E C O N O M I C S B U L L E T I N

The relationship between payroll and performance disparity in major league baseball: an alternative measure

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Abstract

This paper introduces an alternative method of measuring competitive balance in major league baseball and employs it to assess both payroll (talent) disparity and performance (wins) disparity for 30 selected years between 1929 and 2002. Attention is devoted to the impact of two critical events in the evolution of the game: the influx of non−white players and the advent of free agency. The joint effect of these events was to increase payroll disparity while simultaneously reducing performance disparity. A single equation regression model found the effect of payroll disparity on wins disparity in the post free agency period to be positive and significant. The increasing disparity in payrolls since the mid 1990s, particularly in the American League, suggests that the luxury tax has been ineffectual and that greater performance disparity can be expected in the near future.

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1. Introduction

Recently there has been an escalating concern regarding payroll disparity across teams in Major League Baseball. This concern has been exacerbated in recent years by the continual on-field success of high payroll teams such as the New York Yankees and the Atlanta Braves.

Both the National Football League and the National Basketball Association instituted salary caps (NFL in 1993; NBA in 1984) as a means toward eliminating payroll disparity. League officialdom (including labor leaders) apparently expected the resulting movement toward competitive balance to enhance league success. The renewal of those caps would seem to validate those expectations. In an attempt to acquire a comparable degree of league success, Major League Baseball has instituted a payroll tax for teams whose payroll exceeds some specified limit. In theory this will reduce payroll disparity and enhance competitive balance between teams. This paper employs the Index of Dissimilarity in an examination of the relationship between payroll and win disparity in Major League Baseball.

Several questions arise concerning payroll and win disparity in Major League Baseball. 1) Has there been an increasing disparity in payrolls across teams in Major League Baseball? 2) Has competitive balance changed over time? 3) How did the advent of free agency affect disparity in payrolls and competitive balance? 4) Is there a correlation between the disparity in payrolls and competitive balance in Major League Baseball? 5) Has the institution of the payroll tax affected the disparity in payrolls and competitive balance? Several of these questions have been examined in the current literature.

2. Literature Review

The last fifteen years have seen the economics profession generate a thorough body of research regarding the issue of competitive balance in MLB. These efforts have utilized a variety of competitive balance indicators including the range of winning percentages; the standard deviation of winning percentages; the relative entropy measure of information theory; the concentration of league championships; the Gini coefficient; the dispersion and season-to-season correlation of winning percentages; and the Herfindahl-Hirschman index. Of these indicators, the most favored (for in-season competitive balance) has been the standard deviation of winning percentage compared to its idealized value.

The basic conclusions from literature concerning competitive balance and payroll disparity in Major League Baseball are consistent no matter what measure of disparity the authors chose. Horowitz (1997), Zimbalist (2000), and Schmidt and Berri (2002) found that the level of competitive balance has increased in Major League Baseball over time. Rottenburg (1956), El Hodiri and Quirk (1971), and Fort and Quirk (1995) found that free agency has not affected competitive balance but has increased the level of payroll disparity in Major League Baseball. Horowitz (1997) and Schmidt and Berri (2003) found that the addition of outside population groups has positively affected the level of competitive balance.

Several articles including Schmidt (2001), Schmidt and Berri (2001), and Schmidt and Berri (2002) have measured the degree of competitive balance in professional sports leagues using Gini coefficients. Schmidt and Berri (2002) examined competitive balance using both Gini coefficients and winning percentage standard deviations. They concluded that both approaches yield similar results.

Utt and Fort (2002) questioned the use of Gini coefficients to measure competitive balance in sports leagues for two reasons. Because one team cannot attain all the wins in any league, the denominator of the conventional Gini coefficient will be too large and the resulting Ginis too small when used to measure competitive balance.

