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Baseball Errors

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Abstract

This paper examines the factors that determine the rate of errors called in major league baseball, and changes in the error rate over time. We find that (1) the rate of errors depends on the quality of play and characteristics of the field, but that (2) these do not fully explain variations in the error rate. With regard to point 1, we find that the error rate is higher when the quality of fielding is suspect, i.e., the performance of an expansion team in its first year, or the fielding done by replacement players during World War II, and lower when playing conditions are better, e.g. on artificial turf and during night games. With regard to point 2, we find evidence that official scorers are biased toward the home team, but that the bias declined when the stakes involved increased, with the advent of arbitration and free agency.

KEYWORDS: bias, official scorer, free agency

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I. Introduction and Background

This paper examines the factors that determine the rate at which errors are called in major league baseball, and changes in the error rate that have occurred over time. We investigate whether official scorers are biased toward the home team and if so, whether the extent of their bias has changed over time. This is a matter of some importance to sports economists and other baseball researchers, since the frequency of errors is often assumed to be an objective measure of the quality of play in the field. However this research should be of interest well beyond its ramifications for baseball, because our analysis of the factors influencing official scorers, who make the decisions on errors, has implications for many other markets.

This paper adds to a literature that has been contributed to by economists, psychologists, sociologists and statisticians, and does not fit comfortably into a subcategory of a single discipline. This research is both theoretical and empirical; the empirical work uses statistical methods to evaluate decisions made by agents that directly affect others. The issue is whether the agents make such decisions appropriately, or are influenced by factors that, whether by law, professional norm or social custom, are not supposed to affect their decisions. This research includes the vast empirical literature on discrimination; examples range from the decisions made by police on which vehicles to search (Knowles et al. (2001)), decisions on acceptance of manuscripts made by academic journals (Blank (1991)), decisions by arbitrators (Burger and Walters (2005)), and decisions by referees in sports (Duggan and Levitt (2002)).

The research that is closest to ours examines bias by officials in sports. Garicano et al. (2005) found that referees in professional soccer games favored the home team because of pressure from the crowd in the stadium. Referees assisted the home team by taking measures to shorten close games when the home team was ahead, and to lengthen games when the home team was behind. Sutter and Kocher (2004) found home team bias in the decisions made by soccer referees on the length of the game, and in the awarding of penalties. Many articles in the psychology literature find that referees are biased in various ways: some in favor of the home team, some in favor of athletes from the referee's country, some in favor of keeping the game close to attract viewers for television.[1]

[1] See, e.g., Nevill et al. (2002), who found that background crowd noise caused soccer referees to award fewer fouls against the home team than otherwise. Thu et al. (2002) found that college basketball referees call significantly more fouls against the team that is ahead when the game is on national television. Seltzer and Glass (1991) found that judges of Olympic skating events awarded significantly higher scores to participants from their own countries and that scoring was driven by "cold war" politics.

A. The Characteristics of Official Scorers

Since the subject of this paper is the decisions made by official scorers, it is appropriate to examine their characteristics – the requirements for the job, how they are hired and fired, how they are compensated, their incentives and anything else that might influence their decisions. Official scorers are now hired by the commissioner of Major League Baseball.[2] They are currently (in 2006) paid $130 per game, and were paid comparable amounts in real terms in prior years.[3]

Both the impartiality and competence of official scorers have been questioned by some observers. One reason for this scrutiny is that there are virtually no formal requirements for becoming a scorer, little or no restrictions on their outside activities, and no formal evaluation of their performance.[4] Plaschke (1993) notes that scorers are allowed to drink on the job, fraternize with players, and play in rotisserie leagues in which a fictitious "team" can win thousands of dollars.

B. Scorer Bias

Another question is whether scorers are impartial. There have been allegations that at least some scorers systematically favor the home team. Although, as previously noted, scorers are employed by the commissioner's office, it appears that most scorers are hired on the recommendation of the public relations directors of teams. Some have argued that as a consequence, the PR director of the home team has substantial leverage on the decisions made by the scorer. A scorer may work in as many as 80 games in the home team's stadium. There have been cases

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[2] Before the year 2000 season official scorers were hired separately by each league. After the 1999 season all the staff and responsibilities of the league offices were transferred to the commissioner of Major League Baseball.

