A Natural Experiment for the Efficient Market Hypothesis: Periodic Information Updating in MLB Betting Markets

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Background and Significance
Recent research has shown that the rate at which umpires are favorable to pitchers has changed considerably since 2008 (Mills, 2016), significantly reducing offensive output in Major League Baseball (MLB) since the implementation of new evaluation technology for umpires. However, there remains substantial heterogeneity in the strike zones called by umpires, with some consistently favorable to batters, while others are more favorable to pitchers. Given the impact that these differences in strike zones can have on offensive output, the question arises as to whether these characteristics are desirable for MLB, particularly in the context of betting markets that have been shown to drive viewership for sports events (Salaga & Tainsky, 2015). We therefore address the question of the efficiency of these markets in the context of policy enforcement at the league level.

According to the efficient market hypothesis (EMH), all information is included in the price of a given asset. Sports betting markets have long been used to test this proposition, given the ubiquity of interest and available data on historical sporting outcomes. Even and Noble (1992) note two central tests for evaluating the EMH using sports betting markets as the context for analysis. The first involves assessing the degree of bias in betting lines with respect to predicting game outcomes, while the second directly tests the probability of placing a winning bet. In this work, we perform the first test noted by Even and Noble (1992) to identify the existence of semi-strong form efficiency in these betting markets as they relate to information about umpire assignment. Specifically, semi-strong form efficiency states that the market is reflective of all publicly available information. Our regression therefore directly tests whether our publicly available information gathered about individual umpires has been fully integrated into the totals lines.

The MLB betting market has long been fertile ground for the testing of market efficiency. For example, Brown and Abraham (2002) show that structural changes in a league—in this case, expansion, realignment, and interleague play—can introduce uncertainty in player and team performance and result in profitable betting strategies in the totals market. The authors illustrate, however, that the market quickly adjusted and the inefficiency was eliminated in short order. Paul and Weinbach (2004) challenge these finding and note the somewhat unique context of baseball totals markets—where payouts are not reciprocal for an over/under bet—which requires the consideration of further odds adjustments when evaluating efficiency. Paul, Weinbach, and Weinbach (2014) also identify inefficiency in the MLB totals market as it relates to atmospheric conditions, showing a consistent profitable strategy of betting the over for games played in Colorado—a known haven for home runs and high offensive output.

Empirical Approach
This paper addresses the EMH using detailed data on MLB game outcomes and umpire strike zone tendencies. We leverage the fact that umpire assignments are largely random and unknown prior to the start of any regular season series. Specifically, home plate assignments are not publicly revealed until immediately prior to the start of the first game of a series, and therefore markets should not be able to fully integrate umpire strike zone information for these games. However, after the first game of the series, the umpire rotation is perfectly predictable, allowing the integration of known home plate umpire assignments in totals markets at and after the start of this first game. This characteristic of umpire scheduling is used as a natural experiment to evaluate the impact of revealed umpire information at the start of the first game of a series relative to the efficiency of totals prior to this knowledge. We use a measure of the individual umpire favorability toward hitting or pitching over the past 90 days (ZoneDev; semi-strong form efficiency). This measure is estimated using pitch-by-pitch locational data with a semi-parametric generalized additive model of the pooled league strike zone (about 185,000 observations per model), controlling for
both batter handedness and ball-strike count. This strike zone model is updated each day of the season from 2008 through 2014 using all data from the past 90 regular season game days. We then take the difference between the outcome of every call made by the umpire (Strike = 1, Ball = 0) and the predicted probability of a strike call from the pooled model, conditional on location, handedness, and ball-strike count. The error terms for each pitch are then averaged over this same previous 90 day span for pitches called by each individual umpire.

Each measure is entered into a panel fixed effects (year, home, and away teams) regression to predict the total runs scored in the upcoming games alongside the betting market closing total for each. We first estimate all observations pooled in a single model. We then split our sample into first games and later games of a series, respectively, to identify differences in information availability to bettors and bookmakers. The general model is estimated as follows:

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\text{TotalRuns}_{ig} = B_0 + B_1 \text{ClosingLine}_g + B_2 \text{ZoneDev}_{ig} + T_g + H_g + A_g + \epsilon_{ig}
\]

Here, the dependent variable is the total expected runs scored in game g umpired by umpire i. ClosingLine\(_g\) is the listed closing over/under total line, while ZoneDev\(_{ig}\) identifies the zone deviation measure for umpire i at the time of game g. T\(_g\), H\(_g\), and A\(_g\) refer to the yearly, home team, and away team fixed effects, respectively, while \(\epsilon_{ig}\) is the game-umpire specific error term. In this regression, based on the test noted by Even and Noble (1992), we identify inefficiency by the statistical significance of the B2 coefficient estimate. Specifically, this informs us whether the measure provides additional information about the actual total runs scored, above and beyond the contribution of the market determined ClosingLine.

Results
Our current results reveal evidence that totals markets do adjust to information related to umpire assignment in directions expected from their favorability toward more ball or strike calls, but only once that information is released (specific to games later in the series). Despite this adjustment, the magnitude of the closing total line change is smaller than the estimated impact of the umpire strike zone, possibly leaving room for profit among bettors and violating the semi-strong efficiency proposition, leaving these markets only weakly efficient. We will expand upon these results with various robustness checks to our models.

Significance to Sport Management
This work contributes to the long line of literature in both sport management and economics which uses live sport as a mechanism to test the efficiency of a market. The results illustrate how the timing of the release of information is incorporated into market pricing. It also demonstrates how the combination of technological advancement, employee monitoring and subsequent data collection can lead to advances in the ability to predict outcomes—a finding salient to any sport related firm seeking to use data to improve firm and employee performance.