Their second concern about the use of Gini coefficients to measure competitive balance also revolves around the denominator of the conventional Gini coefficient. Over the years most leagues have not only expanded, but have also introduced various evolving scheduling formats. When MLB expanded in 1969 it introduced an unbalanced scheduling format. More recent expansions brought changes to the make-up of the unbalanced format. The introduction of interleague play in 1997 brought new complications to the creation of schedules. Each of these changes affects the potential disparity in wins and hence, the denominator of the Gini coefficient. The consequence of a variable Gini denominator is potentially misleading conclusions about competitive balance. (See, for example, the claim of Utt and Fort (2002) that "failing to adjust Gini coefficients … provides some puzzling qualitative results.")

3. An Alternative Method of Measuring Competitive Balance

Since the concerns raised by Utt and Fort regarding the use of the Gini to measure competitive balance revolve around the denominator, one possible solution is to eliminate the denominator. A measure of inequality known as the ***Index of Dissimilarity*** is linked to the concept of comparing the actual Lorenz curve with the lines of perfect equality, i.e., the numerator of the conventional Gini coefficient. A version this statistic has been used extensively in sociology and human geography as an indicator of residential and geographic segregation. The Index of Dissimilarity (ID) is given as

$$\text{ID} = 0.5\sum_{i=1}^{N}\left|X_i - Y_i\right|. \qquad (1)$$

Where X denotes each team's proportion of total teams and Y denotes each team's proportion of total wins. Since this Index has no denominator, its use appears to address the issues raised by Utt and Fort regarding the usefulness of the Gini coefficient to analyze competitive balance.

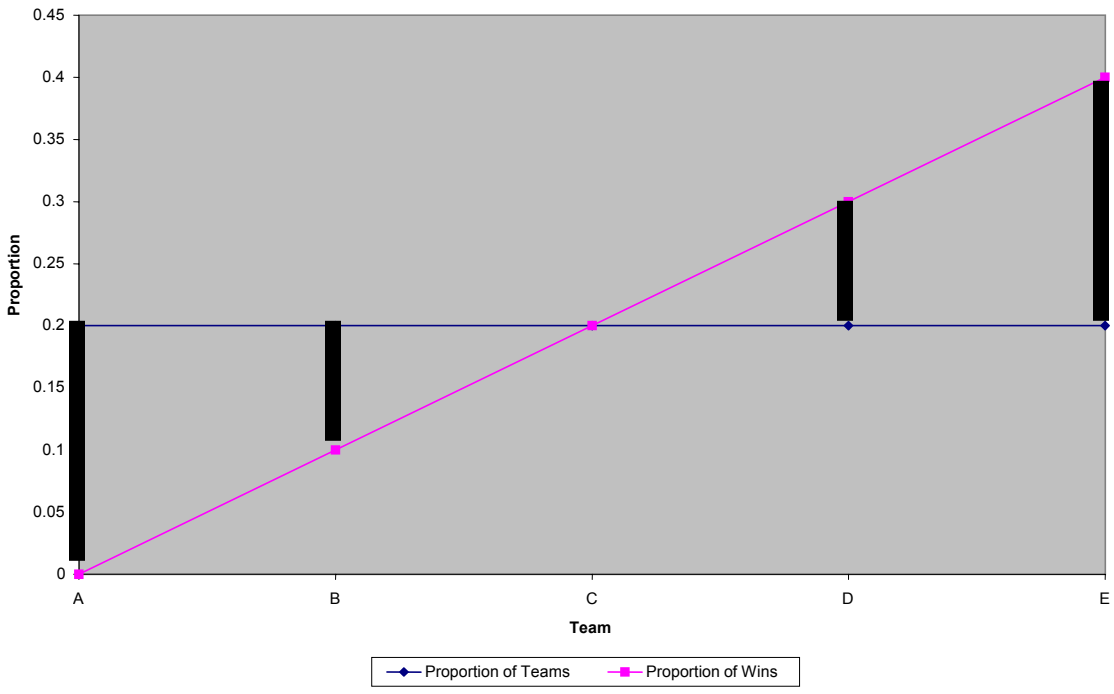
The following simple example illustrates the calculation of the Index of Dissimilarity. Assuming a five team league where each team plays every rival 5 times, Table I gives a potential distribution of wins and the calculations necessary for the Index of Dissimilarity.