[3] A 1991 article reported that the official scorers for the Atlanta Braves, a National League team, were paid $65 a game. Scoggins (2004) states that in 1978 the fee was $25 per game in the American League. A typical major league game lasts two hours and 50 minutes.

[4] When scoring was the responsibility of the Baseball Writers Association of America, candidates were required to observe 100 games a year for three consecutive seasons before taking a position as official scorer. Thereafter for a period of several years the National League required candidates to take a test, but this practice was discontinued in the mid-1990s. However, potential scorers must file an application, and still usually serve an apprenticeship under an incumbent scorer before they assume full responsibility. It should also be noted that in 2001 the Commissioner of Major League Baseball established a scoring committee, which currently has five members, to review calls made by official scorers. This committee can make recommendations, but does not have the power to overturn a scorer's decisions.

where scorers whose decisions have displeased the home team have been replaced.[5]

Since close proximity to the home team is part of the scorer's working conditions, it is appropriate to consider how a possible bias in favor of the home team could affect his rulings. In some (relatively unusual) cases it is clear how his rulings would be affected. If the home team pitcher had a no-hitter going in the late innings, a biased scorer might be inclined to call a marginal play an error rather than a hit. If a home team batter had a hitting streak going, and did not yet have a hit in the late innings, a biased scorer might not call a marginal play an error. If a home-team infielder had a long streak of error-free games, a biased scorer might call a marginal play a hit.[6]

It is much less obvious how home-team bias would be reflected in the data over the course of the whole season. When the home team is at bat, and a fielder bobbles the ball, a biased scorer might be inclined not to call an error, since that would deprive the home team batter of a hit.[7] Now suppose the home team is in the field. The scorer might still be inclined to call the play a hit, since an error is generally more damaging to the fielder than a hit is to the pitcher. On the other hand, when the visitors are at bat a biased scorer could be more likely to call a marginal play an error, since a home team player will be adversely affected no matter what he does. Thus if a scorer's propensity to call errors differs depending on which team is in the field, he could be less likely to call errors when the home team is at bat; that is, the scorer might call more errors against the home team! It should, however, be noted that if there is home team bias, it may be difficult to measure. Players may be less likely to make errors in their home stadium than elsewhere, since they are generally more comfortable there, more familiar with the field, and are supported by the crowd.

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[5] In 1992 the Seattle Mariner players signed a petition to have their official scorer replaced. Kurkjian (1992). Scoggins (2004) stated that the management of the Boston Red Sox issued a directive not to re-hire a scorer whose ruling of a hit had ended a potential no-hitter of a Red Sox pitcher.

[6] There are many articles in newspapers and on the internet complaining about questionable calls that preserved a potential no-hitter, or a hitting streak, or a streak of error-free games. While we certainly do not claim that our survey of such articles is complete, all the articles that we have seen involved calls made in favor of a player on the home team.

[7] Alternatively, a home team batter might reach second base on a hit that might have been only a single if the outfielder had made a good play. In this case the scorer must decide whether the hit is a double, or instead a single, with an error assigned to the fielder.

It is well known that with the advent of arbitration in 1973 and free agency in 1976, salaries of players rose abruptly.[8] The higher stakes involved for players and teams naturally increased the importance of decisions made by the official scorer.[9]

C. Measures Taken to Avoid Bias

Until about 1979, almost all scorers were employed as sports writers, often by newspapers, and were members of the Baseball Writers Association of America (BBWAA). However, by then many newspapers had forbidden their sports reporters from taking positions as official scorers. The concern was that a decision by the scorer could anger a player, so that he might refuse to talk to the writer, which would diminish the value of his sports column. By the same token, concern about this possibility might lead a scorer who was a reporter to depart from impartiality in his rulings. In response to this concern, the BBWAA withdrew from all scoring activities in 1979. In subsequent years sports writers still acted as scorers in some cities, while in others scoring was done by individuals from a broad range of occupations: retired sportswriters, high school and college coaches, amateur umpires, teachers, nursing home operators and librarians, among others.

