The Designated Hitter Rule and Team Defensive Strategy in Japan's Professional Baseball Leagues

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Working Paper No. 06-7
April 6, 2006

Abstract

Economists have debated whether and why the designated hitter (DH) rule in North American major league baseball led to an increase in hit-batsmen. We use data from Japan's professional baseball leagues, the Pacific League (DH rule) and the Central League (no DH rule), to re-examine this question. Initial empirical findings reveal increases in hit-batsmen in the Pacific League after we control for the DH's effect on team batting performance. After controlling for interactions between pitcher quality and the DH rule, we find that the DH rule induced changes in team defensive strategies and, consequently, an increase in hit-batsmen. Subsequent rule changes reduced the effectiveness of these strategies.

JEL Classification: D81, J28

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Note: We thank Sang-Hyop Lee and Price Fishback for helpful discussions.

I. INTRODUCTION

We use data from Japan's professional baseball leagues to examine the effects of the designated hitter (DH) rule on team defensive strategies. The DH rule allows another player on the team roster to bat and run the bases in place of the pitcher, thereby ensuring that the pitcher never bats. In North American Major League Baseball (MLB), the American League (AL) introduced the DH rule in 1973 and continues to use it, while the National League (NL) has never used the rule. Using MLB performance data, Goff, Shughart and Tollison (1997), hereafter GST (1997), found that AL batters were hit by pitches more frequently than their NL counterparts during DH-rule seasons. They attributed this difference to moral hazard by pitchers, arguing that pitchers in the DH-rule league can hit opposing batters of their choice with less concern for personal retaliation as the rule exempts them from facing opposing pitchers at the plate.[1] Trandel, White and Klein (1998), hereafter TWK (1998), offered a new estimation equation to measure the DH's effects on hit-batsmen, updated the sample of GST (1997) by adding seven seasons (1991-1997), and found that the DH's effect on hit-batsmen was statistically insignificant. TWK (1998) also questioned the moral hazard story by arguing that a pitcher merely acts as an agent of his team's manager and that retaliation is rarely directed at pitchers themselves.[2] They stressed that AL batters are on average better hitters as the DH rule replaces a weak-hitting pitcher with a big-hitting slugger and argued that pitchers have a lower opportunity cost of hitting sluggers than pitchers. The lower opportunity cost of hitting sluggers should lead to more hit-batsmen in the AL than the NL. Levitt (1998) also found no evidence that pitchers who frequently hit

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[1] Batters can, however, charge the pitcher on the mound, and opposing pitchers can also retaliate by hitting other players on the pitcher's team. Since the pitcher cannot bat, opposing team managers could order increases in these responses to limit dangerous brush-back pitches against their players.

[2] Trandel (2004) argued that if a team retaliates when its own batter has been hit, then there should be a positive correlation between the number of opposing batters hit by the team's pitchers and the number of hit-batsmen on the team. Using MLB team data for 1960-2002, he found no evidence of statistically significant correlations between these two variables in the full sample or in particular decades. Bradbury and Drinen (2005) used a remarkably detailed play-by-play data set for each MLB team to search for retaliation against a pitcher who hit a batter. They found that a pitcher was four times more likely to be hit when an opposing player had been hit in the previous half-inning.

opposing batters are hit more often by opposing pitchers. In response to these criticisms, Goff, Shughart and Tollison (1998), hereafter GST (1998), acknowledged that the DH effect disappears when the sample period is extended through the 1997 baseball season. They hypothesized that the NL expansion in 1993 and the players' strike in 1994-95 may have diluted NL pitching and led to more hit batsmen in the NL, thereby diminishing the size and statistical significance of the DH effects in the AL.