Table I. Example Calculations for Index of Dissimilarity for Wins

Team	Wins	X	Y	|X-Y|
A	20	0.2	0.4	0.2
B	15	0.2	0.3	0.1
C	10	0.2	0.2	0
D	5	0.2	0.1	0.1
E	0	0.2	0	0.2
Total	50	1.0	1.0	0.6

The calculation of Index of Dissimilarity is shown on the following graph. The Index of Dissimilarity is ½ times the absolute value of the sum of the vertical distance between the two lines at each observation (shown by the bold vertical lines on the graph below). Unlike the Gini coefficient it is not calculated as an area graphically.

Figure I. Index of Dissimilarity for a Five Team League



In this example the ID = 0.3. It can be interpreted as the minimum proportion of total wins that must be reallocated to produce perfect equality. The preceding example has 50 total wins. The Index of Dissimilarity says that a minimum of 30% of these wins must be reallocated for each team to achieve an equal number of victories. This means that 15 wins must be reallocated to achieve perfect equality in wins. If 10 wins are taken from team A and given to team E, and 5 wins are taken from team B and given to team D, each team would have ten victories. The larger the initial disparity, the greater the

reallocative need and hence the larger the ID value. Therefore, larger ID numbers indicate greater competitive imbalance in Major League Baseball.

The Index of Dissimilarity adapted to MLB payrolls similarly indicates the minimum proportion of total league payroll that must be reallocated to achieve perfect equality in team payrolls. This measure is a powerful indicator of the level of revenue sharing necessary to equalize team payrolls. It should be noted here that the ID only measures the proportion of total wins that need to be reallocated to achieve perfect equality. It does not differentiate between the various distributions that may have produced the initial allocation. One team having 8 more victories than all other teams is treated exactly the same as 8 teams having one more victory than all of the others. In a sense then it provides an entirely different look at competitive balance than standard deviation, which addresses how individual performances are dispersed around a mean.

4. Data

The sample contains data on MLB per team payrolls and wins for 30 selected years from 1929 to 2002. Eleven observations are from the pre-1957 period and nineteen from the post-free agency period. Observations were limited by the lack of payroll data for many years. Calculations were made separately for the American and National Leagues. The Index of Dissimilarity for payroll and wins is provided in the following table.

Table II. Index of Dissimilarity Values 1929-2004

	American		National	
	ID Payroll	**ID Wins**	**ID Payroll**	**ID Wins**
2004	0.176		0.140	
2003	0.191	0.079	0.124	0.056
2002	0.187	0.090	0.126	0.064
2001	0.170	0.075	0.149	0.056
2000	0.171	0.044	0.118	0.060
1999	0.211	0.066	0.167	0.069
1998	0.169	0.061	0.200	0.071
1997	0.148	0.047	0.127	0.047
1996	0.193	0.051	0.114	0.045
1995	0.109	0.063	0.145	0.047
1994	0.087	0.057	0.127	0.057
1993	0.107	0.045	0.149	0.077
1992	0.114	0.056	0.113	0.051
1991	0.115	0.042	0.103	0.050
1990	0.122	0.044	0.090	0.048
1989	0.129	0.051	0.120	0.050
1988	0.138	0.061	0.087	0.052
1987	0.121	0.049	0.118	0.049
1986	0.128	0.048	0.096	0.057

1977	0.171	0.087	0.122	0.063
1976	0.135	0.049	0.110	0.070
1956	0.113	0.083	0.092	0.073
1955	0.121	0.094	0.089	0.053
1954	0.128	0.125	0.087	0.076
1953	0.095	0.094	0.103	0.089
1952	0.103	0.067	0.089	0.090
1950	0.148	0.115	0.060	0.070
1946	0.100	0.084	0.020	0.079
1943	0.076	0.067	0.078	0.075
1939	0.120	0.108	0.096	0.086
1933	0.096	0.070	0.059	0.076
1929	0.087	0.077	0.071	0.070

