and team statistics utilized in this study was the *Official NBA Guide* (1998–1999; 1997–1998;1996–1997; 1995–1996).

[b] Free throw percentage is simply free throws made divided by free throws attempted.

[c] Points-per-shot (Neyer, 1995, pp. 322–323) is the number of points a player or team accumulates from its field goal attempts. Its calculation involves subtracting free throws made from total points, and then dividing by field goals attempted. Employing points-per-shot, rather than field goal percentage, allowed for the impact of three point shooting to be captured more efficiently.

discrimination in professional basketball. A variation of the second method, which can be conveniently entitled "Wins Created," was introduced by Berri and Brook (1999) and further refined by Berri (1999). As with the measures of a baseballs player's productivity, each method will be examined in terms of how well it can explain both team wins and the coaches' selection of post-season honors.

Two versions of Points Created are offered by Bellotti (1994), a simple version that weights each statistic equally,[20] and a slightly more complex version where each statistic is valued according to weights suggested by Bellotti. Similar to Jenkins, the former model will be considered for this exploration.[21]

The formulation of the simple version of Points Created is as follows:

$$\begin{aligned}\text{Points Created} = {} & [\text{PTS} + \text{RBD} + \text{RBO} + \text{STL} + \text{BLK} + \text{AST}] \\ & - [\text{MFGA} + \text{MFTA} + \text{TO}] - [\text{PF} \times 0.5]\end{aligned} \tag{5}$$

The ability to accurately predict the media's selection of the most valuable player (MVP) for each season is the primary claim to accuracy the creator of Points Created offers. Writing after the conclusion of the 1993–1994 season, Bellotti noted that the player named most valuable finished first or second in Points Created for each of the previous 10 seasons.[22] Given this rudimentary finding, it would appear that Bellotti has developed a method that is consistent with the player evaluations of sports writers. For this discourse, however, it is necessary to establish how effectively Points Created can explain both the player evaluations of coaches and team wins.

The latter task is examined by Eq. (6).

$$Y_{3n} = A_{3n} + \alpha_3 X_{3n} + \epsilon_{3n} \tag{6}$$

where $Y_3 = \text{WINS}$, $X_{31} = \text{TPC}(+)$, $n = 1, \ldots, z$ with $z = 114$. The theorized impact of TPC is listed in parentheses.

As reported in Table 6, the estimation of Eq. (6) reveals that TPC does have a statistically significant impact on team wins. However, only 52% of team wins can be explained by this index. Although assuming each factor is of equal weight does simplify the analysis, it apparently does so at the cost of reduced accuracy. Further statistical analysis reveals that each of the statistics tabulated for the players does not have an equal impact on wins.[23] Would an

Table 6
White heteroskedasticity—consistent standard errors and covariance

Independent variables	Coefficient	Standard error	t-statistic	p-value
Constant	(89.907)	1.008	(8.984)	0
TPC	.016	.001	13.396	0
Observations: 114	R-squared	.519	Adjusted R-squared	.515
	F-statistic	121.043	p-value: F-statistic	0
	Standard deviation of dependent variable	14.480	Standard error of regression	1.083

Estimated coefficient for Eq. (6). Dependent variable is wins. Estimation method: ordinary least squares.

alternative method that does not assume most factors are of equal value provide a significantly more accurate depiction of each player's production?

The answer to the above query can be found by noting the following relationships:

1. wins in professional basketball are a function of points scored and points surrendered;
2. points scored (points surrendered) is a function of the team's (opponent's) acquisition of the ball, the team's (opponent's) ability to maintain possession of the ball, and finally the proficiency of the team (opponent) to convert possessions into points.

Given that each of these relationships can be measured *via* the statistics the NBA tabulates, the estimation of the model reported in Eqs. (7) and (8) should result in the measurement of each player's marginal product or production of wins.[24]

$$Y_{4n} = f_{4i} + \sum_{k=1}^{7} \alpha_{4k} X_{4kn} + \alpha_{28} Y_{4n} + \epsilon_{4n} \tag{7}$$

$$Y_{5n} = f_{5i} + \sum_{k=1}^{9} \alpha_{5k} X_{5kn} + \epsilon_{5n} \tag{8}$$

where $Y_4 = \mathrm{WINS}$, $X_{41} = \mathrm{PPS}(+)$, $X_{51} = \mathrm{DPPS}(+)$, $Y_5 = \mathrm{DPTS}(-)$, $X_{42} = \mathrm{FT}(+)$, $X_{52} = \mathrm{DFT}(+)$, $X_{43} = \mathrm{FTA}(+)$, $X_{53} = \mathrm{PF}(+)$, $X_{44} = \mathrm{RBO}(+)$, $X_{54} = \mathrm{RBD}(-)$, $X_{45} = \mathrm{ASTO}(+)$, $X_{55} = \mathrm{DASTO}(+)$, $X_{46} = \mathrm{DTO}(+)$, $X_{56} = \mathrm{TO}(+)$, $X_{47} = \mathrm{RBD}(+)$, $X_{57} = \mathrm{RBO}(-)$, $X_{58} = \mathrm{FGA}(+)$, $X_{59} = \mathrm{FTA}(+)$, $n = 1, \ldots, z$ with $z = 114$, f_i is the team specific fixed effects. The theorized impact of each factor is listed in parentheses.