We noted above that many observers believe that the PR director of the home team has some leverage over the scorer's decisions. In response to this perception, the official of the American League who supervised scorers requested that during a game the scorer sit "far away" from the PR director.[10]

In the empirical work reported below we investigate whether scorers have a home-team orientation. First, however, we consider changes in conditions over time that might affect the number of errors, even if scorers were impartial and their standards never changed. Specifically, we will consider technical progress and changes in rules about errors. Once we understand all the factors that affect errors, we will be in a better position to determine whether scorers are biased.

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[8] Fort (2003) reports that "The increase [in average salary] from 1971 to 1975, the 5 years prior to free agency, was about 7 percent in real terms. After free agency, with competitively determined salaries, things were quite different. Average salaries during the 5 years of free agency (1976 to 1980) rose 93 percent, again in real terms."

[9] Under the rules the scorer can change his decision until 24 hours after the game has ended. Official Rule 10.01(a). This provides a natural opportunity for the players and staff of either team to lobby him.

[10] Plaschke (1993).

D. Technical Progress

Researchers have noted many technical changes that may have improved fielding performance over the years. Scully (1989) cites a number of improvements in gloves: the addition of fingers and padding to the original fingerless gloves; the introduction of webbing, which allowed a built-in pocket; the innovations of finger padding, computer design, and advanced stitching techniques. The introduction of artificial turf is believed to have greatly reduced the frequency of erratic bounces that could lead to errors; we test this hypothesis below.[11] Night games were introduced to major league baseball gradually beginning in 1935.[12] The lighting at a night game is generally more predictable than at a day game, and it should be less common for balls to be "lost in the sun." Our empirical work will test the effect of night games on errors. Rubinstein (1992) notes improvements in the maintenance of fields and the fact that, since about 1920, balls have been replaced with fresh ones the moment they become scuffed or soiled. Before 1920 the muddied ball was harder to field and more likely to take an erratic bounce.

E. Rule Changes

There have been formal changes in the Official Baseball Rules[13] concerning errors twenty times since 1877; the most recent of these changes was made in 1969, and thus precedes our data set based on individual games. Accordingly we would not expect rule changes to explain much of the variation in errors during the period 1969-2005. Older rule changes concerning errors are described in the appendix.

II. Empirical Analysis

A. The Data

To test the hypotheses about the determinants of the error rate, we have used two data sets, one with aggregate data and the other with microdata over a shorter period. The first data set, obtained from Thorn et al. (1999) and James et al. (1998), and supplemented by more recent data, has, among other variables, the number of errors and games played in each year, from 1886 through 2004 for the National League, and from 1901 through 2004 for the American League.

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[11] Commentators also note that with artificial turf, "the ball arrives in a hurry." Crasnick (1993).

[12] The first night game in major league baseball was on May 24, 1935.

[13] A history of all changes in the Official Baseball Rules is provided in Thorn et al. (4th edition 1995), but not in the 6th edition.

The second data set, obtained from Retrosheet,[14] has the number of errors made by each team in every regular season game during the period from 1969 through 2005.

B. Analysis of Annual Data

We used the first data set to analyze changes in the error rate over time. Two variables are designed to capture deviations from the norm in quality of fielding. First, we have a dummy variable representing the war years 1942-1945. In March 1941 the first major league player was drafted for this conflict. By January 1945, 5400 of the 5800 professional baseball players in the U.S. at the time of Pearl Harbor (December 7, 1941) were in military service.[15] Four hundred and twenty-eight players from the 16 major league teams – an average of more than 26 per team - entered the armed forces.[16] There is considerable evidence, apart from anecdotal accounts, that the quality of play in the major leagues, including the quality of fielding, declined substantially during this period. For example, major leaguers were replaced by minor league players; a number of major league players who had previously retired were able to rejoin major league rosters; and by the 1946 season, with the end of the war, most of the replacement players were gone.[17] Consequently we would expect that the error rate increased during the war years. Secondly, we have constructed a variable Expansion Team representing the performance of each expansion team in its first year in its league. The record of games won by such teams has historically been far below average,[18] and one might expect that their fielding has been substandard.[19]