5.1 Disparity in Payrolls and Victories Since 1929

The ID values reported above yield several unambiguous observations. First and foremost, since 1929, the disparity in payrolls across teams in Major League Baseball has increased dramatically. The American League Index for payrolls in 1929 was approximately 0.087. By 2000 it rose to an all-time maximum of approximately 0.211. This indicates that 21.1% of the total American League payroll would need to be reallocated to equalize team payrolls. In the National League the Index for payrolls in 1929 was approximately 0.071, with a maximum of 0.200 coming in 1998. Payroll disparity in Major League Baseball in 2000, as measured by the Index of Dissimilarity, was more than twice as large as in 1929.

Conversely, the disparity in victories since 1929 across teams in Major League Baseball has declined. In 1929 the Index of Dissimilarity for wins in the American League was approximately 0.077. The Index for wins reached a maximum of approximately 0.125 in 1954, fell to an all-time low of 0.042 in 1991, and has since risen. In 1954 in the American League 12.5% of total wins would need to be reallocated to equalize victories, but in 1991 only 4.2% of victories would need to be redistributed to obtain a similar result. In the National League the Index for wins in 1929 was 0.070. It reached a maximum in 1952 of 0.090 and a minimum of 0.045 in 1996. It too has since risen. The disparity in victories in both leagues reached maximum points in the 1950s and has declined in recent times.

The correlation coefficient between Index of Dissimilarity coefficients for payrolls and wins in the American League over the 1929-2003 period is 0.0067. The correlation coefficient for this same time period in the National League was -0.27. This indicates that greater payroll disparity since 1929 is correlated with less victory disparity since 1929 in the National League. In the American League the correlation coefficient is so low that the two are essentially un-correlated. This would seem to indicate that concern in Major League Baseball over the growing disparity in payrolls across teams is unfounded. Such a conclusion would be erroneous. This comparison does not consider how the advent of free agency and additional population groups affected payroll and victory disparity in MLB.

5.2 The Impact of Free Agency/Additional Population Groups

Prior to 1957, the average Index for wins in the National League was .0762. After 1976, the average Index for wins in the National League was .0569. This represents a 25.3% decrease in wins disparity in the National League after 1976. In the American League the average Index for wins prior to 1957 was .0895. After 1976 the Index for wins was .0582. This represents a 35.0% decrease in wins disparity in the American League.

After 1976, the level of disparity in payrolls in MLB also changed, but in the opposite direction. Prior to 1957, the average Index for payrolls in the National League was .0767. After 1976, the average Index for payrolls was .125. This represents a 63.0% increase in payroll disparity in the National League after 1976. In the American League prior to 1957 the average Index for payrolls was .108. After 1976 the Index for payrolls was .146. This represents a 35.2% increase in payroll disparity in the American League.

Two major changes occurring during the 1956-1976 period that may account for this difference were the influx of non-white players and the advent of free agency. With these changes it became more difficult for a small number of teams to monopolize talent. With some players now free to move between teams and an overall higher talent pool, talent became more evenly distributed across the league. Therefore wins also became more evenly distributed across the league.

At the same time, aggressive teams were now forced to spend significantly more than their competitors in an attempt to garner as much talent as possible. Hence, the Index of Dissimilarity for payrolls increased dramatically after the inception of free agency.

5.3 Disparity in Payrolls and Victories: Pre Global Search

Schmidt and Berri (2003) term the addition of new population groups to the potential labor force in baseball increasing global search for labor. Because the addition of other population groups had a significant impact on the disparity in wins, separate analyses of the pre-global search and post-free agency periods are warranted. The pre-global search correlation coefficient between the payroll and wins Indices of Dissimilarity is 0.41 for the American League and 0.59 for the National League. This indicates that prior to global search for labor, increasing disparity in payrolls across teams is correlated with increasing disparity in victories across teams.