As noted in Berri (1999), this model presents a basic theory of basketball. Eq. (7) essentially states that wins are a function of points scored and points surrendered. The number of points a team scores is determined by the team's acquisition of the ball (DPTS, RBD, DTO), the efficiency of its ball handling (ASTO), and its ability to extract points from its possessions (PPS, FTA, FT, RBO).[25] Given that this list of determinants includes how many points a team surrenders, Eq. (7) is simply a restatement of the proposition that wins are a function of points scored and points surrendered (Berri, 1999, p. 415).

Eq. (8) presents a model of the opponent's scoring. The construction of an equation designed to explain points surrendered begins with the relationship between shot attempts and the opponent's accumulation of points. If one controls for both offensive rebounds (RBO) and turnovers (TO), then the number of shots a team takes (FGA, FTA)[26] represents the number of opportunities the opponent has to score. The other determinants of the opponent's scoring include the efficiency of the opponent's ball handling (DASTO) and the ability of the opponent to turn its possessions into points (PF, DFT, DPPS, RBD) (Berri, 1999).

As noted, these two equations were estimated with four seasons of data, beginning in 1994–1995 and concluding with the 1997–1998 campaign. The results reported in Tables 7 and 8 indicate that much of the variation in team wins and the opponent's scoring can be explained by the aforementioned list of independent variables. Furthermore, each variable is both statistically significant at the 1% level and of the expected sign. Such findings are evidence that the productivity of both an NBA player and a team can be empirically derived, and thus, the value of an NBA player can be both objectively and accurately determined.[27]

Table 7
White heteroskedasticity—consistent standard errors and covariance

Independent variables	Coefficient	Standard error	*t*-statistic	*p*-value
PPS	173.400	12.835	13.510	0
FT	74.123	2.240	3.662	0
FTA	.013	.003	3.993	0
ORB	.031	.005	6.502	0
ASTTO	18.566	3.109	5.973	0
DTO	.020	.005	4.101	0
DRB	.020	.005	3.680	0
DPTS	(.021)	.002	(11.770)	0
Observations: 114	*R*-squared	.964	Adjusted *R*-squared	.947
	F-statistic	57.476	*p*-value: *F*-statistic	0
	Standard deviation of dependent variable	14.480	Standard error of regression	3.323

Estimated coefficients for Eq. (7). Dependent variable is wins. Estimation method: ordinary least squares. Team specific fixed effects.

To compare the analysis provided by Bellotti and Berri, the marginal values of each factor utilized in the estimation of Eqs. (7) and (8) must be computed. This is accomplished by first incorporating Eq. (8) into Eq. (7). From this single equation the marginal values of the statistics used to directly evaluate the player, as well as team tempo and team defense are ascertained.[28] As revealed in Table 9, the value of each statistic does not have an equal impact upon wins. Rather, a player's ability to rebound, limit turnovers,[29] and shoot efficiently are of greater value to a team than assists, personal fouls and accumulating substantial point totals without paying proper attention to the adept utilization of one's shot attempts (Berri, 1999, p. 417). In

Table 8
White heteroskedasticity—consistent standard errors and covariance

Independent variables	Coefficient	Standard error	*t*-statistic	*p*-value
DPPS	4,000.013	329.238	12.149	0
DFT	1,358.708	529.005	2.568	.012
PF	.325	.101	3.228	.002
DRB	(.274)	.096	(2.864)	.005
DASTO	797.521	61.558	12.956	0
TO	1.139	.116	9.833	0
ORB	(1.425)	.093	(15.264)	0
FGA	1.153	.060	19.205	0
FTA	.458	.051	9.030	0
Observations: 114	*R*-squared	.987	Adjusted *R*-squared	.981
	F-statistic	16.025	*p*-value: *F*-statistic	0
	Standard deviation of dependent variable	427.260	Standard error of regression	58.650

Estimated coefficients for Eq. (8). Dependent variable is DPTS. Estimation method: ordinary least squares. Team specific fixed effects.

Table 9
Marginal values according to Wins Created and Points Created

	Marginal value Wins Created	Elasticity Wins Created	Marginal value Points Created
Player statistics			
Missed field goal	(.026)	(2.256)	(.016)
Two point field goal made	.027	1.676	.032
Offensive rebound	.061	1.566	.016
Defensive rebound	.026	1.473	.016
Player turnover	(.044)	(1.341)	(.016)
Opponent's turnover (steal)[a]	.038	1.202	.016
Made free throw	.022	.857	.016
Assist	.014	.648	.016
Three point field goal made	.053	.580	.049
Personal foul	(.007)	(.307)	(.008)
Missed free throw	(.012)	(.170)	(.016)
Tempo statistics			
Field goal attempt	(.024)	(3.846)	–
Free throw attempted	(.010)	(.500)	–
Defensive statistics			
Opponent's missed field goal (blocked shot)[b]	.012	1.083	.016
Opponent's two point field goals made	(.013)	(.804)	–
Opponent's assist	(.013)	(.579)	–
Opponent's three point field goals made	(.026)	(.278)	–
Opponent's free throw missed	.010	.133	–
Opponent's free throw made	(.003)	(.133)	–

[a] The opponent's turnovers includes both the number of steals tabulated by the individual players, and other turnovers the credit of which is not assigned. Given that each of the opponent's turnovers leads to an additional .038 wins, the value of an additional steal is assumed to have the same impact. In considering the opponent's turnovers, then, steals are utilized in evaluating individual players while, as explained, the opponent's turnovers that were not steals are employed in constructing the team defensive factor.