This paper has three objectives, the first of which is to use data from the two Japanese professional baseball leagues to provide new tests of theories showing how the DH rule changed team strategies and pitcher incentives to produce an increase in the relative number of hit batsmen in the league adopting the DH rule. As in North American MLB, one league in Japan—the Pacific League—introduced the DH rule in 1975 and continues to use it, while a second league—the Central League—has never used it. The parallel rule structures in Japan and North America allow empirical inquiry into the effects of the DH rule with a new data set, one which we believe is superior to the MLB data set. Unlike MLB, Japanese professional baseball did not have a major player strike during the 1958-2004 seasons (our sample period) and had a fixed number of teams (six per league) from the 1958 through the 2004 seasons.[3] Japanese baseball experienced a two-game player strike in September 2004, but this pales in comparison to the strike in 1994/1995 in North American MLB which resulted in the loss of the 1994 post-season and continued into the 1995 season.[4] The more stable institutional environment for Japanese professional baseball teams should serve to improve the reliability of regression estimates of the DH's impact on variables such as the differences in the number of hit batsmen between the two leagues, as variations in hit batsmen cannot be due to changes in the number of teams or a player strike.

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[3] Operating with 8 teams between 1901 and 1960, the AL expanded to 10 teams in 1961, 12 teams in 1969, and 14 teams in 1977. Also operating with 8 teams between 1901 and 1960, the NL expanded to 10 teams in 1962, 12 teams in 1969, 14 teams in 1993, and 16 teams in 1998.

[4] None of the empirical results in our paper are affected by whether our sample period for Japanese baseball data includes the strike year (2004) or is truncated in 2003. The MLB 1994/1995 strike began on August 12, 1994, resulted in the loss of the 1994 post-season, and was not settled until April 25, 1995 when play resumed after a federal judge ordered that the 1995 season begin under the rules of the expired contract.

Our second objective is to use less aggregated data—team data rather than league data—and panel data estimation techniques to test existing theories of the impact of the DH rule on hit-batsmen. Our third objective is to extend existing theories of team defensive strategy, which focus on the characteristics of the batting team's hitters, by incorporating the characteristics of the defensive team's pitchers into the empirical analysis. We find that the DH rule induced teams to shift their team defensive strategy, choosing more aggressive pitching strategies and, consequently, more hit-batsmen.

The analysis proceeds as follows. In Section II, we show that the number of hit-batsmen in the Pacific and Central Leagues closely varied when neither league used the DH rule; displayed large gaps for 13 years after the Pacific League adopted the DH rule; and converged again after more strict rules on "dangerous balls" were adopted in 1989. We use regression specifications from prior literature to examine whether the hit-batsmen differential across the two leagues can be explained by the improved batting line-up that results from replacing a pitcher with a designated hitter. We supplement this analysis by using more disaggregated team data and panel data estimation techniques to test these hypotheses. Section III extends existing theories of team defensive strategies by arguing that a manager's pitching strategy is determined by the offensive capabilities of opposing batters and the capabilities of his team's pitchers. Using team panel data and a new estimation equation, we find that pitcher performance is a statistically significant determinant of team defensive strategy. Section IV summarizes the findings.

II. THE DH RULE AND CHANGES IN HIT BATSMEN ACROSS LEAGUES

Figure I provides rates of hit-batsmen (hit-batsmen/10,000 plate appearances or HB rates) for the Pacific and Central Leagues since 1958.[5] When the sample period is divided into two sub-periods by the Pacific League's adoption of the DH rule in 1975, the average HB rates are greater in the post-DH period in both leagues. As Table I shows, the mean HB rate in

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[5] GST (1997) and TWK (1998) both use "at-bats" as a basis to normalize hit batsmen statistics. We use "plate appearances" because hit batsmen occur as part of plate appearances. At bats exclude hit batsmen.

the Pacific League increased from 73.3 before 1975 to 81.7 thereafter, while in the Central League the mean HB rate was 68.4 before 1975 and 75.0 thereafter. The difference in the mean HB rate was 4.9 before 1975 and 6.6 after 1975. Using a *t*-statistic test for difference in means, the null hypothesis that the average HB rates are equal in both leagues cannot be rejected at the 5 percent significance level for both the pre-DH and DH periods.