5.4 Disparity in Payrolls and Victories: Post Free Agency

Increased salary disparity is correlated with a decline in competitive balance prior to free agency. Is that still true in the post free agency period? The correlation coefficient between the Index of Dissimilarity for payrolls and wins subsequent to free agency is 0.53 for the National League and 0.55 for the American League. A strong positive correlation exists between the disparities in payrolls and wins in the post free agency period.

6. The Recent Trend in Payroll and Wins Disparity

The following graphs give an overview of the Index of Dissimilarity for payrolls and wins for each league since 1986. The first pair of graphs (Figures I and II) compares within-league Indexes of Dissimilarity for payrolls and wins. The second pair of graphs (Figures III and IV) compares the Index of Dissimilarity for payrolls and wins between the leagues. From these graphs several conclusions are obvious. Payrolls are much more disparate than wins in each league. Disparity in payrolls is also much more volatile than disparity in wins since 1986. There is a significant upward trend in payroll disparity in both leagues since 1986 but that trend is more pronounced in the American League than in the National League. There is no obvious trend in win disparity in either league since 1986. In the last few years win disparity has jumped significantly in the American League but not in the National League.

Figure II. Payroll and Win Disparity: American League

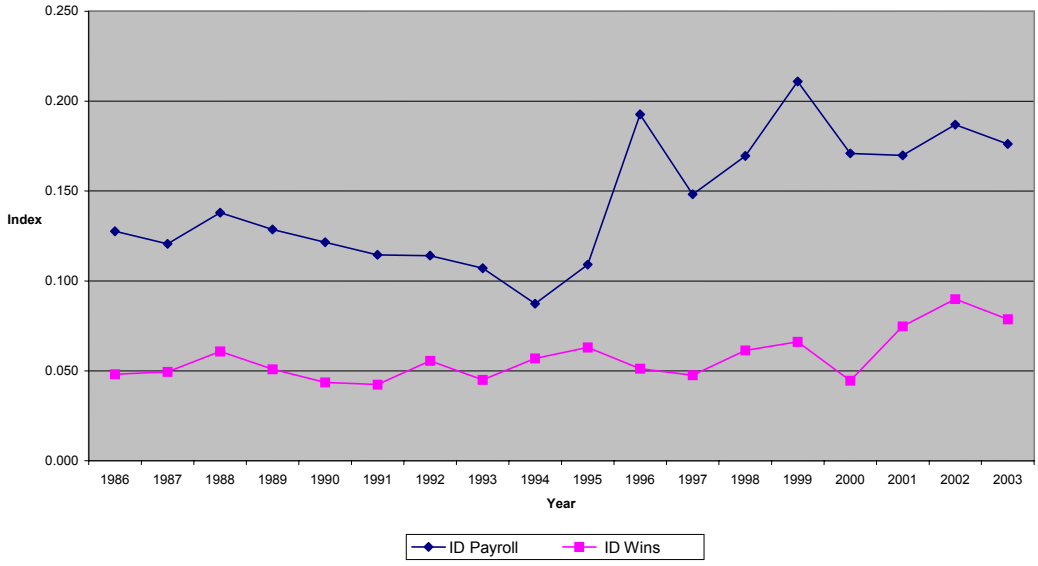
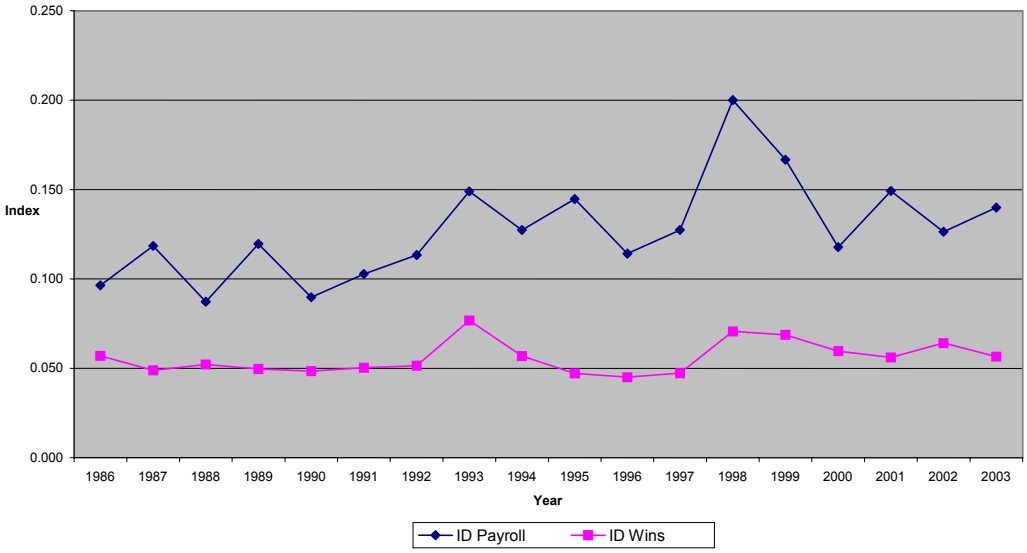