[b] A blocked shot produces a missed shot for the opponent. Therefore, the opponent's missed shots that were blocked are allocated to the individual player's production of wins. Missed shots of the opponent that were not caused by a blocked shot are included in the calculation of the team defensive factor.

other words, much of the data originally accumulated by the NBA in its inaugural season is less valuable than the data that the league began to tabulate in the 1970s.

5.2. Examining the All-Rookie Team

The proceeding discussion suggested that *via* econometric analysis one can connect the player's production to team wins. Can the coaches intuitively reach the same conclusions *via* the discipline of market forces? To answer this questions, the coaches' voting pattern[30] will be examined *via* both Points Created and Wins Created. The factors utilized in this examination are listed in Tables 10 and 11, along with the corresponding summary statistics.

Table 10 lists summary statistics for 111 first year players from four seasons, beginning with the 1994–1995 campaign. Each of these players played at least 600 min in his Rookie season.[31] For comparison purposes, summary statistics for only the Rookies who garnered voting points are listed in Table 11. In general, representative Rookies who received votes were drafted higher

Table 10
Rookie performance variables (All-Rookies, observations: 111)

Rookie statistics	Notation	Mean	Standard deviation	Maximum	Minimum
Draft position	DRAFT	17.43	14.38	58.00	1.00
Points Created	PC	602.69	380.33	2,043.00	130.00
Voting points received	VP	15.63	19.98	56.00	0
Wins Created	WINS	2.38	3.53	17.50	(3.67)

and were more productive than the average Rookie from the entire population of Rookies who logged significant minutes. The results with respect to productivity are maintained whether one considers Points Created or Wins Created. To ascertain which methodology is most consistent with the coaches' evaluations, the voting record is examined from two perspectives.

The first evidence that contradicts the assertion of the instrumental rationality hypothesis is reported in Table 12. The first All-Rookie Team is reported for each of the years considered in this inquiry along with each player's VP, RWINS, and RPC. Furthermore, each of the Rookies who played at least 600 min[32] was ranked according to Points Created and Wins Created, and the ranking of the players listed is reported.

The rudimentary evidence reported in Table 12 indicates that Points Created is much more consistent with the coaches' voting record. Of the 21 players named to the All-Rookie first team, 17 or 81%, were ranked in the top five by Points Created. In contrast, only 11 of the first team players, or 52%, were also ranked in the top five by Wins Created. According to this latter method, in each of the years examined the coaches "missed" on at least one player. For example, Tracy McGrady produced an estimated 5.8 wins in 1998, more than the combined production of first team All-Rookie members Ron Mercer and Keith Van Horn. While Van Horn was a unanimous first team selection, though, not one coach selected McGrady to the first or second All-Rookie Team (1996, 1997).

Van Horn's selection is particularly illustrative of the coaches' inability to consider all of the aspects of a player's production in a fashion consistent with the empirical evidence. An examination of the New Jersey Net's allocation of player minutes reveals that Van Horn likely played his minutes at the power forward position. If one compares Van Horn's per minute production to the average per minute production teams received from their power forwards, one quickly notes that his per minute production is below average in terms of such positive factors as rebounds and shooting efficiency. With respect to the primary negative factor, turnovers, Van

Table 11
Rookie performance variables

Rookie statistics	Notation	Mean	Standard deviation	Maximum	Minimum
Draft position	DRAFT	14.76	13.42	58.00	1.00
Points Created	PC	764.05	375.04	2,043.00	167.50
Voting points received	VP	24.10	20.43	56.00	1.00
Wins Created	WINS	3.20	3.93	17.50	(3.67)

Rookies who received votes for the All-Rookie Team (observations: 72).

Table 12
Examining the All-Rookie first team voting points, Points Created, and Wins Created