During the DH period, another rule change occurred in the Pacific League that could have affected the number of hit batsmen. In July 1982, the Acting Chairman of the Pacific League issued a memorandum to league umpires, stating that "dangerous balls" should not be tolerated. In 1989, both leagues formalized the 1982 Pacific League memorandum by adding a clause to the official rulebook prohibiting a pitcher from throwing "dangerous balls."[6] An umpire was given the authority to remove the pitcher or both the pitcher and his manager from the game when he judged that a pitcher had intentionally thrown at a batter. In the same year, the Pacific League adopted its own four-pronged guidelines providing umpires with more concrete guidance on how and under what circumstances to penalize pitchers and their managers for the occurrence of "dangerous balls".[7]

We note that the timing of the 1982 and 1989 rules changes is roughly consistent with the timing of the declining gap in the HB rate during the DH period. After the issuance of the Pacific League "dangerous balls" memorandum in 1982, the gap between HB rates in the two leagues eventually disappeared over the course of the next seven seasons (1982-1988), with almost all of the catch-up occurring between 1985 and 1988. In the 1989

[6] The "dangerous balls" clause was added to the 1989 Official Rulebook as Section 8.02(d). The section (8.02) in which it was included enumerates a list of prohibited actions for pitchers.

[7] These four items are: (1) when umpires judge that a pitcher has thrown intentionally at a batter, the pitcher and his manager should be immediately removed from the game. This applies even when the ball did not actually hit the batter; (2) when the ball hits the batter after players in the dugout have verbally instigated their team's pitcher to throw at a batter, the pitcher and his manager should be immediately removed from the game. This applies even when the ball did not actually hit the batter, if the umpires judge that the pitcher has been engaged in dangerous pitching; (3) a warning is declared when a ball hits the batter on the head regardless of the umpires' judgment whether the pitch was intentional. After the warning, any pitcher who hits batters on the head should be immediately removed from the game; and (4) umpires have the authority to give warnings to any pitcher they judge to be engaged in dangerous pitching, in which case item (3) above applies.

season the Pacific League's HB rate fell (slightly) below the Central League's HB rate for the first time since the introduction of the DH rule in 1975. The impact of the "dangerous balls" rule is also supported by the change in the mean difference of HB rates across leagues. The average difference in HB rates was 4.9 prior to the introduction of the DH rule (1958-1974), which increased to 16.2 during the DH period before the dangerous balls rule was introduced (1975-1988). A *t*-test reveals that the difference in HB differentials across these two periods is statistically significant at the 1 percent level. After the dangerous ball regime is introduced (1989-2004), the mean differential in HB rates across the two leagues falls to –1.7. A *t*-test reveals that the mean differential in HB rates during the dangerous balls period (1989-2004) is not statistically different at the 5 percent level from the mean differential in HB rates during the pre-DH period.[8]

We follow these simple difference in means tests with regression analyses designed to test both for the existence of changes in hit-batsmen across the three periods with different rules (no DH, DH, and DH with dangerous balls rule) and for the rationale underlying identified changes in team behavior.

Effects of Designated Hitter Rule on Total Hit Batsmen

Our first set of regression analyses focuses on documenting changes in the annual number of hit batsmen in the two leagues over time. First, we replicate GST's (1997) original regression specification (1) using Japanese data from 1958-2004.

$$(1) \qquad Dif\text{-}HB_t = \beta_0 + \beta_1 DH_t + \beta_2 Dif\text{-}PA_t + \varepsilon_t$$

The dependent variable, $Dif\text{-}HB_t$, is the difference in hit-batsmen across the two leagues in year t. The DH_t dummy is one for the Pacific League between 1975 and 2004, and $Dif\text{-}PA_t$ stands for differences in plate appearances across the two leagues. Second, we rerun the original GST specification with

[8] The *t*-statistic for the null hypothesis that there are no HB differentials between the pre-DH period (1958-1974) and DH period with no dangerous balls rule (1975-1988) is 2.929. The corresponding statistic for the pre-DH period (1958-1974) and the DH period with the dangerous balls rule (1989-2004) is 1.903 which is statistically significant at the 10 percent level.

two DH dummy variables that represent DH rule regimes with and without penalties for "dangerous balls" in the following form:

(2) $Dif\text{-}HB_t = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \beta_3 Dif\text{-}PA_t + \varepsilon_t$.