Figure III. Payroll and Win Disparity: National League



The figures below place both leagues together on the same graph. The first figure shows the level of win disparity for each league and the second shows payroll disparity for each league. These figures make it apparent that payroll and win disparity have been quite different at times across the two leagues. For the 18 seasons from 1986 through 2003, the level of American League payroll disparity exceeded National League payroll disparity 14 times, including the last five seasons. In the case of win disparity, the two leagues have been close with the exception of six seasons: 1993, when NL disparity far exceeded AL disparity; 2000, when NL disparity modestly exceeded AL disparity; and 1995, 2001, 2002, and 2003, when AL disparity either modestly or greatly exceeded NL disparity.

Looking at just the last three completed seasons one can see, for the first time, a relatively large excess by one league (American) over the other in both levels of disparity.

Figure IV. Level of Win Disparity: Different Leagues

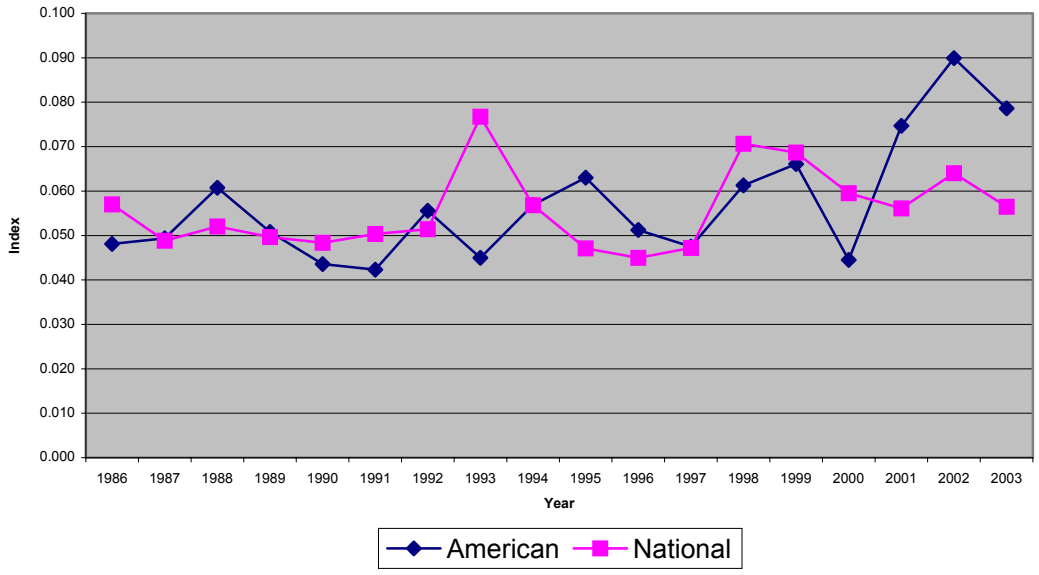
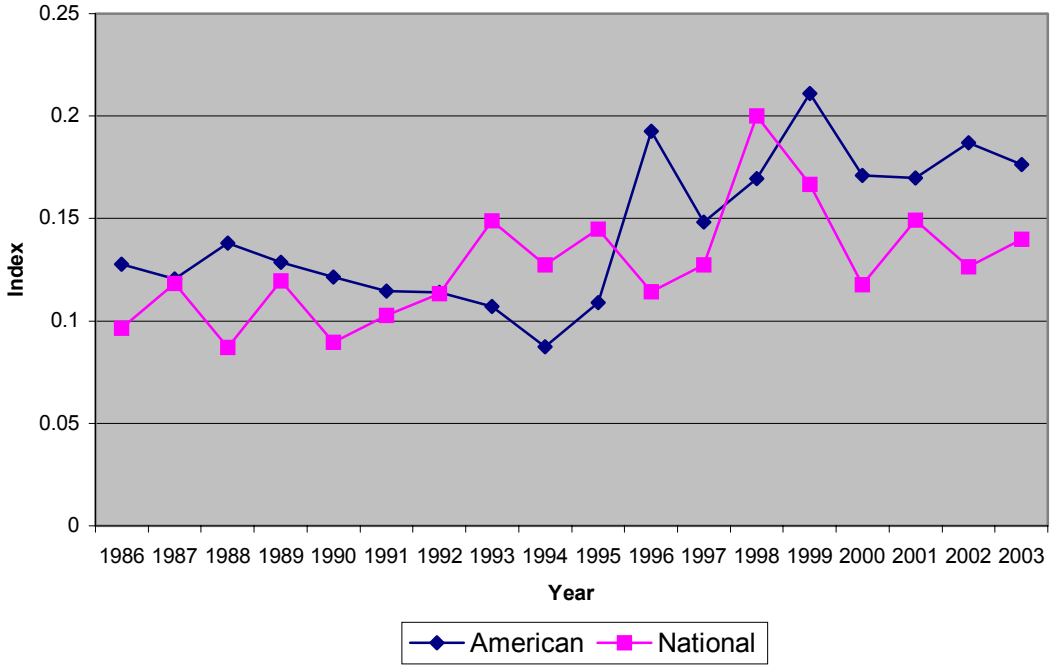