Rookies	PC	WINS	VP	Rank PC	Rank WINS
1997–1998 first team					
Tim Duncan	2,043.0	17.50	56	1	1
Keith Van Horn	902.0	−2.83	56	5	27
Brevin Knight	1,135.5	12.83	54	3	2
Zydrunas Ilgauskas	1,336.0	12.65	51	2	3
Ron Mercer	914.5	2.43	50	4	9
Misses 1997–1998					
Michael Stewart	740.5	5.90	0	8	4
Tracy McGrady	568.0	5.85	0	14	5
1996–1997 first team					
Shareef Abdur-Rahim	1,261.5	5.14	56	3	4
Allen Iverson	951.5	2.82	55	1	9
Stephon Marbury	1,352.5	2.82	55	5	8
Antoine Walker	1,317.5	1.61	49	2	15
Marcus Camby	897.0	4.41	49	7	5
Misses 1996–1997					
Dean Garrett	889.0	9.64	9	8	1
Kerry Kittles	1,163.5	6.23	41	4	2
Ray Allen	903.0	6.04	31	6	3
1995–1996 first team					
Damon Stoudamire	1,324.0	3.19	56	2	11
Joe Smith	1,372.0	10.49	54	1	2
Jerry Stackhouse	970.5	.05	52	8	19
Antonio McDyess	1,025.0	4.33	50	6	6
Arvydas Sabonis	1,255.5	11.63	41	3	1
Michael Finley	1,187.5	4.05	41	4	7
Misses 1995–1996					
Kevin Garnett	1,075.5	7.47	35	5	3
Brent Barry	757.0	4.55	21	10	4
Theo Ratliff	518.0	4.34	1	13	5
1994–1995 first team					
Jason Kidd	1,201.0	8.55	52	3	2
Grant Hill	1,381.5	9.31	51	1	1
Glenn Robinson	1,296.0	3.22	50	2	13
Eddie Jones	834.5	6.41	45	7	3
Brian Grant	1,091.0	6.26	42	4	4
Misses 1994–1995					
Michael Smith	685.5	6.07	6	13	5

Horn produced more turnovers per minute than the average power forward. Van Horn, though, was well above average in terms of shot attempts, and therefore his per minute scoring was above average. It was this ability to accumulate substantial scoring totals, despite an inability to shoot efficiently, that propelled Van Horn towards the top in terms of both Points Created and apparently the evaluations of the coaches. However, as indicated in the discussion of Wins Created, Van Horn's ability to take a significant number of shots does not necessarily translate into team wins if his conversion rate is below average.

The elementary analysis indicates that the simple analysis of Bellotti, not the Wins Created method, is most consistent with the coaches' evaluation of playing talent. From this evidence one is tempted to conclude that the instrumental rationality story does not apply to the actions of coaches in the NBA. Further evidence can be obtained if one analyzes the voting record with the model reported in Eq. (9).

$$Y_{6n} = A_{6n} + \sum_{k=1}^{2} \alpha_{6k} X_{6kn} + \epsilon_{6n} \tag{9}$$

where $Y_6 = \text{VP}$, $X_{61} = \text{RWINS}$ or RPC(+), $X_{62} = \text{DRAFT}(-)$, $n = 1, \ldots, z$ with $z = 111$. Theorized impact of each factor is listed in parentheses.

The dependent variable is the number of voting points each Rookie received. The explanatory variables in Eq. (9) are either the estimate of each Rookie's Wins Created or Points Created, and the place each player was taken in the Rookie draft. The employment of RWINS or RPC is included as a potential proxy for the coaches' evaluation of the players' performances their Rookie seasons. DRAFT[33] is included in an effort to approximate the coaches' original perception of the players' worth. Before the estimation of this model can be reported some discussion must be offered regarding the nature of the data utilized.

As noted, 111 Rookies are considered in this study, and of these, 72 received votes from the coaches for the All-Rookie first or second teams. For the remaining 39 players, the dependent variable in Eq. (9) is zero. For these players, further declines in production would not result in further declines in voting points received. Additionally, five players received the maximum number of voting points possible. Once one receives 56 voting points,[34] further increases in either Points Created or Wins Created will not result in further increases in consideration for the All-Rookie Team. The ability of Eq. (9) to explain the number of voting points received by players at the extremes of the distribution is doubtful given the standard ordinary least squares methodology. Hence, Eq. (9) was treated as a censored regression and estimated as a TOBIT model.

The censoring of the initial 111 observations was conducted in the following fashion. First, the utilization of DRAFT to measure the coaches' initial perception of the Rookies limited the initial sample to 99 players. Of these, 27 received no consideration for the All-Rookie Teams; while as noted, five players received the maximum number of voting points. The left and right censoring of the data left 66 observations to examine *via* Eq. (9). The results of this examination are reported in Tables 13 and 14.

Table 13 reports the examination of the head coaches' voting record with respect to the Rookies' Wins Created. From the estimated coefficients, standard errors, and corresponding p-values, one can see that neither RWINS or DRAFT is statistically significant at the 5 or 10% levels. Such results imply that the coaches do not measure a Rookies' productivity in terms of the Wins Created method laid forth in this text. What of the Points Created methodology?

Table 14 reports the estimation of Eq. (9) with RPC utilized as an explanatory variable. From the corresponding p-values one can see that a Rookie's Points Created is statistically significant at the 5% level. Although DRAFT is once again statistically insignificant, indicating the coaches are not influenced at the conclusion of a campaign by initial perceptions, these results cast doubt on the ability of the coaches to process information efficiently. The reported results indicate that 86% of the variation in the coaches voting record can be explained by a model based upon an index that does not measure player productivity accurately. Such results

Table 13
QML (Huber/White) standard errors and covariance

Independent variables	Coefficient	Standard error	z-statistic	p-value
Constant	19.345	75.748	.255	.798
RWINS	3.550	4.146	.856	.392
DRAFT	(.852)	1.742	(.489)	.625
σ	19.713	15.861	1.243	.214
R-squared	.498	Adjusted R-squared	.483	
Left censored observations	28.000	Right censored observations	5.000	
Uncensored observations	66.000	Total observations	99.000	
Total sample	111.000	Log likelihood	(315.705)	

Estimated coefficients for Eq. (9). Dependent variable is VP. Estimation method: maximum likelihood—censored normal (TOBIT).