One dummy variable, $DH1_t$, covers the 1975-1988 DH period, while a second dummy, $DH2_t$, corresponds to the 1989-2004 DH period with the "dangerous balls" rule.[9] Third, we conduct the same analyses of the normalized (for plate appearances) hit-batsmen interleague differences ($Dif\text{-}HBN_t$) using TWK's revised regression specification:

(3) $Dif\text{-}HBN_t = \beta_0 + \beta_1 DH_t + \varepsilon_t$

(4) $Dif\text{-}HBN_t = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \varepsilon_t$.

OLS regression results with these specifications are presented in Table II. As in GST (1997) and TWK (1998), we correct for first-order autocorrelation using the Cochrane-Orcutt transformation. Specifications with a single DH_t dummy [columns 1 and 4) have low explanatory power (R^2) and are not statistically significant (F-statistic). In addition, estimated coefficients for DH_t are not statistically different from zero at the 10 percent level. These results do not support the proposition that the DH rule led to an increase in hit-batsmen.

When we divide the DH period in two, both the original GST [column 2] and the normalized TWK [column 5] specifications produced positive and statistically significant estimated coefficients for $DH1_t$ at the 5 percent level and statistically insignificant estimated coefficients for $DH2_t$ at the 10 percent level. These results imply that the DH rule, before specific penalties for hitting batters were imposed on pitchers and their managers in 1989, was associated with an increase in the number of hit batsmen in the Pacific League.

It is possible that the observed impact of the DH rule on hit-batsmen is merely picking up the effect of the better batting lineup with the DH rule on the number of hit-batsmen. As TWK (1998) and Levitt (1998) point out,

[9] We also ran this analysis with DH2 specified to begin in 1983, which is the season after the Pacific League memorandum on dangerous balls was issued. The results are broadly similar.

adoption of the DH rule allows a team manager to have a stronger batting line-up by replacing a weak-hitting pitcher with a designated hitter with a high slugging average. Aggressive pitching to sluggers comes with the expected cost of more hit batsmen going to first base and with the expected gain of fewer big hits, due to the effects of brush-back pitches on the batter's concentration and stance at the plate. To the extent that a team manager chooses to order pitchers to engage in aggressive pitching more often to designated hitters than to pitchers, the number of hit batsmen should be greater with the DH rule.

To test the TWK hypothesis that introduction of the DH rule improves the quality of the batting line-up and hence leads to more hit-batsmen, we add a widely used measure of batter productivity—the difference in league slugging averages (Dif-SA_t)—to the GST specification (2) and the normalized TWK specification (4) as a proxy for harder-to-measure batter quality:

(5) $$Dif\text{-}HB_t = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \beta_3 Dif\text{-}PA_t + \beta_4 Dif\text{-}SA_t + \varepsilon_t$$

(6) $$Dif\text{-}HBN_t = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \beta_3 Dif\text{-}SA_t + \varepsilon_t.$$

Using league data, we estimate specifications (5) and (6) using OLS and correct for first-order autocorrelation using the Cochrane-Orcutt transformation. The regression results, reported in Table II [columns 3 and 6], are virtually identical to those reported for the same specifications without $Dif\text{-}SA_t$ [Table II, columns 2 and 5]. The estimated coefficients on $Dif\text{-}SA_t$ are positive, as predicted by TWK and Levitt, but are not statistically significant at the 10 percent level.