Another dummy variable, which indicates whether the team in the field is in the National League, is designed to test whether the error rate differs between the two leagues. Now why would it be expected to differ? Some have argued that errors occur when fielders attempt to throw out speedy base runners, and that runners in the National League have more speed. Hakes and Sauer (2004) found that during the period 1977-1992 the National League always had higher rates of

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[14] Retrosheet is an all-volunteer nonprofit organization founded in 1989 to collect play by play accounts of as many major league baseball games as possible, and provide them without charge to researchers and the general public. Its web site is www. retrosheet.org. Interested parties may contact Retrosheet at 20 Sunset Rd., Newark, DE 19711. Hakes and Sauer (2004) would add to this "God Bless Retrosheet," and we say Amen.

[15] Thorn (1999), at 2515 (article by Harrington E. Crissey, Jr.)

[16] Jeanes (1991), citing Neft and Cohen (1991).

[17] Jeanes (1991), and Holtzman (1995).

[18] Scully (1989) notes that "Typically, the win percentage of expansion clubs averages about .440 for the first decade of their existence." Id. at 146.

[19] The data provided for the Expansion Team variable, which cover an expansion team in its first year, are subtracted from the data provided for the expansion team's league in that year.

stolen base attempts than the American League, and had higher rates of successful steals in 14 of the 16 seasons studied.[20] In order to investigate the effect of base running speed or attempted steals on errors, we have added as a proxy variable stolen bases per game (average stolen bases per game for each league for each year). If this variable captures any differences in the error rate between the two leagues resulting from more attempted steals in the National League, and the dummy variable for the National League remains significant, there must be some other conditions in the National League that cause a higher rate of errors – for example, a possible difference in the standard applied by the official scorers.

There are dummy variables for every decade beginning with 1886-1895, with two exceptions: (1) since we have a dummy variable for the war years 1942-1945, the preceding period, 1936-1941 covers only six years instead of a decade; (2) the last complete decade is 1986-1995, so that the most recent period 1996-1999 covers only four years. The omitted reference category is the period 2000-2004.

[20] An interesting question, raised by Hakes and Sauer, is how much of this difference is attributable to the use of the designated hitter rule in the American League. A designated hitter substituting for a pitcher may through his hitting create more opportunities for steals, but may himself have little speed. Another claim that has been made is that the propensity to steal depends on the size of the ball park; i.e., when stadiums are smaller it is often better for a base runner to wait for a home run to bring him in, rather than to attempt a steal, and risk being tagged out. See Wills (2001).

Table 1 – Time Trend of the Error Rate, 1886-2004

Independent Variables	(2) Log of Error Rate
Constant	-0.564
1886-1895	1.158** (0.070)
1896-1905	0.974** (0.045)
1906-1915	0.762** (0.031)
1916-1925	0.676** (0.016)
1926-1935	0.613** (0.015)
1936-1941	0.580** (0.015)
1942-1945 (wartime)	0.539** (0.018)
1946-1955	0.404** (0.018)
1956-1965	0.330** (0.018)
1966-1975	0.276** (0.013)
1976-1985	0.184** (0.015)
1986-1995	0.072** (0.016)
1996-1999	0.029* (0.014)

Note: (*) denotes significance at the 5 percent level, (**) significance at the 1 percent level. Standard errors are in parentheses. Stolen Bases Per Game is determined for each league for each year.

Table 1 (cont.) – Time Trend of the Error Rate, 1886-2004

Independent Variables	(2) Log of Error Rate
Expansion (= 1 for an expansion team in its first year, otherwise = 0)	0.132** (0.044)
National League	0.021** (0.007)
Stolen Bases Per Game	0.275** (0.040)
No. of observations	237
adjusted R^2	0.983
Square root of mean square error	0.051

Note: (*) denotes significance at the 5 percent level, (**) significance at the 1 percent level. Standard errors are in parentheses. Stolen Bases Per Game is determined for each league for each year.