Table 14
QML (Huber/White) standard errors and covariance

Independent variables	Coefficient	Standard error	z-statistic	p-value
Constant	(18.182)	29.177	(.623)	.533
RPC	.057	.023	2.447	.014
DRAFT	(.188)	.568	(.331)	.741
σ	10.276	4.021	2.556	.011
R-squared	.860	Adjusted R-squared	.855	
Left censored observations	28.000	Right censored observations	5.000	
Uncensored observations	66.000	Total observations	99.000	
Total sample	111.000	Log likelihood	(265.725)	

Estimated coefficients for Eq. (9). Dependent variable is VP. Estimation method: maximum likelihood—censored normal (TOBIT).

imply that (1) the coaches do utilize the statistical evidence in evaluating playing talent, and (2) contrary to the precepts of instrumental rationality, in general the coaches apparently process this information incorrectly.[35]

6. Concluding observations

The evidence presented suggests the decision-makers in MLB do process information in a fashion consistent with the dictates of instrumental rationality. However, similar economic agents in professional basketball fail to demonstrate the same capability. Why would such a difference exist?

The beginning of an answer lies perhaps in the different experience each sport has with team and player performance statistics. As noted, baseball has tabulated a wide range of statistics since the inception of the National Association in 1871. Decision-makers in basketball, though, initially learned to evaluate players without the assistance of numerous statistics. Furthermore, unlike baseball, the connection between team wins and the numbers the NBA eventually tabulated is not obvious. Part of the story behind these results may perhaps lie in these two characteristics and the concept of anchoring and adjustment advanced earlier.

Basketball, though, is generally thought of as a competitive sport[36] and this data has existed for over 20 years. Why are NBA decision-makers unable to see the relationship between player productivity and team wins today? Although the NBA is somewhat competitive on the court, like all professional team sports, a lack of competition exists within the marketplace. As Neale (1964) argues, professional sports tends to be a natural monopoly. Barriers to entry exist in this industry in both the output and input markets.

Currently the NBA consists of only 29 franchises, with entry into the league controlled by existing franchises. Typically new franchises must be invited by the league; and only after a costly review process in terms of time and money, is a new team offered the opportunity to participate. Additionally, substantial barriers to entry exist for persons who wish to coach in the NBA. An examination of the work history of the NBA coaches reveals, not surprisingly, that each had prior experience as an NBA assistant, player, or college head coach.[37] In essence, without prior connections, one does not work as a head coach in the NBA. Such barriers to entry could restrict the flow of new ideas into the industry; hence the conditions necessary for the rationality assumption to hold may not exist in the NBA.

The barriers to entry with respect to the labor market may also result in professional inbreeding, where each NBA coach ultimately utilizes very similar methods to evaluate talent. Although this paper suggests that these methods are flawed, because the NBA regular season is a classic zero-sum game; regardless of the methods the NBA coaches utilize the number of winners will always equal the number of losers. Furthermore, each year the NBAs post-season results in a champion who vindicates the basic methodology of the NBA coaching fraternity. Such yearly reconfirmation likely prevents the NBA coaches from ascertaining that the basic techniques employed result in a flawed appraisal of playing talent.

What of the teams that fail miserably? Would not the losers have an incentive to find alternative methods? Such may not be the case if the NBA coaches believe the difference between what the data suggest according to the Points Created index and the team's actual accumulation of wins can be explained. Coaches in all team sports, but especially in basketball, cite the issue of team chemistry. Casual observation indicates that teams that produce fewer wins than observers expect are frequently cited as having poor team chemistry. Organizations that are more successful than the appraisal of talent would suggest are labeled as having good team chemistry. If coaches do mislabel the residual as team chemistry this could also explain why coaches are unable to ascertain the flaw in their methods of evaluating player performance. To test this conjecture one would need to determine if the error term in Eq. (2) is correlated with an estimate of team chemistry. Certainly this is a topic for future research.

Notes

1. See Scully (1974), Medoff (1976), Cassing and Douglas (1980), Hill and Spellman (1983), Raimondo (1983), Hill (1985), Scott et al. (1985), Zimbalist (1992a,b), Blass (1992), among others.
2. For a review of the literature prior to 1990, see Kahn (1991). More recent studies of discrimination were conducted by Jenkins (1996), Hanssen (1998), Hanssen and Anderson (1999), Hoang and Rascher (1999), Bodvarsson and Brastow (1999), among others.

