ON THE EVOLUTION OF COMPETITIVE BALANCE: THE IMPACT OF AN INCREASING GLOBAL SEARCH

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The Coase theorem maintains that where free-market precepts exist, the allocation of property rights does not impact the distribution of resources. An application to Major League Baseball suggests that institutions such as free agency and the reverse-order amateur draft would not impact player distributions and therefore would not impact competitive balance. The present study finds that the distribution of wins is generally consistent with the precepts of the Coase theorem and therefore suggests a course for those who wish to alter the level of competitive balance: Major League Baseball should increase its focus on expanding the size of its labor pool. (*JEL* O15, L83, C22)

> When there are no transaction costs the assignment of legal rights have no effect upon the allocation of resources among economic enterprises.
> —Stigler (1988)

I. INTRODUCTION

The epigraph captures the essence of what is generally referred to as the Coase theorem. Rottenberg (1956), preceding Coase by four years, made the same point in the context of professional baseball. Specifically, Rottenberg examined the distribution of playing talent under two institutions. The first allocated the rights to buy and sell players to the owners of Major League Baseball teams. The second system allowed the players to freely choose their employer. Rottenberg (1956, 255) offered the following proposition:[1] "When there are no impediments to the buying and selling of playing talent, the assignment of the rights to this talent will have no effect upon the allocation of players among Major League Baseball teams."

Following the argument of Rottenberg, institutional changes, such as a free market for veteran players and a reverse-order amateur draft, should not affect the distribution of players. Furthermore, because the allocation of talent within a sport is intimately related to the degree of competitive balance, these changes should not impact the distribution of wins.[2] If such policies, though, do not alter competitive balance, what factors are important?

As will be detailed, prior research has suggested that competitive balance in Major League Baseball is not constant but rather has improved for much of the latter half of the 20th century. The present study examines whether the observed changes in the level of competitive balance contradict the precepts of the Coase theorem. Additionally, we desire to examine a separate, largely ignored factor described in the works of evolutionary

*We have benefited from helpful comments from the editor and two anonymous referees. All remaining errors remain our sole responsibility.

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1. Rottenberg (1956, 255) further states, "It seems, indeed, to be true that a market in which freedom is limited by a reserve rule such as that which now governs the baseball labor market distributes players among teams about as a free market would."

2. Of course, if teams are not concerned with profit maximization—that is, if they are concerned with win maximization—institutional arrangements may matter.

ABBREVIATIONS

ABA: American Basketball Association
AFL: American Football League
MLE: Maximum Likelihood Estimation
MLS: Major League Soccer
NASL: North American Soccer League
NFL: National Football League
NHL: National Hockey League
WHA: World Hockey Association

Economic Inquiry
(ISSN 0095-2583)
Vol. 41, No. 4, October 2003, 692–704

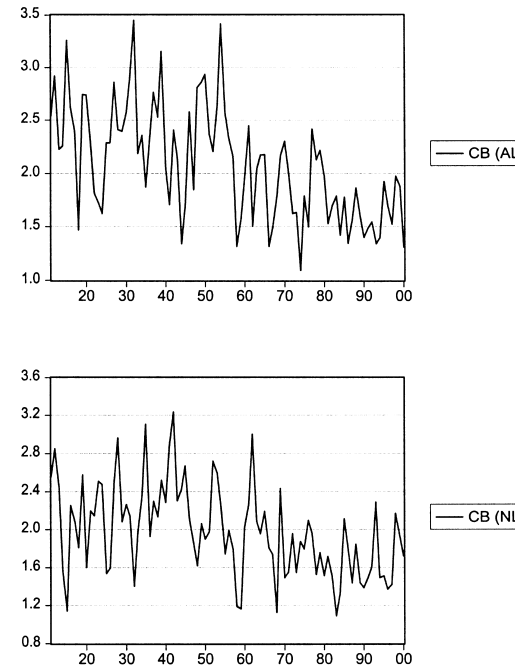
DOI: 10.1093/ei/cbg037

biologist Stephen Jay Gould (1986; 1996) and economist Andrew Zimbalist (1992a; 1992b). Specifically, these authors argue that an expanding population of athletes would influence the convergence of team performance.

Overall, our results suggest that the driving force behind Major League Baseball's improved competitive balance has been increases in the population of players Major League Baseball can employ. Although there exist marginal evidence of an impact from institutional changes, these vary and are quite small.

Our study begins with a review of how competitive balance is measured. The measure of competitive balance will then be contrasted with Major League Baseball's stated position. From this discussion we move on to a discussion of the various institutions baseball has enacted to alter the distribution of wins in the sport and the works of Rottenberg and Gould, all of which suggests that such institutions are not the primary cause of competitive balance in Major League Baseball. We then examine the empirical validity of these views via an examination of the time-series nature of competitive balance. The final section offers some concluding observations.

FIGURE 1
Noll-Scully Competitive Balance (CB_t) Measures American (AL) and National Leagues (NL)



II. THE MEASUREMENT OF COMPETITIVE BALANCE

The examination of competition balance begins with a measure of the distribution of wins in Major League Baseball. Following the lead of Quirk and Fort (1992, 244), who built on Noll (1988), competitive balance can be measured by comparing "the actual performance of a league to the performance that would have occurred if the league had the maximum degree of competitive balance in the sense that all teams were equal in playing strengths. The less the deviation of actual league performance from that of the ideal league, the greater is the degree of competitive balance."

The intuition suggests the following Noll-Scully measure of competitive balance (CB):

$$(1) \qquad CB_{it} = \sigma(wp)_{it}^{actual} / \sigma(wp)_{it}^{ideal}; \quad \text{where } \sigma_{it}^{ideal} = \mu(wp)$$

where $\sigma(wp)_{it}$ is the standard deviation of winning percentages within league (i) in period (t). Also, $\mu(wp)_{it}$ is league (i)'s mean and N the total number of games.[3] Finally, as noted by Quirk and Fort, the idealized standard deviation represents the standard deviation of winning percentage if each team in a league has an equal probability of winning. The greater the actual standard deviation is relative to the ideal, the less balance exists within the professional sports league.