C. Results from Aggregated (League) Data

Results for the regression on the log of the error rate are set forth in Table 1, which shows that the error rate has declined in every period.[21] What accounts for this trend? Probably a number of factors: there has been technical progress and improvement in field conditions, improvement in players through better methods of training, coaching and conditioning, and there may also have been some relaxation of standards by official scorers.

As expected, the error rate is significantly higher for expansion teams in their first year. To see the effect of the war years, note that the coefficient of wartime is 0.042 less than that of the six-year period ending in 1941, but 0.135 greater than

[21] For readers who are unfamiliar with multiple regression analysis, the idea underlying this statistical technique is to isolate the effect on the dependent variable (here the log of the error rate) of changing one independent variable, holding other variables constant. For example, in Table 1 the coefficient of the 1956-1965 dummy variable is 0.330 and is highly significant. Now $e^{0.33} - 1 = 0.39.$ This means that, if we were to change the calendar time from the reference category, the period 2000-2004, to the period 1956-1965, the error rate would increase by 39 percent, holding other things constant. In other words, other things equal, the error rate was on average 39 percent higher during the period 1956-1965 than it was in 2000-2004.

that of the subsequent decade ending in 1955.[22] Thus the ineptness of wartime players largely, though not completely, offsets the secular trend of decline in the error rate. The coefficient for stolen bases indicates that errors are more frequent when the opposing team has more speed.

We find that the rate of errors is higher in the National League than the American League. There are three possible explanations for this result: (1) the quality of fielding is higher in the American League; (2) the standards of American League scorers are lower; and (3) conditions in the National League are more likely to cause errors.

For possibility (3), we might look at any rules that differ between the two leagues. However, there is only one difference in rules, namely that the designated hitter rule applies only in the American League.[23] However this difference should mean, *ceteris paribus*, that the ball is hit into play more often in the American League, which should increase the error rate per game there. On the other hand, there is a countervailing argument, based on the fact that the designated hitter rule allows a team to unbundle a player's hitting ability from his defensive skills. In the American League, the designated hitter is often someone who hits well, but has limited defensive skills. It is possible that a player who is only a designated hitter in the American League would be kept on the roster if he were in the National League, since the expected gain from his hitting could outweigh the expected loss from his defense.[24] This would introduce some mediocrity into the defensive effort of the National League team, relative to an American League team. If this effect outweighed the increased pressure on fielders in the American League resulting from substitution of a good hitter for the pitcher in the batting order, there could be a net increase in the error rate in the National League compared to the American League.

To investigate this matter further, we did a paired comparison of errors per game in each league during the period 1960-1972, immediately prior to the advent of the designated hitter rule in 1973. It turns out that errors per game were

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[22] In another specification we changed the time intervals so that the period before and after the war years was the same: 1938-41 and 1946-49 respectively. The estimated coefficients and standard errors for these periods, in chronological order, were 0.5239 (0.0187); 0.4893 (0.0210); and 0.3444 (0.0264). The difference between the war years and the preceding period was not significant ($p = 0.088$), but the difference between the war years and the subsequent period was highly significant ($p < 0.001$).

[23] Section 6.10, Official Baseball Rules (April 2000). The Designated Hitter Rule was adopted by the American League on December 10, 1972 and became effective in the 1973 season.

[24] It is also possible that a player who becomes a designated hitter in the American League would not, but for the d-h rule, have made the roster of a major league team. This would be consistent with anecdotal reports that adoption of the d-h rule enabled a number of players to extend their careers.

significantly higher in the National League (p = 0.0006).[25] Thus the difference between the error rate in the two leagues cannot be attributed to the designated hitter rule.