3. Instrumental rationality, also known as calculative rationality, intentional rationality or procedural rationality, states that “economic actors choose efficiently the means that advance the actor’s objectives” (Etzioni, 1988, p. 136, 145). In other words, economic actors utilize the available information correctly in making decisions (North, 1994, p. 360). It is this definition of rationality that will be employed in this study.
4. The Silver Slugger award is given to the best offensive player at each defensive position. Players are to be chosen solely according to their performance at the plate. The baseball managers and coaches who evaluate the playing talent are prohibited from voting for players on their team, a rule designed to further the objectivity of the evaluation.
5. Although numerous post-season awards are determined by the media, these two awards are one of the few selected directly by decision-makers employed in these industries. In the NBA, the All-Defensive team is also selected by the head coaches. All other post-season awards in the NBA are chosen by the media. In baseball, the authors were unable to find any other award determined by the managers.
6. An alternative decision one could examine is the salary determination process. Although the negotiation of player salaries is a more significant action for decision-makers in each industry, the study of this activity presents problems for the researcher. A player’s wage is not strictly a function of past productivity, but also expectations regarding future productivity and the present market the team participates in when negotiating with a player. In contrast, post-season awards, although ultimately a trivial issue, is more likely to be an accurate representation of the coaches’ general ability to measure player productivity. Each of the aforementioned awards is simply a statement the managers and coaches make regarding the productivity of players within their respective sport. Although one could argue that coaches and managers do not take the voting for the award as seriously as their other duties, it seems unlikely these individuals would, if they are processing information “rationally,” consistently select inferior players to these teams.
7. Additionally, numerous other economists and scholars in the other social sciences have disputed the assumption of rationality and offered alternatives to this perspective. See Tversky and Kahneman (1974), Akerlof and Dickens (1982), Etzioni (1988), North (1992), McCain (1992), among others. For a review of the literature, see Hosseini (1997).
8. According to Etzioni (1988), this group includes Daniel Kahneman, Amos Tversky, Lee Ross, Paul Slovic, and Richard Thaler.
9. See Simon (1978).
10. See Kahneman and Tversky (1973) and Anderson et al. (1980).
11. See Engel and Blackwell (1982).
12. See The New Baseball Archive. http://baseball1.com/statistics/team/tmb-1871.html [accessed: June 2001].
13. The summary statistics are based upon the teams’, rather than the players’, accumulation of each factor.
14. In Blass’s original analysis, based upon the years 1976–1986, GIDP + CS was statistically significant at the 5% level.
15. See http://homes.arealcity.com/baseballstats/glossary.html [accessed June 19, 2000] (Baseballstats.net, 2000).

16. Blass does not offer a name for the output of his runs model. Initially we intended to use runs created. Bill James, though, utilized this name for a statistic calculated as on-base-percentage $\times$ total bases.
17. Only players with at least 100 at-bats were included in the rankings. Because the Silver Slugger award only considers a players performance at the plate, stolen bases and caught stealing were not considered in the calculation of a player's runs produced. Furthermore, due to data limitations, grounded into double plays was also omitted.
18. The summary statistics are based upon the teams', rather than the players', accumulation of each factor.
19. As noted by Jenkins (1996), both the works of Quirk and Fort (1997) and Scully (1995) suggest that the utilization of an index, rather than using a multitude of separate statistics, provides a more accurate measurement of an individual player's productivity.
20. The exception is personal fouls, which are given half the value of all the remaining statistics.
21. The simple method was utilized by Jenkins (1996). Each method was also statistically examined to estimate its ability to explain team wins. While neither was an empirical success, the simple version was superior, in terms of adjusted R^2, to the more complex method.
22. The connection between Points Created and the MVP balloting continued to hold for each of the next three seasons, although Michael Jordan was only fourth in Points Created when he was perhaps sentimentally named the 1997–1998 MVP in his final season.
23. To test whether or not each factor does has an equal impact on wins, the following model was estimated, utilizing team specific fixed effects and ordinary least squares.

$$\text{WINS} = f(\text{PTS}, \text{FGA}, \text{RBO}, \text{RBD}, \text{AST}, \text{STL}, \text{BLK}, \text{PF}, \text{TO})$$

    The coefficients were then examined, *via* an F-test, to see if Bellotti's assumptions regarding their relative value could be defended. The result of this test was that the null hypothesis (Bellotti's simple specification) was not accepted. Results are available from the authors upon request.
24. The model utilized here was introduced by Berri and Brook (1999) and further refined by Berri (1999). One is referred to each exposition for an explanation of the various econometric issues addressed by this model. The model presented in Berri (1999) did consider both regular season and post-season performance. Hence the dependent variable in Eq. (7) for Berri (1999) was the percentage of games won. This represents the only difference between the model presented here and that which was reported in the earlier work. The discussion of this model follows directly from the explanation offered in Berri (1999).
25. FTA is included to capture the ability of a player to draw a personal foul from his opponent.
26. As explained in Berri (1999) and Berri and Brook (1999), shot attempts capture the impact of team tempo.
27. The steps one follows in utilizing the results reported in Tables 8 and 9 in the measurement of player wins is reported in Berri (1999). One is referred to this work for a detailed discussion of both team tempo and team defense.

28. The reduced form equation includes several ratios whose interpretation would be eased if the components were examined separately. The steps followed to determine the value of these components is as follows: by taking the derivative of wins with respect to the numerator of PPS, one can determine the value of a point from a field goal attempt. The derivative of wins with respect to the denominator of PPS yields the value of a field goal attempt. The impact of a made three point field goal is then ascertained by multiplying the value of a point from a field goal attempt by three, and then adjusting this total by the value of a field goal attempt. The value of a two point field goal made is determined in a similar fashion, while the value of a missed field goal is simply the value of a field goal attempt.