Utilizing this measure, CB_t, we calculated the level of competitive balance in Major League Baseball for both leagues for the years 1901 to 2000. The results of these calculations are reported in Figure 1. The figure highlights the fact that the level of competitive balance in Major League Baseball has

3. Average winning percentage is typically 0.500. With respect to Major League Baseball, two exceptions to this general condition are possible. First, the introduction of interleague play in 1997 allowed for each league's (μ) to differ from (0.5). A divergence from a mean of (0.5) also was possible prior to interleague play. Major League Baseball has traditionally not played games between noncontenders toward the end of the season postponed due to inclement weather. When this happens, the number of games played for each team can differ. Given these possibilities, we used the actual mean winning percentage in the calculation of the idealized standard deviation rather than the assumed value of (0.5).

TABLE 1
OLS Trend Estimates for Competitive Balance (CB_t)

	Sample 1911–2000		Sample 1960–2000	
Dependent Variable	**Constant**	**Time**	**Constant**	**Time**
CB_t AL	2.742**	−0.012**	2.601**	−0.011**
	(0.109)	(0.002)	(0.335)	(0.004)
CB_t NL	2.439**	−0.008**	2.721**	−0.011**
	(0.108)	(0.002)	(0.377)	(0.005)

Note: ** indicates rejection of H_0 at the 1% level.

improved for much of the latter half of the 20th century, that is, both measures show a marked increase in the level of competitive balance beginning after 1960.[4] Finally, Table 1 reports the trend estimates for the (2) series. Specifically, whether one examines the entire period or the past (40) years, each series has experienced a similar and significant downward trend. Finally, the standard deviation of the (2) series has declined. For 1911–59, the standard deviation of CB_t was (0.512) and (0.489) for the American and National Leagues, respectively. These values fell to (0.335) and (0.377), respectively, for the 1960–2000 period.

This factual account stands in contrast to the prevailing view offered by both industry insiders and various members of the media.[5] From their perspective, baseball has a competitive balance problem. Major League Baseball's Blue Ribbon Panel suggested that significant disparities exists in the distribution of both revenue and wins.[6] From 1995–99, the only years the panel considered, no team with a payroll in the bottom 50% of the payroll rankings appeared in Major League Baseball's annual postseason competition. The panel members argued that such a result renders the outcome of the season a foregone conclusion for teams without the revenues necessary to compete. Specifically, these teams understand at the onset of a season that postseason success is not in their future.

The Blue Ribbon Panel recommended a number of changes, many of which seem to limit player movement or to convey greater rights to the teams. For example, the panel proposed to overhaul the amateur draft. Their proposal recommended that foreign players be subject to the draft and that teams maintain the rights of draftees beyond the one-year period they currently hold. In addition, the panel proposed an annual "competitive balance draft," under which the eight clubs with the worst records could draft players not on the 40-man roster of the eight playoff teams.[7]

These proposals hearken back to the arguments offered in support of baseball's reserve clause. For those unfamiliar with baseball history, the reserve clause was enacted in a secret meeting of the National League in 1879 (Eckard, 2001). The clause initially allowed teams to reserve five players at the end of each season who would not be allowed to sign with another organization. The number of players was restricted until eventually every player's contract contained a clause that stated the team could re-sign the player at the conclusion of a contract according to the terms set by the team.

As detailed in Eckard (2001), the National League justified the rule by claiming "the

4. A variety of alternative competitive balance measures have been offered in the literature. These include the dispersion and season-to-season correlation of team winning percentages (Butler, 1995; Quirk and Fort, 1992; Balfour and Porter, 1991), the relative entropy approach (Horowitz, 1997), the Gini coefficient (Schmidt, 2001; Schmidt and Berri, 2001), and the Herfindahl-Hirschman index (Depken, 1999) Each of these measures indicate that competitive balance did improve in the latter half of the 20th century in Major League Baseball.

5. Bud Selig, the commissioner of Major League Baseball, argued during the 2002 season that the lack of competitive balance has had such a detrimental effect that six to eight teams would be bankrupt by the end of 2003. Pappas (2002), though, in an analysis of Major League Baseball's own financial data, disputed such an interpretation.

6. The Commissioner's Blue Ribbon Panel on Baseball Economics was convened by Major League Baseball to investigate the issues of competitive balance and economic health. Specifically, the panel's stated purpose was to "examine the question of whether Baseball's current economic system has created a problem of competitive imbalance in the game" (Levin et al., 2000).

7. The panel also advocated eliminating the compensation pick awarded to clubs who lose players to free agency, noting that many players on the verge of free agency are traded midseason to clubs with better records, who then get the draft pick.

financial results of the past season [1879] prove that salaries must come down" Later statements issued by the league couched the defense of the reserve clause in terms of competitive balance. With a study of league standings, though, Eckard presented evidence that competitive balance was not a significant issue for the National League in 1879. Specifically, Eckard shows that the relation between city population and team wins was actually negative, suggesting that at the time the reserve clause was instituted the league was actually dominated by teams from smaller markets. Hence, Eckard concludes that the reserve clause was only created to limit player salaries and increase the profits of the National League.