Figure V. Level of Payroll Disparity: Different Leagues



The table below contains the average Index of Dissimilarity for payrolls and wins for the past two decades[1]. These results indicate that during the 1990's the American and

[1] The 2000 decade only includes four observations, from 2000–2003.

National Leagues were very similar. Since the 1990's the National League has not changed much, but both average payroll disparity and average win disparity in the American League are significantly higher.

Table III. Average Index of Dissimilarity by Decade

	Index Payroll		Index Wins	
	American	National	American	National
1990's	0.137	0.134	0.053	0.056
2000's	0.179	0.131	0.072	0.059

7. Model and Expected Results

A simple, single-equation regression model was created to isolate the effect of payroll disparity on competitive balance in Major League Baseball. The dependent variable in the model is wins disparity (IDW) measured using the Index of Dissimilarity. The model's independent variables are: (1) payroll disparity (IDP), also measured by the Index of Dissimilarity; (2) GS, a dummy variable for global search. Because payroll data was not available for many years, there is a huge gap in our data from 1956 to 1976. During that period other population groups were added to the potential labor force in baseball. Hence, GS = 1 post 1975, 0 pre 1976; and, (3) Leag, a dummy variable representing the league. Leag = 1 if American League, 0 if National League.

The anticipated sign of the payroll disparity variable is positive. Greater dissimilarity in payrolls should result in greater disparity in victories in MLB. Some articles have found that increasing global search, or the addition of other population groups, has had a positive effect on competitive balance. Therefore, the anticipated sign of the global search variable is negative.

The final independent variable represents the league. There may be differing competitive balance in the American League than in the National League. The data seem to indicate competitive imbalance has been greater in the American League than in the National League during some periods. This has been particularly true in the past three years. Therefore, the sign of this variable should be positive.