    Except for the independent impact of a player's ability to draw a foul, as measured by the inclusion of free throw attempts, the value of a free throw made and missed is determined in a similar fashion. The derivative of wins with respect to both free throws made and attempted was calculated. Then the value of a free throw made is the respective derivative, plus the dual impact of a free throw attempt *via* FT and the value of FTA listed in Eq. (7). The value of a missed free throw is simply the dual value of a free throw attempt.
29. Although the results reported in Table 6 indicate the relative importance of player turnovers, the individual player's accumulation of this statistic was not reported on the NBAs official Website (www.NBA.com) prior to the 1999–2000 season. Given that this was the only primary statistic not reported, this omission suggests that decision-makers in the NBA do not truly understand the significance of this factor.
30. The coaches are asked to vote for a first and second All-Rookie Team. If a player is selected by a coach for the first team he receives two points; a second team selection is worth one. The five players with the most voting points are named to the first team, while the next five highest totals are named to the second team. The coaches are not allowed to vote for their own players, so the maximum number of voting points a player can receive is $(m-1) \times 2$, where m equals the number of teams.
31. Over the years considered in this study no Rookie received consideration for the All-Rookie Team who played less than 600 min. The results reported are robust if the sample is extended to All-Rookies with at least 500 min, or All-Rookies who played.
32. Except for the 1994–1995 season, the number of Rookies who played 600 min was 28. During the 1994–1995 campaign, 27 Rookies tallied 600 min.
33. The order of selection was found in *The Complete Handbook of Pro Basketball* (various years). Given that the first pick in the draft is generally perceived to be the most promising Rookie, and the 58th selection the least promising, the *a priori* sign for X_{62} is negative.
34. In the first season examined by this study the number of teams, and thus head coaches, was only 27. To allow for an accurate comparison of the voting record across times, the number of voting points each player received in 1994–1995 was divided by 52 and then multiplied by 56. This adjusted voting points was then utilized as the dependent variable in the estimation of Eq. (9).
35. Previous writings have presented results that are somewhat consistent with this finding. The work of Clement and McCormick (1989) demonstrated that the more successful coaches in college basketball utilize player statistics in allocating playing time.

However, this previous work also suggested that a player's scoring had a bigger impact on minute played than a player's rebounding. Assuming that the relationship between these factors and wins is the same in college as it is in the professional game, such a result suggests that coaches in the college ranks also fail to understand the relationship between the player's actions and team outcomes. With respect to the NBA, the work of Hoang and Rascher (1999) showed that factors such as shooting percentage, assists, rebounds, steals and blocks were not statistically significant determinants in the hiring decisions of NBA decision-makers. In fact, the only player performance variable these researchers found to be significant was a player's scoring. Such evidence suggests that the persons responsible for hiring and firing of NBA players do not consider every aspect of a player's performance in making decision.

36. As noted by Quirk and Fort (1997), the NBA is the least competitive of the four major professional team sports in North America.
37. Information of each coach's work history was found in the *Official NBA Register* (1995–1996, 1996–1997, 1997–1998, 1998–1999).

References

Akerlof, G., Dickens, W., 1982. The economic consequences of cognitive dissonance. American Economic Review 72 (3), 307–319.

All-Rookie Team, 1996. The Colorodoan, p. D4.

All-Rookie Team, 1997. Rocky Mountain News, p. 18C.

Anderson, C.A., Leper, R., Ross, L., 1980. Perseverance of social theories: the role of explanation in the persistence of discredited information. Journal of Personality and Social Psychology 39 (6), 1037–1049.

Baseballstats.net, 2000. Available at: http://homes.arealcity.com/baseballstats/index.html.

Bellotti, R., 1988. Basketball's Hidden Game: Points Created, Boxscore Defense, and Other Revelations. New Brunswick: Night Work Publishing Co.

Bellotti, R., 1994. The Points Created Basketball Book, 1993–1994. New Brunswick: Night Work Publishing Co.

Berri, D.J., 1999. Who is most valuable? Measuring the player's production of wins in the NBA. Managerial and Decision Economics 20, 411–427.

Berri, D.J., Brook, S.L., 1999. Trading players in the NBA: for better or worse. In: Fizel, J.L., Gustafson, E., Hadley, L. (Eds.), Sports Economics: Current Research. Westport: Praeger Publishing.

Blass, A.A., 1992. Does the baseball labor market contradict the human capital model of investment? The Review of Economics and Statistics 74 (2), 261–268.

Bodvarsson, O., Brastow, R., 1999. A test of employer discrimination in the NBA. Contemporary Economic Policy 17 (2), 243–255.

Cassing, J., Douglas, R.W., 1980. Implications of the auction mechanism in baseball's free agent draft. Southern Economic Journal 47, 110–121.

Clement, R.C., McCormick, R.E., 1989. Coaching team production. Economic Inquiry 27, 287–304.

Engel, J.F., Blackwell, R.D., 1982. Consumer Behavior, 4th Edition. New York: Holt, Rinehart and Winston.

ESPN StatSearch, 2000. Available at: http://espn−mlb.factcity.net/factcity/factcity [accessed: June 15].

Etzioni, A., 1988. The Moral Dimension: Toward a New Economics. New York: Macmillan.