III. THE ROTTENBERG (COASE) THEOREM

Given the precepts of classical theory, the distribution of playing talent should follow the dictates of the market. In which case, whether the player or the team holds the right to the athlete's services is theoretically immaterial. If a player could generate a greater stream of revenue in any one market, then franchises located elsewhere would have an incentive to sell the player to the team located in the higher-revenue market. In essence, the ability of teams to buy and sell playing talent circumvents the stated intention of the reserve clause.[8]

The reserve clause was removed via negotiations between the player's union and team owners in 1976.[9] The two sides agreed that players who had accumulated six or more years of Major League experience would become free agents at the conclusion of their current contracts. Although players with less than six years of service were still restricted in their ability to sell their services, players who accumulated such tenure were able to offer their talent on an open market. The industry argued (and continues to argue), that free agency has a detrimental impact on the distribution of wins. The theoretical work of Rottenberg, though, suggests that the institution of a free market for players should not impact the distribution of playing talent, hence competitive balance should not change.

The change in institutions in baseball provides a natural test for the Rottenberg (Coase) theorem. Specifically, the theorem maintains that the levels of competitive balance before and after the institution of free agency should not differ. The results of examining Figure 1 suggest that the tale one can tell depends on the length of time one examines. If one restricts the analysis to the ten years both before and after free agency, one finds no statistical difference in the level of competitive balance observed in either the American League or the National League.[10] If one considers a larger sample, though, spanning the 24 years both before and after the institution of free agency, a different story may be told. Specifically, from 1951 to 1976, the level of competitive balance according to the CB_t measure averaged 1.96 and 1.90 in the American and National Leagues, respectively. For 1977 to 2000, though, the average level of competitive balance fell to 1.70 in the American League. The average National League number fell to 1.64. Each of these changes is statistically significant according to standard Student t-tests.[11] The impact of the introduction of the amateur draft follows similarly.[12]

8. The usual requirements of low transaction costs and lack of restrictions on players sales applies.

9. We would be remiss if we did not acknowledge the role that Curt Flood played in free agency. Though his on-field accomplishments were substantial (he was a key player on the St. Louis Cardinals, a team that went to three World Series during his tenure), Flood's greatest impact on the game came off the field. After being traded to the Phillies following the 1969 season, Flood refused to accept the transfer. He argued that baseball's reserve clause illegally prevented him from practicing his trade as he chose. The case eventually was decided by the Supreme Court. Despite the fact that he lost the case, Flood's stand paved the way for the eventual success of the players' union in establishing the right of free agency.

10. In the ten years prior to free agency, competitive balance according to the CB measure averaged 1.74 in the American League and 1.76 in the National League. After free agency, competitive balance in the American League worsened, averaging 1.83 from 1977 to 1986. Over the same time period, competitive balance improved in the National League to 1.63. To test whether these differences are statistically significant, a standard Student t-test was employed. The results rejected (at the 5% level of significance) the hypothesis that the average level of competitive balance changed in the ten years before and after free agency. Such a result is consistent with the work of Fort and Quirk (1995).

11. Such a result is consistent with the work of Eckard (2001). Although Eckard utilized alternative measures of competitive balance, specifically the variance in league winning percentage and the concentration of league pennant winners, he found competitive balance to improve in the years after free agency. Eckard reached this conclusion via a simple examination of the level of competitive balance both before and after the institution of free agency in 1976. As with each study reviewed, no other hypothesis for the observed changes was considered.

12. Although the reserve clause effectively tied a player to one team, a free market for players who had never signed a contract did exist until 1964. In that year, following the

These last results seem inconsistent with the arguments of Rottenberg and Coase. However, an alternative explanation for the observed changes are not considered. In essence, most studies examining free agency and the amateur draft begin with the supposition that these institutions would alter the level of competitive balance. On observing changes in the distribution of wins, these studies then conclude that the institution examined is the cause of the observed changes. The works of Gould (1986; 1996) and Zimbalist (1992), however, suggest that another factor may be at work: an expanding labor population.

IV. INCREASING THE GLOBAL SEARCH FOR PLAYING TALENT

The breaking of the color line by Jackie Robinson of the Brooklyn Dodgers in 1947 changed the racial composition of Major League Baseball. Prior to this date, the typical Major League Baseball player had been a white American. After 1947, Major League Baseball teams realized that a global search for talent was necessary if the team wished to remain competitive.[13]

Globalization of baseball is now evident on the playing fields in the United States. Players still hail from the traditional areas of recruitment, such as the United States, Dominican Republic, Puerto Rico, Venezuela, and Cuba, but many players from Mexico, Australia, Japan, and Korea also play in the Major Leagues. Even such countries as Spain, Belgium, the Philippines, Singapore, Vietnam, the United Kingdom, Brazil, Nicaragua, and the Virgin Islands have produced professional baseball players. In 2000, the number of foreign-born players on Major League Baseball rosters was 312, constituting 26% of all players (Levin et al., 2000).

The impact of the game's globalization on competition in baseball has recently been highlighted in the writings of Gould (1986; 1996) and Zimbalist (1992a; 1992b). Gould (1986), for example, applied the nature of biological evolution to the inability of Major League Baseball players to hit for a 0.400 average after Ted Williams last accomplished this feat in 1941. In contrast to reports that the inability of modern players to approach this level of performance represented a decline in the abilities of today's athletes, Gould suggested that this change actually represented an improvement in the average skills of the modern baseball player.

Gould argued that the distribution of athletic talent in a population should follow a normal curve. At the right tail of this distribution lay the people with the greatest level of athletic ability. Given that there is a biomechanical limit to the ability of humans, the athletes in the far right tail tend to be relatively equal or, in other words, fairly close to the biological limit. At the beginning of the 20th century, when the people playing Major League Baseball were only white Northeastern American males, the population baseball could draw from was relatively small. Consequently, although baseball employed the most talented players available, the population consisted of players close to the biomechanical limit and many others from further away.