We noted above that errors often occur when fielders attempt to throw out speedy base runners, and that at least since 1977 the National League has consistently had a higher rate of stolen base attempts than the American League. Since we included stolen bases per game as a proxy for attempted steals, and the dummy variable for the National League is still significant, there must be some other conditions in the National League leading to a higher rate of errors. A possible explanation for the difference in the error rate is (2), a difference in standards. Alternative hypotheses seem implausible. It seems unlikely, for example, that the quality of fielding is much different between the two leagues (possibility 1), given that they draw on the same pool of talent and participate equally in the same draft, and that the level of compensation does not seem to differ between leagues; each league hires free agents from the other league. Moreover, no difference in quality is indicated by the results of interleague games played to date. It therefore seems more likely that the standards are lower in the American League. Parenthetically, it is important to the players of each league only that standards be uniform across the league, not that they be uniform across both leagues. Awards and honors such as the Gold Glove and the All-Star Team,[26] and incentive clauses in players' contracts, are generally based on the player's performance relative to others in his league.

D. The Marginal Effects of Hits and Errors

To investigate the issue of bias, we must consider how the incentives of a scorer could affect his decision whether to call an error. Since, as indicated above, there can be substantial interaction between the scorer and the players of home and visiting teams, we should first consider the impact of the scorer's decision on the players who are affected by it.

As noted above, a scorer biased toward the home team would be less inclined to call an error when the home team was at bat, since that would deprive the home team batter of a hit. When the home team is in the field, calling a batted ball a hit benefits the home team fielder, but penalizes the home team pitcher, so the tradeoff makes it more likely that the call would be made objectively.

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[25] During the period 1960-1972 the mean errors per game (per team) was .9064 in the NL and .8379 in the AL (t = 4.597 with 12 degrees of freedom).

[26] Other league-specific awards are the Most Valuable Player, Rookie of the Year, the Cy Young Award, and the Player and Pitcher of the Month.

E. An Analysis of Data on Errors Made in Each Game

To analyze the rate of errors further, we used data from Retrosheet on the number of errors made by each team in every regular season game during the period from 1969 through 2005. Since the number of errors made by a team is a nonnegative integer, we estimated a Poisson model and a negative binomial model, a generalization of the Poisson model. We report only the results of the negative binomial model since the parameter estimate of overdispersion of the Poisson was highly significant in all specifications.

In this data set the mean number of errors made by a team in a game was 0.781, the standard deviation 0.934, the median one, and the maximum was eight. In the specification in column 2 of Table 2 we have dummy variables for each year, 1969 being the omitted reference variable. To test the effect of time within the season, we have included variables for each month of the baseball season, omitting March and April. Other variables indicate whether the team was playing in a night game, or on artificial turf.[27] We include a dummy variable which indicates whether the team in the field is in the National League, to test whether the standard for errors differs between the two leagues. We have also added stolen bases per game as a proxy variable for speed. Here this variable is defined as the opposing team's rate of stolen bases for the season, i.e. the total number of bases stolen by its players during the season, divided by the total number of games it played. Another variable, "chances," is not defined in the usual way;[28] here it means the total number of outs made by the opposing team, minus the number of its strikeouts.

[27] It should, however, be noted that artificial turf is not homogenous, nor is its alternative, grass. The artificial turf used in major league ballparks includes AstroTurf; AstroTurf-8; Play-All System Grass Turf, consisting of sand, pea gravel, peat, calcined clay and bluegrass; SporTurf (reported to have the "liveliest bounce by far in the majors," (Lowry (1992), at 55)); and TartanTurf. Variants of grass, on the other hand, include bluegrass; a mixture of Merion bluegrass and clover; Merion bluegrass; Santa Ana Bermuda grass; Prescription Athletic Turf; and Tifway 419 Bermuda grass. There may also be a difference between the surfaces of the infield and outfield. See generally Lowry (1992).

[28] e.g., as an opportunity to make a fielding play, that results in an out, assist, or error.