Friedman, M., 1953. Essays in Positive Economics. Chicago: University of Chicago Press.

Hanssen, A., 1998. The cost of discrimination: a study of MLB. Southern Economic Journal 64 (3), 603–627.

Hanssen, F.A., Anderson, T., 1999. Has discrimination lessened over time? A test using baseball's all-star vote. Economic Inquiry 37 (2), 326–352.

Hill, J.R., 1985. The threat of free agency and exploitation in professional baseball: 1976–1979. Quarterly Review of Economics and Business 25 (4), 68–82.

Hill, J.R., Spellman, W., 1983. Professional baseball: the reserve clause and salary structure. Industrial Relations 22, 1–19.

Hoang, H., Rascher, D., 1999. The NBA, exit discrimination, and career earning. Industrial Relations 38 (1), 69–91.

Hosseini, H., 1997. Cognitive dissonance as a means of explaining economics of irrationality and uncertainty. Journal of Socio-Economics 26 (2), 181–189.

Jenkins, J.A., 1996. A reexamination of salary discrimination in professional basketball. Social Science Quarterly 77 (3), 594–608.

Kahn, L.M., 1991. Discrimination in professional sports: a survey of the literature. Industrial Labor Relations Review 44, 395–418.

Kahneman, D., Tversky, A., 1973. On the psychology of predictions. Psychological Review 80 (4), 237–251.

McCain, R.A., 1992. A Framework for Cognitive Economics. Westport, CT: Preager Publishers.

Medoff, M.H., 1976. On monopsonistic exploitation in professional baseball. Quarterly Review of Economics and Business 16 (2), 113–121.

Neale, W., 1964. The peculiar economics of professional sports. The Quarterly Journal of Economics 78 (1), 1–14.

Neyer, R., 1995. Who are the True Shooters? STATS Pro Basketball Handbook, 1995–1996. New York: STATS Publishing, pp. 322–323.

North, D., 1994. Economic performance through time. American Economic Review 84 (3), 359–368.

Raimondo, H.J., 1983. Free agents' impact on the labor market for baseball players. Journal of Labor Research 4, 183–193.

Quirk, J., Fort, R.D., 1997. Pay Dirt: The Business of Professional Team Sports. Princeton: Princeton University Press.

Scott Jr., F., Long, J., Sompii, K., 1985. Salary versus marginal revenue product under monopsony and competition: the case of professional basketball. Atlantic Economic Journal 13 (3), 50–59.

Scully, G.W., 1974. Pay and performance in MLB. American Economic Review 64 (6), 917–930.

Scully, G.W., 1995. The Market Structure of Sports. Chicago: University of Chicago Press.

Simon, H., 1992. Introductory comment. In: Simon, H., Egidi, M., Marris, R., Viale, R. (Eds.), Economics, Bounded Rationality and the Cognitive Revolution. Brookfield, Vermont: Edward Elgar Publishing Limited, pp. 3–7.

Simon, H., 1978. Rationality as a process and as product of thought. American Economic Review 68.

The New Baseball Archive, 2001. Available at: http://www.baseball1.com/

The Sporting News: Official NBA Guide, 1995–1996. In: Carter, C., Sachare, A. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

The Sporting News: Official NBA Guide, 1996–1997. In: Broussard, M., Carter, C. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

The Sporting News: Official NBA Guide, 1997–1998. In: Broussard, M., Carter, C. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

The Sporting News: Official NBA Guide, 1998–1999. In: Broussard, M., Carter, C. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

The Sporting News: Official NBA Register, 1995–1996. In: Puro, G., Sachare, A., Veltrop, K. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

The Sporting News: Official NBA Register, 1996–1997. In: Bonavita, M., Broussard, M., Stewart, S. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

The Sporting News: Official NBA Register, 1997–1998. In: Bonavita, M., Broussard, M., Stewart, S. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

The Sporting News: Official NBA Register, 1998–1999. In: Bonavita, M., Broussard, M., Roberts, B. (Eds.). St. Louis, MO: The Sporting News Publishing Company.

Tversky, A., Kahneman, D., 1974. Judgement under uncertainty: heuristics. Science 185, 1124–1131.

www.NBA.com, in press. Accessed: various times

Zimbalist, A., 1992a. Salaries and performance: beyond the scully model. In: Sommers, P. (Ed.), Diamonds are Forever: The Business of Baseball. Washington, DC: The Brookings Institution, pp. 109–133.

Zimbalist, A., 1992b. Baseball and Billions. New York: Basic Books.

Further Reading

The Complete Handbook of Pro Basketball, 1995. In: Hollander, Z. (Ed.). New York: Signet Books.
The Complete Handbook of Pro Basketball, 1996. In: Hollander, Z. (Ed.). New York: Signet Books.
The Complete Handbook of Pro Basketball, 1997. In: Hollander, Z. (Ed.). New York: Signet Books.
The Complete Handbook of Pro Basketball, 1998. In: Hollander, Z., Compton, E. (Eds.). New York: Signet Books.
NBA All-Rookie Team, 1995. The Denver Post, p. 11C.
Schick All-Rookie Team, 1999. NBA.comNews and Features: http://www.nba.com/news_feat/00699104.html [accessed: February 1].