When the population of players exhibits such diversity in talent, a truly skilled player can achieve a level of performance far beyond that of the average player. As the population of available players expanded, due to both racial integration and the expanding global search, the number of players approaching the limit of athletic ability increased. Consequently,

lead of the NFL and the NBA, Major League Baseball introduced a reverse-order amateur draft. Like the reserve clause, the stated intention of the draft was to promote the level of competitive balance. The draft is organized so that the teams that finish last in the prior season are able to choose the top amateurs the following spring. Once an amateur player is drafted by a team, that team then has one year to sign the player. In that year, no other team is able to negotiate with the player. Again, following the Rottenberg theorem, if teams can buy and sell playing talent, one would still expect a team in a smaller market to be willing to sell its most talented drafted players to teams located in larger markets. The work of Fort and Quirk (1995), however, offered evidence that competitive balance improved after the institution of a player draft, specifically with respect to the American League. The work of La Croix and Kawaura (1999) also found an amateur draft to have a positive impact on competitive balance in Japanese baseball.

13. Goff et al. (2002) offered evidence that the integration of Major League Baseball was first undertaken by historically successful teams. Competitive pressure eventually led all team to integrate by the 1960s. The globalization of America's pastime extended beyond a simple search for talent to a search for additional markets. The search for new markets began in 1953 with the first east-to-west franchise relocation and the arrival of Hank Aaron in Milwaukee with the Braves, a club that had moved from Boston the previous winter. The more celebrated and excoriated movements of the New York Giants and the Brooklyn Dodgers to San Francisco and Los Angeles, respectively, set the stage for the expansion of baseball franchises that occurred in the 1960s. Certainly the expansion in the population Major League Baseball used to find talent was tied to the expansion in markets observed in the 1950s and 1960s.

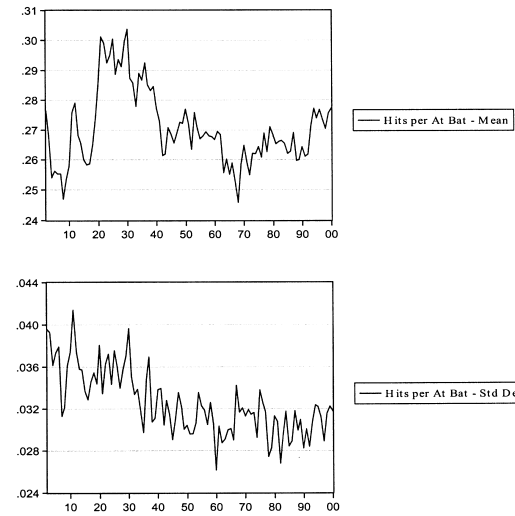
large deviations from the mean performance were no longer observed, and therefore the 0.400-hitter disappears. This argument was largely echoed in Zimbalist (1992a; 1992b). Zimbalist noted that competitive balance had improved following the institution of free-agency, but such improvement was most likely due to the "compression of baseball talent."

As a precursor to our analysis, Figure 2 reports the behavior of the mean and standard deviation of hits per at-bat, that is, batting average, for Major League Baseball. Consistent with Gould's hypothesis, there has been little change in the mean batting average across time, particularly if one excludes the 1920s and 1930s. In contrast, the variance of batting averages has declined.

Following Chatterjee and Yilmaz (1991), this argument may be extended to competitive balance. Specifically, because player performance will converge on the mean when the population of players more frequently consists of those close to the biological limit of human, teams (which consist of these more similar players) should also be converging on the mean winning percentage.[14] In other words, as the number of players close to the biological limit expands, the talent each team has access to will increase, making the game itself increasingly competitive. To test the aforementioned hypothesis, Chatterjee and Yilmaz (1991) examined the variability of winning percentage in Major League Baseball. Similar to the evidence offered in Figure 1 and Table 1, these authors found baseball to be increasingly competitive over time.

Along similar lines, if competitive balance was dictated only by the underlying population

FIGURE 2
Time Series Plots of Hits Per At-bat: Mean and Standard Deviation Estimates for Major League Baseball



of potential athletes and not by league institutions, then one should see similarities in the level of competitive balance within different leagues in the same sport, yet differences across sports.[15] We examine this hypothesis by investigating the level of competitive balance in five different sports (baseball, basketball, American football, hockey, and soccer) and the following leagues: the American and National League in baseball, the National Basketball Association (NBA) and American Basketball Association (ABA); the National Hockey League (NHL) and World Hockey Association (WHA); the National Football League (NFL) and the American Football League (AFL); and the Bundesliga, North American Soccer League (NASL), and Major League Soccer (MLS). To facilitate comparison, only years for which leagues simultaneously existed in the sport are examined.

Table 2 reports the average level of competitive balance in each of these leagues.[16] The

14. An intermediate step is required. Specifically, the Gould hypothesis suggests that all players, below and above average, approach a biomechanical limit. However, because below-average players are farther away, they approach the limit at a faster pace, at least in percentage terms, than above-average players. Furthermore, one would suspect that the probability of winning is an outgrowth of the caliber of individual players a team has to choose from, particularly in baseball. The Gould hypothesis, therefore, argues that as the talent pool rises, greater player homogeneity should be observed. Given no change in the way players are distributed, the probability of a poor team, now stocked with players closer in talent to those of the stronger team, must rise relative to stronger teams. This provides another reason for including the dummy variables: these variables capture changes in the way players are distributed. Finally, this is precisely the issue that Chatterjee and Yilmaz (1991) examined. These authors found that variability in winning percentages in both the National and American League has been declining over time.