Table 2 – The Determinants of Errors, 1969-2005: Negative Binomial Model

Variable	(2)	(3)	(4)
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
Intercept	-0.345	-0.302	-0.333
Artificial Turf	-0.092** (0.007)	-0.089** (0.007)	-0.093** (0.007)
At Home	0.041** (0.013)	0.026* (0.011)	0.045** (0.012)
At Home × Years After 1976	-0.044** (0.015)	-0.026* (0.012)	-0.050** (0.013)
Expansion Team	0.058* (0.023)	0.047* (0.021)	0.057** (0.021)
National League	0.046** (0.006)	0.044** (0.006)	0.047** (0.006)
Night Game	-0.021** (0.007)	-0.014* (0.006)	-0.013* (0.006)
Stolen Bases Per Game	0.172** (0.013)	0.192** (0.012)	0.174** (0.012)
Time		-0.009** (0.000)	-0.002 (0.002)
Time Squared			-0.0002** (0.000)
Chances	0.007** (0.001)	0.007** (0.001)	0.007** (0.001)
May	-0.051** (0.011)	-0.052** (0.011)	-0.053** (0.011)
June	-0.078** (0.011)	-0.079** (0.011)	-0.080** (0.011)
July	-0.068** (0.011)	-0.068** (0.011)	-0.069** (0.011)
August	-0.083** (0.011)	-0.084** (0.011)	-0.085** (0.011)
September	-0.042** (0.011)	-0.043** (0.011)	-0.044** (0.011)
October	0.024 (0.026)	0.021 (0.026)	0.018 (0.026)
Year70	-0.011 (0.027)		
Year71	-0.064* (0.027)		

Note: the dependent variable is the number of errors made by a team in each game. Absolute values of standard errors, which are robust, are in parentheses. (*) denotes significance at the 5 percent level, (**) significance at the 1 percent level. The "Time" variable equals 1 in 1969, 2 in 1970, etc. The omitted reference category for years is the year 1969. For the monthly variables, the omitted reference period is March and April. "Chances" is not defined in the usual way; here this variable means the number of outs made by the opposing team, minus the number of its strikeouts. (table continued on following page).

Table 2 (cont.) – The Determinants of Errors, 1969-2005: Negative Binomial Model

Variable	(2)	(3)	(4)
	Coefficient (Standard Error)		
Year72	-0.012 (0.027)		
Year73	0.032 (0.027)		
Year74	0.047 (0.027)		
Year75	0.085** (0.026)		
Year76	-0.014 (0.027)		
Year77	0.015 (0.027)		
Year78	-0.003 (0.028)		
Year79	-0.001 (0.028)		
Year80	-0.031 (0.028)		
Year81	-0.062* (0.030)		
Year82	-0.061* (0.028)		
Year83	-0.052 (0.028)		
Year84	-0.032 (0.028)		
Year85	-0.063* (0.028)		
Year86	-0.060* (0.028)		
Year87	-0.115** (0.028)		
Year88	-0.120** (0.029)		
Year89	-0.081** (0.028)		
Year90	-0.135** (0.029)		
Year91	-0.159** (0.029)		
Year92	-0.192** (0.029)		
Year93	-0.126** (0.027)		

Note: the dependent variable is the number of errors made by a team in each game. Absolute values of standard errors are in parentheses. (*) denotes significance at the 5 percent level, (**) significance at the 1 percent level. The omitted reference category for years is the year 1969 (table continued on following page).

Table 2 (cont.) – The Determinants of Errors, 1969-2005: Negative Binomial Model

Variable	(2)	(3)	(4)
	Coefficient (Standard Error)		
Year94	-0.150** (0.030)		
Year95	-0.174** (0.029)		
Year96	-0.152** (0.028)		
Year97	-0.188** (0.028)		
Year98	-0.194** (0.027)		
Year99	-0.176** (0.028)		
Year00	-0.180** (0.028)		
Year01	-0.218** (0.028)		
Year02	-0.244** (0.028)		
Year03	-0.262** (0.028)		
Year04	-0.261** (0.028)		
Year05	-0.300** (0.028)		
α	0.130** (0.005)	0.132** (0.005)	0.131** (0.005)
No. of observations	156,200	156,200	156,200
Log likelihood	-184,099.	-184,159.	-184,148.

Note: the dependent variable is the number of errors made by a team in each game. Absolute values of standard errors, which are robust, are in parentheses. (*) denotes significance at the 5 percent level, (**) significance at the 1 percent level. The omitted reference category for years is the year 1969. α is the parameter indicating overdispersion of the Poisson model.