8. Regression Results

The estimated equation (with t-statistics in parentheses) is

$$IDW = 0.0596 + 0.2531\ IDP - 0.0362\ GS + 0.0003\ Leag \qquad (2)$$

(4.5537) (-9.1177) (-0.09817)

Adjusted R^2 0.58

Dickey Fuller Unit Root Test

ADF Test Statistic -4.704270 1% Critical Value -3.5437

5% Critical Value -2.9109

Where: IDW = annual league wins Index of Dissimilarity
IDP = annual league payroll Index of Dissimilarity
GS = dummy variable for global search; GS =1 from 1976 forward;
GS =0 prior to 1976
Leag = Dummy variable for the league; Leag =1 for the American
League; Leag = 0 for the National League

The adjusted R^2 indicates that the independent variables explain 58% of the variation in disparity of wins in Major League Baseball as measured by the Index of Dissimilarity. The Dickey Fuller unit root test indicates no problems with spurious correlation.

The estimated parameter of IDP is positive and significant at the 99% confidence level. This indicates that greater payroll disparity across teams in Major League Baseball leads to greater win disparity or greater competitive imbalance in Major League Baseball.

The estimated parameter of GS is negative and significant at the 99% confidence level. This indicates that beginning in 1976 there was a significant change in win disparity in Major League Baseball. There are two possible explanations for this result. Free agency began in 1976. However, other research seems to indicate that free agency has not affected competitive balance in Major League Baseball. Secondly, population of Major League Baseball players was more diverse after 1976 than it was prior to 1957. Schmidt and Berri (2003) found that increasing global search for labor in Major League Baseball significantly increased competitive balance. Therefore the sign of this variable is consistent with Schmidt and Berri's findings.

The estimated parameter of Leag is positive but not significant. This indicates that the factors that affect the disparity in wins in the American League are no different than the National League.

9. The Payroll Disparity Elasticity of Win Disparity

Given the estimated equation above and assuming IDP = .131, GS=1, and Leag=0, the payroll disparity elasticity of win disparity = .59. This means that at the current average level of payroll disparity in the National League, every 1% increase in payroll disparity will result in a .59% increase in win disparity.

Given the estimated equation above and assuming IDP = .179, GS=1, and Leag=1, the payroll disparity elasticity of win disparity = .66. This means that at the current average level of payroll disparity in the American League, every 1% increase in payroll disparity will result in a .66% increase in win disparity.

10. Predicted Index of Dissimilarity for Wins for 2004

Beginning of season payrolls for each team in Major League Baseball for 2004 are now available. Based on these payrolls the Index of Dissimilarity for the American League is 0.176 while the National League Index of Dissimilarity is 0.140. Payrolls in

the American League for 2004 are 25.7% more disparate than payrolls in the National League. Based on the regression results above, the predicted Index of Dissimilarity for wins for each league for 2004 are listed below.

Table IV: Predictions for Competitive Balance in 2004

League	Predicted IDW
American	0.069
National	0.059

This represents a predicted 16.9% greater level of win disparity in the American League than in the National League. This may have implications for attendance and league success in the American League versus the National League.

11. Conclusions

This paper used the Index of Dissimilarity to measure payroll and win disparity in Major League Baseball. Results were similar to results found by other authors using Gini coefficients and standard deviations to examine similar issues. Payroll disparity has increased over time in Major League Baseball, particularly with the advent of free agency. The level of win disparity has decreased over time in Major League Baseball. A positive correlation was found between payroll and wins disparity, in the post free agency area. Recently, the level of payroll and win disparity has been significantly larger in the American League than in the National League. Based on starting payrolls from 2004, the level of win disparity in the American League is predicted to be approximately 17% greater than in the National League. The results seem to indicate that the recently imposed luxury tax has not depressed the level of payroll disparity in Major League Baseball. If the desire of Major League Baseball is to reduce payroll disparity and enhance competitive balance measures beyond the current luxury tax may be necessary.

If payroll disparity in Major League Baseball increases in the future the findings of this paper suggest that wins disparity in Major League Baseball will also increase. If uncertainty of outcome is positively correlated with league success, this may cause declining success in Major League Baseball in the future.

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