15. Much of this argument follows from the work of Berri and Vicente-Mayoral (2001).

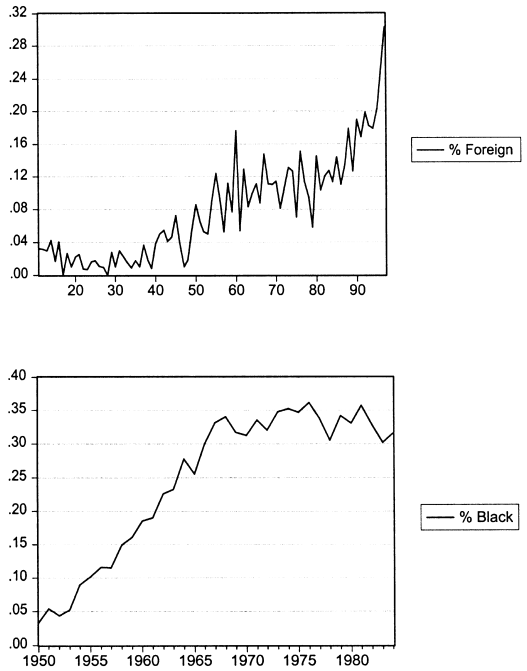
16. Berri and Vicente-Mayoral (2001) examined 13 leagues, as opposed to the 11 we report in Table 2. With respect to American football, we only report the data from the NFL and AFL. Berri and Vicente-Mayoral also reported the level of competitive balance in the Canadian Football League and the Arena Football League. The results were consistent with the theoretical extension of

TABLE 2
Competitive Balance (CB_t) across Various Professional Team Sports

Sport	League	Years	Average Level of CB_t
Basketball	NBA	1967–68 to 1975–76	2.59
	ABA	1967–68 to 1975–76	2.60
Baseball	AL	1901–2000	2.12
	NL	1901–2000	2.08
Hockey	NHL	1972–73 to 1978–79	2.59
	WHA	1972–73 to 1978–79	1.89
Football	NFL	1960–1969	1.57
	AFL	1960–1969	1.58
Soccer	Bundesliga	1964–95	1.32
	NASL, MLS	1967–84, 1996–2000	1.34

dispersion of wins within leagues in baseball, basketball, football, and soccer are statistically similar.[17] The lone exception is hockey, the sport with the smallest sample of simultaneously existing leagues.[18] The level of competitive balance, in contrast, achieved by each sport is quite different. The most competitive is soccer, the sport with the largest underlying population of athletes. The least competitive sport is professional basketball, which extensively draws its talent from the small pool of tall athletes.[19]

FIGURE 3
Measures of Player Diversification



V. EMPIRICAL METHODOLOGY AND RESULTS

For the past century, Major League Baseball has taken a variety of steps designed, according to baseball's hierarchy, to alter the level of competitive balance in the sport. These innovations include changing how the rights to players were distributed as well as expanding the pool of available talent. The purpose of this inquiry is to examine if either of these actions is the primary cause of the observed changes in the distribution of wins.

Our efforts begin with Figure 3, where two separate measures of baseball's larger player pool are offered. The first (a) represents the percentage of Major League Baseball players that were foreign-born, and the second (b) represents the percentage that is black.[20]

Gould's work, that is, leagues drawing from the same populations did exhibit similar levels of competitive balance.

17. Berri and Vicente-Mayoral (2001) tested whether or not the reported means are statistically equivalent via the standard Student t-test. The t-statistic was calculated by these authors for the following league pairs: The NBA and ABA from 1967–68 to 1975–76; the NHL and WHA from 1972–73 to 1978–79; the Bundesliga and NASL from 1967–84; the NFL and AFL from 1960–69; and the NL and AL from 1900–2000. Except for the NHL and WHA, Berri and Vicente-Mayoral report that every league pair was found to have a statistically equivalent average level of competitive balance.

18. As reported by Berri and Vicente-Mayoral (2001), the level of competitive balance achieved in the brief history of the WHA was quite similar to the level achieved in the history of the NHL.

19. The size of an athlete is a significant resource in both basketball and football. However, what is meant by size and the nature of the restriction differs across the two sports. In football, substantial weight may help when playing certain positions. Such weight, though, may be manufactured via diet and exercise. For professional basketball, where height is the predominant physical characteristic, diet and exercise are not of much assistance. As is frequently noted by people employed in the sport, one cannot teach height. In other words, no amount of diet or exercise will make an athlete who is six feet tall into a seven-footer. Hence, professional basketball faces a much more rigid restriction relative to professional football. Consequently, we would argue that only in basketball does the size requirement substantially limit the pool of available talent. For other factors that may influence competitive balance, see Sanderson (2002). The work of Sanderson was a part of a special issue of the *Journal of Sports Economics* devoted to the topic of competitive balance in sports.

Both measures suggest that increased diversification of Major League Baseball players is a characteristic of the industry. To examine the impact an expanding population has on competitive balance, we take advantage of the time series characteristics of the CB_t and player-composition measures. Specifically, we examine whether the series have a long-run relationship, that is, whether they are cointegrated. Furthermore, we examine whether competitive balance responds to changes in the make-up of players.

Empirical Methodology

In their seminal treatment of cointegration, Engle and Granger (1991) describe the process of cointegration as that of attraction—two (or more) cointegrated series are held together through time. Specifically, although the (2) series may deviate from each other, there exists a process(es) that return the series to their defined equilibrium. In the present case, Gould's theory suggests that competitive balance and the population pool may be related across time. Furthermore, if the two are related, Gould's supposition would suggest that the attraction should flow from the increased population toward competitive balance, that is, an increased player search should Granger cause increased competitive balance.