F. Results from Individual Game Data

In Table 2, the dependent variable is the number of errors made by a team in each game. To illustrate the interpretation of the results, the estimated coefficient of the month of August is -0.083, and is highly significant. This means that if one were to change the time of year from (March-April), the omitted reference period, to August, but hold other variables constant, the expected number of errors would decline by 8.0 percent, since

$$e^{-0.083} - 1 = -0.080.$$

The omitted reference year in Table 2 is 1969. The downward drift in the error rate found in Table 1 is confirmed in Table 2. The coefficient of the year 2005 shown near the bottom of column 2, -0.300, indicates that errors by a team per game declined by 25.9 percent from 1969 to 2005, while the raw data indicate a decline of approximately 28.6 percent over this period. The results for the monthly variables indicate that a team's fielding performance improves after the initial shakedown of March and April, the omitted reference period, except for October, when a team's position in the standings has been determined, and teams often call players up from the minors to evaluate them in major league play (recall that this data set does not include playoff games).

We find that errors increase with the number of chances. With respect to the environmental variables, we find that errors are less frequent during night games, which have less variable lighting than day games, and on artificial turf, which is a more uniform, predictable playing surface than grass. These results are robust across all specifications.

Table 2 also confirms several results of Table 1: there is a significant positive effect for an expansion team in its first year. The coefficient for stolen bases indicates that errors are induced by the speed of the opposing team. The rate of errors is higher in the National League than the American League. This difference evidently cannot be explained by a difference between the leagues in the rate of attempted steals, nor by a difference in the rate of opportunities to make errors.

There is evidence of home team bias, but the results for the interaction term indicate that it has declined as the stakes for players have increased, with the advent of arbitration in 1973 and free agency in 1976. We know that the changes in the stakes were followed by actions to mitigate home team bias taken by the BBWAA in 1979 and by the American League. In contrast, Garicano et al. found that home team bias of soccer referees increased after there was an exogenous increase in the rewards for winning the game.

III. Summary and Conclusion

This paper analyzes the determinants of errors in major league baseball. We found that the error rate was higher in situations where there is reason to believe the fielding is substandard, i.e. the performance of an expansion team in its first year, or the fielding of replacement players during World War II. With respect to environmental factors, we found that errors are less frequent during night games and on artificial turf. Errors are more frequent when the opposing team has more speed. The rate of errors is higher in the National League, which suggests, if it does not prove, that the American League applies a lower standard to fielding performance. These findings are new.

Finally, we find evidence that scorers are biased toward the home team, but that this bias has been reduced by institutional responses to the greater stakes involved for players and teams.

Appendix: Changes in Official Baseball Rules

There have been formal changes in the Official Baseball Rules[29] concerning errors twenty times since 1877; the most recent of these changes was made in 1969. Some changes, especially in the earlier years, had a major impact, for example the 1887 rule that rescinded previous rules that charged an error to a pitcher for a wild pitch and to a catcher for a passed ball.[30] However, many subsequent formal changes in the rules were largely redundant restatements of previous rules, or codification of the existing practice of official scorers.

Two rule changes in recent years might be suspected to have an impact in changing the status quo. In 1955 a new rule stated that "Slow handling of the ball which does not involve mechanical misplay shall not be construed as an error," and a 1967 rule provided that "Mental mistakes or misjudgments are not to be scored as errors unless specifically covered in the rules." However, one cannot be sure that even these changes had much of an impact, given that there are so many rules governing errors in specific situations. There is no indication in our empirical results that there were significant changes in these years.

Changes in other baseball rules or practices can also affect the incidence of errors. For example, a contraction of the strike zone makes it more likely that runners will reach base and that balls will be hit into play, which should increase the number of errors per game.

[29] A history of all changes in the Official Baseball Rules is provided in Thorn et al. (4th edition 1995), but not in the 6th edition.

[30] James et al. (1998) reports that ". . . prior to 1889, pitchers were often charged with errors on hit batsmen and wild pitches, and catchers were charged with errors on passed balls." Ibid. at 2646.

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