To examine the long-run properties of the set of variables, the present paper opts for the Johansen maximum likelihood estimation (MLE) approach rather than the Engel-Granger two-step method preferred by some. The choice is motivated by the recent findings of Gonzolo (1994) demonstrating that the Johansen MLE approach has stronger small sample properties. In addition, Gonzolo has shown that the Johansen MLE approach is less sensitive to the choice of lag structure. As has been highlighted within the literature, the estimation of both long- and short-run estimates can be sensitive to such a choice.[21]

In brief, the Johansen MLE approach integrates both of the long- and short-run responses. The approach maybe summarized by the following general k-order VAR model (see Johansen, 1988; 1992a; 1992b):

$$(2) \quad \Delta X_t = \mu + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \varepsilon_t,$$

where X_t is a vector of $I(1)$ variables at time t, the $\Gamma_i \Delta X_{t-i}$ terms account for the stationary variation related to the past history of the variables, and the Π matrix contains the cointegrating relationships. Furthermore the Π matrix may be separated into two components, such that $\Pi = \alpha\beta'$, where the cointegrating parameters—that is, equation (1)—are contained within the β matrix and the α matrix describes the weights with which each variable enters the equation, that is, equation (2). Cointegration, then, requires that the β matrix contain parameters such that Z_t, where $Z_t = \beta' X_t$, is stationary. Finally, the α matrix is thought to represent the speed with which each variable changes to return the individual vectors to their respective long-run equilibrium. Such a matrix may be estimated from the error correction equations.

In terms of directional causality, the use of cointegration techniques presents a difficulty because all of the included variables are assumed to be endogenous and therefore cannot provide direct information on the exogeneity of the variables. Crowder (1998), though, offers straightforward tests for exogeniety through examination of the Γ_i and α estimates. Specifically, if ΔX_{it} fails to respond to the defined long-run disequilibrium, that is, $\alpha_i = 0$, then X_{it} is said to be weakly exogenous.[22] In addition to weak exogeneity, strong exogeneity requires that ΔX_{it} fail to respond to the incorporated (k) lags of ΔX_j, that is, $\Sigma\Gamma_i = 0$.

20. We would like to thank Sean Lahmen, author of the Baseball Archive (www.baseball1.com) for the data on the number of foreign-born players in Major League Baseball. We also thank Andrew Hanssen for providing the data on racial integration. The latter data have previously been utilized in a study of discrimination in Major League Baseball (Hanssen, 1998). Given that some players would fall into both categories, that is, foreign-born blacks, there is some degree of overlap between the two series. However, both provide separate and distinct tests. One group examines an increasing search due to racial integration, the majority of which came (at least initially) from within the nation and probably was responsible for an initial increase in the talent pool. The second group examines a increasing search globally regardless of race or color and likely was responsible for later increases.

21. Specifically, a lag structure that is too high may overparameterize and may thus reduce the power of the cointegration tests. However, a lag structure that is too low may not produce residuals that are Gaussian.

22. The use of strong and weak exogeneity follows the definitions presented in Engel et al. (1983).

Once stationarity has been established, it is precisely the Γ_i and α estimates that are of interest. Shocks that alter the defined long-run equilibrium, $Z_t = \beta' X_t$, by creating a wedge between the cointegrated variables require some adjustment by the included variables to re-attain the defined equilibrium. In the present case, the policy prescription of increasing the labor search would, hypothetically, increase the labor pool and therefore alter the makeup of players. The question is, therefore, to what extent do the individual cointegrated variables, that is, competitive balance measures, move to clear the disequilibrium created by the shock, Γ_i and α. We recognize that although the Coase theorem may suggest that institutional factors, such as free agency, fail to influence competitive balance measures, that is, X_t, these factors may still have an impact and therefore could bias the estimated results (Johansen and Juselius, 1992). For example, high transactions costs or restrictions on the sale of players would limit the applicability of the theorem. Daly (1992), among others, has argued that the sale of players was significantly restricted prior to free agency.

Therefore, we included several of these factors as conditioning variables. Conditioning variables are generally incorporated to eliminate unwanted influences that might affect the estimates of the cointegrating vectors, but because they are not in any hypothesized vectors, it would be inappropriate to include them in the system. These variables, though, may be influential, and their effects would need to be included. Consequently we chose to include dummy variables (for expansion in each league, the institution of free agency, and the reverse-order draft). Specifically, we included the conditioning vector C_t', where $C_t' =$ (Expansion, Free Agency, and Draft Dummies). In terms of specification, a pure pulse specification for the dummy variables would clearly be inappropriate, hence we introduced the variables as unity for the entire postinstitutional change period, that is, the dummy for free agency is (1) from 1976 to the conclusion of the study. Finally, it is possible (perhaps even likely) that significant multicollinearity exists between the dummy variables. Therefore, in the final estimation we replaced the individual dummy representation with the sum of the variables, *dummy-all*.

Empirical Results

A starting point for any long-run analysis involves investigation of the integrated level of the incorporated data. To examine the stationarity of the variables, both augmented Dickey-Fuller and Phillips-Perron analysis were performed. As noted in Table 3, both test results confirm the presence of a unit root in competitive balance and player diversity measures.

Given the $I(1)$ nature of the data, the variables are introduced in levels and may therefore be cointegrated. In addition, a lag structure must be selected for the Johansen MLE procedure. To determine the appropriate number, we examined the Hannan-Quinn, AIC, and SBC tests on various lag options. Overall, these tests suggest that the two-variable VARs have different lag structures. Specifically,

TABLE 3
Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests

	ADF Statistic (p)	Phillips-Perron Statistic (l)		ADF Statistic (p)	Phillips-Perron Statistic (l)
Sample 1901–2000			*Sample 1901–2000*		
CB_t AL	−0.940 (2)	−1.096 (3)	CB_t NL	−0.946 (2)	−1.077 (3)
d(CB_t AL)	−8.607 (2)**	−14.382 (3)**	d(CB_t NL)	−8.438 (2)**	−14.499 (3)**
Sample 1911–1997			*Sample 1950–1984*		
% Foreign	−1.293 (2)	−0.325 (3)	*% Black*	−2.272 (1)	−2.444 (3)
d(*% Foreign*)	−8.489 (2)**	−14.327 (3)**	d(*% Black*)	−3.700 (1)**	−6.708 (3)**

Notes: The augmented Dickey-Fuller statistics were computed using (p) lags. The choice of p was based on minimization of the Schwartz-Bayesian criteria. The Phillips-Perron statistics were computed using the AR(1) regression including a constant. The choice of truncation lag (l) is based on Newey-West. In addition, ** represents significance at the 99% critical level.

TABLE 4
The Cointegrating Vectors: Normalized β Estimates

	Normalized On	LR Restriction	$\chi^2(1)$ Statistic		Normalized On	LR Restriction	χ^2 (1) Statistic
% Foreign (1911–97)	CB_t (*AL*)	$\beta = -1.00$	2.156 (0.142)	*% Black* (1950–84)	CB_t (*AL*)	$\beta = -1.00$	1.476 (0.224)
	CB_t (*NL*)	$\beta = -1.00$	3.352 (0.067)		CB_t (*NL*)	$\beta = -1.00$	2.664 (0.103)

Notes: The (n) overidentifying restrictions are imposed on the estimated matrix and the log-likelihood ratio tests are by the method suggested in Johansen and Juselius (1992). The ratio test statistics estimated $\chi(n)$ p-values are reported in parentheses.

though the (CB_t[NL]—% *foreign born*) VAR selects a lag of (4), the AL version opts for (2). Both AL and NL versions of the *% Black* VAR chose a lag of (1). Finally, to examine the sensitivity of the choice, the following was replicated using the alternative lag lengths, that is, (1), . . . (4). The results from these were qualitatively similar to those presented later.

A final issue in the analysis is whether to include intercept and trend variables. Such tests may be sensitive to this choice. To address these issues, Johansen (1992a; 1992b) maintains that an examination of cointegration should begin with as general an approach as possible. Therefore, we examined the restricted results with both constant and trend terms to assess their relative importance. In the majority of cases, both trend and constant terms were significant; therefore, the cointegrating equations were estimated with both.

With the use of Johansen and Juselius's (1992) procedure, it is possible to obtain the estimated cointegrating coefficients, that is, the estimated β's, and to test the hypothesized unity restriction. The identifying procedure, though, requires a normalizing restriction. In the present context, the relation is normalized on the league CB_t competitive balance measure. Table 4 reports the results of applying Johansen and Juselius likelihood ratio tests to the two-variable VARs. All tests fail to reject the unity restriction at conventional levels. Though these tests suggest that the variables are cointegrated and tied together through time, it does little to guarantee how the variables maintain their equilibrium. Therefore, a final step in a cointegration analysis is to ascertain these responses.

The endogenous responses of competitive balance to changes in population may provide important information for sports league participants. Exogenous shocks that create a wedge between the cointegrated variables require one and/or more of the variables to move to re-attain the prescribed equilibrium. Such responses, though, may be an outgrowth of either deviations from the defined long-run equilibrium, the disequilibrium gap, or from the incorporated lags.

Specifically, the disequilbrium error term, ϵ_t, represents the deviation away from the defined long-run equilibrium. Given the normalization on the competitive balance measure, if $\epsilon_t > 0$, the adjustment back to equilibrium would require that the CB_t measure to fall and/or for the population measure to rise. Theoretically, any combination of the two will clear the relationship. For $\epsilon_t < 0$, the opposite responses are available. Therefore, the CB_t measure should respond negatively to ϵ_t, and the population measure should move positively.

These results are presented in Table 5. In general, the results are consistent with the theories of Gould because the competitive balance measures do respond endogenously to changes in the population pool.[23] Specifically, although the CB_t measures all respond negatively and significantly to the associated disequilbrium, none of the population measures provide a significant response. Furthermore, the competitive balance response values are relatively close to (1) and therefore suggest that adjustment occurs relatively quickly.

The analysis does allow us to investigate the impact of institutional changes on competitive balance. In support of Rottenberg's position, the vast majority of the individual dummy variables are insignificant within the VECs. There is, however, one exception: the response to the

23. To examine whether the equations are properly specified, Godfrey's LM test for serial correlation, Ramsey's RESET test for functional form, a Jarque-Bera test for normality, and White's test for heteroscedasticity are reported. Overall, the results indicate that the system of equations are well behaved.

TABLE 5

Weak and strong exogeniety tests: Speed of adjustment and associated lag Wald tests.

β	Variable	ϵ_{t-1}	$\sum\triangle(\mathrm{NS})t-j$ $\sum\Gamma_i=0$	$\sum\triangle(\%)_{t-j}$ $\sum\Gamma_i=0$	Dummy-1961	Dummy-1962	Dummy-1965	Dummy-1969	Dummy-1977	Dummy-all	Diagnostic Tests
% Foreign (1911–97)	CB_t AL	**−0.808** **(0.000)**	0.245 (0.666)	2.614 (0.235)	−0.156 (0.487)	—	−0.276 (0.364)	0.171 (0.524)	−0.045 (0.808)	**−0.060** **(0.000)**	JB(2): 0.298 (0.862) W(4): 1.477 (0.148) G(4): 0.227 (0.797) R(1): 0.011 (0.919)
	% Foreign	0.005 (0.657)	−0.007 (0.489)	**−0.884** **(0.000)**	−0.020 (0.211)	—	0.029 (0.159)	−0.018 (0.323)	**0.022** **(0.087)**	0.003 (0.147)	JB(2): 4.732 (0.090) W(4): 0.833 (0.632) G(4): 6.981 (0.010) R(1): 0.087 (0.769)
	CB_t NL	**−0.740** **(0.000)**	−0.184 (0.997)	6.258 (0.223)	—	0.408 (0.147)	−0.594 (0.111)	0.217 (0.430)	−0.021 (0.910)	**−0.053** **(0.054)**	JB(2): 0.292 (0.864) W(4): 1.293 (0.218) G(4): 1.475 (0.236) R(1): 0.165 (0.686)
	% Foreign	0.009 (0.521)	−0.018 (0.418)	**−2.423** **(0.000)**	—	−0.005 (0.809)	0.009 (0.726)	−0.015 (0.413)	**0.026** **(0.034)**	0.003 (0.103)	JB(2): 3.367 (0.186) W(4): 1.001 (0.474) G(4): 0.353 (0.704) R(1): 0.128 (0.721)
% Black (1950–84)	CB_t AL	**−0.843** **(0.000)**	0.051 (0.766)	1.676 (0.647)	0.347 (0.173)	—	−0.012 (0.968)	**0.627** **(0.032)**	**0.840** **(0.004)**	**0.173** **(0.002)**	JB(2): 0.373 (0.830) W(4): 0.920 (0.622) G(4): 1.227 (0.309) R(1): 0.321 (0.576)
	% Black	0.010 (0.339)	−0.008 (0.360)	**−0.486** **(0.010)**	0.009 (0.479)	—	−0.007 (0.613)	**−0.031** **(0.033)**	−0.017 (0.221)	−0.001 (0.979)	JB(2): 1.984 (0.371) W(4): 1.933 (0.100) G(4): 1.921 (0.160) R(1): 0.167 (0.684)
	CB_t NL	**−1.361** **(0.000)**	**0.342** **(0.089)**	**2.078** **(0.089)**	—	1.293 (0.002)	−0.429 (0.161)	**0.721** **(0.008)**	**1.024** **(0.001)**	**0.317** **(0.002)**	JB(2): 0.124 (0.947) W(4): 0.834 (0.593) G(4): 1.849 (0.178) R(1): 0.223 (0.641)
	% Black	0.014 (0.311)	**−0.020** **(0.038)**	**−0.481** **(0.005)**	—	0.001 (0.950)	−0.008 (0.601)	**−0.028** **(0.031)**	−0.021 (0.149)	−0.013 (0.004)	JB(2): 3.086 (0.214) W(4): 1.522 (0.199) G(4): 5.081 (0.040) R(1): 1.271 (0.260)

Notes: The ϵ_{t-1} was computed from the results presented in Table 4. Each equation includes a constant. The coefficients are reported with their associated *t*-statistic for the null hypothesis that the estimated value is equal to zero. $G(q)$ reports the Breusch-Godfrey statistic for serial correlation within the residuals obtained from the estimated model, with lag order of q. JB(q) reports the Jarque-Bera statistic for normality of the residuals obtained from the estimated model, with lag order of q. $W(q)$ reports White's statistic for heteroscedastic errors within the residuals obtained from the estimated model, with lag order of q. $R(n)$ reports the Ramsey RESET statistic for functional form of the estimated model. *p*-values are in parentheses.

free agency (1976) dummy variable within the *% Black* equations. These responses support the owner's position that the introduction of free agency would create greater competitive imbalance.

Significant multicollinearity, though, may exist between the dummy variables. Therefore, we replaced the individual dummy variables with an aggregate measure of institutional change. Specifically, *dummy-all* represents a simple sum of the individual dummy variables in Table 5. The estimated responses within the VECs are reported under the column *dummy-all*.[24] Although significant CB_t responses exist within both league equations and within both population measures, all are quite small in magnitude. Moreover, the population measures suggest different responses, with the *% Black* equations producing greater competitive imbalance and the *% Foreign* equations suggesting greater competitive balance.

Finally, the significant response of our population series to institutional changes, particularly the National League response, is consistent with the arguments recently raised in Shepherd and Shepherd (2002). The authors suggest that the stricter hiring requirements imposed on domestic players, specifically, the reverse-order player draft and minimum age requirements, reduced the potential benefits of signing and developing domestic players. Teams, therefore, have sought out alternatives where such limitations do not exist. In which case, the imposition of these institutional changes should produce a positive response in our population series.

VI. CONCLUDING OBSERVATIONS

The literature examining the economics of professional baseball has generally focused on the impact various institutions have on the level of competitive balance. A difficulty with this literature is that alternative causal factors have not been regularly addressed. Consequently, the applicability of the Rottenberg (Coase) theorem could not be clearly ascertained.

The empirical method employed herein examined both the impact of league institutions as well as the Gould hypothesis, which asserts that the distribution of wins in Major League Baseball is primarily a function of the size of the underlying population of talent. In general, the reported findings support both the work of Rottenberg and Gould. Although competitive balance has improved over time in Major League Baseball, the observed changes appear to be consistent with changes in the available talent pool, not changes in the institutions Major League Baseball has utilized to distribute the rights to playing talent.

Such results stand at variance with the position adopted by Major League Baseball Commissioner Bud Selig.[25] Selig contends that baseball at the dawn of the 21st century has a competitive balance problem. Furthermore, this problem can be at least partially addressed by altering the institutions governing the game. Following the work of Coase and Rottenberg, the changes proposed by Selig would likely increase the amount of revenue retained by the owners of Major League Baseball teams. Such changes, though, following the reported empirical results, would not alter the level of competitive balance.

In terms of what policies may work, it is the case that through much of the 20th century baseball was the sport of choice among American youths. Currently, though, sports participation by boys ages 7–17 is 8.7 million in basketball compared to 6.9 million in baseball (Fort, 2003, p. 20). Given the work of Gould and the empirical results offered here, the relative decline in the popularity of baseball should be of serious concern to those concerned about the level of competition in Major League Baseball. If young men choose not to participate in baseball, the available talent pool will fall, and so will the level of competitive balance. Perhaps the resources expended on resolving yet another labor dispute would be better spent on the promotion of the sport that was once America's pastime.

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24. Because none of the other responses deviated significantly, we do not report these. These are available from the authors on request.

25. Of course, it is possible, even likely, that the position of the commissioner has little to due with competitive balance and more to due with capturing rents for owners. In which case, his position would be consistent. We thank an anonymous referee for raising the issue.

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