The estimated coefficients on SA_t could be statistically insignificant because these regressions were estimated using league data which is the sum of data from the six teams in each league. An alternative approach is to use team panel data and to employ a fixed effects estimator to obtain consistent estimates for the following specification:

(7) $$HB_{it} = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \beta_3 PA_{it} + \beta_3 SA_{it} + \varepsilon_{it}$$

where teams in the Central League—which have never used the DH rule—serve as a control group for teams in the Pacific League. Since team observations are generated from two distinct clusters—the Pacific League and the Central League, there could be cross-sectional correlation due to league-specific shocks affecting the number of batters hit on each team and to strategic interdependence for teams in a given league. In addition, the league regressions alert us to the possibility of AR(1) autocorrelation within panels. Since our panels are balanced, i.e., all have the same number of observations, and the data are equally spaced in time, we are able to use the fixed effect generalized least squares (FEGLS) estimator to estimate coefficients in our panel data model. Using FEGLS enables us to obtain consistent coefficient estimates in the presence of both autocorrelation within panels and cross-sectional correlation across panels (Wooldridge, 2002, 276-279). We run all regression specifications using two different methods for adjusting for autocorrelation within panels: (1) all panels have a common AR(1) autocorrelation parameter; and (2) each panel has a unique AR(1) autocorrelation parameter.

Estimated coefficients for team panel specifications are presented in Table III, columns 1 and 2. Regression results are similar when teams have a common [column 1] or a team-specific [column 2] autocorrelation parameter. The estimated coefficients on team plate appearances (PA_{it}) and team slugging average (SA_{it}) are positive and statistically significant at least at the 5 percent level, which provides support for the TWK and Levitt hypotheses that the number of hit batsmen is positively related to the performance of team hitters. However, the estimated coefficients for $DH1_t$ remain positive and statistically significant at the five percent level, while the estimated coefficients for $DH2_t$ are not significantly different from zero at the 10 percent level. These results reinforce our earlier results: Contrary to TWK and Levitt, the DH rule led to independent changes in the number of hit-batsmen until rule changes imposed larger penalties on managers and pitchers using “dangerous balls” strategies.

The preceding analyses demonstrate that the DH rule in the Pacific League was associated with more hit-batsmen and that a better batting line-up was responsible for some but not all of the increase. As GST (1997, 1998) discussed, the additional effects of the DH rule on hit-batsmen could be due to pitchers who maximize their own (rather than team) utility by throwing at the batters of their choice. This is an explanation based on moral hazard by pitchers who no longer have to face retaliation at the plate. We are skeptical of this argument because the pitcher is under the direct supervision of his manager, who is watching every pitch and every play from the nearby team dugout. Since it is the manager who decides which players play and for how long, a pitcher's behavior should reflect his manager's defensive strategy in a game. A pitcher who pays attention to his own preferences rather than the manager's orders is likely to receive comments on his behavior from the manager, players, team executives, radio and TV broadcasters, and media reporters. Self-indulgent behavior can be found in any organization, but the multifaceted and pervasive monitoring of pitcher behavior leaves us skeptical that moral hazard is likely to be important in this context. Thus, in the next section we investigate other factors which may have affected team pitching strategy under the DH rule.

III. THE DH RULE AND TEAM PITCHING STRATEGY

The literature on the DH rule and hit batsmen has focused on whether the number of hit batsmen varies with the use of the DH rule and how the number of hit batsmen might also be affected by the league or team slugging average. We find it striking that so much attention has been paid to the quality of the batter faced by the pitcher while virtually no attention has been paid to the quality of the pitcher facing the batter. A good pitcher has little incentive to hit a player, as the pitcher has the skills (including control and speed) to induce a better outcome on average. By contrast, a poor pitcher has more incentive to hit a player, as the pitcher has fewer skills and is less likely to induce a better outcome from the batter. While the outcome from hitting a batter is the same for all pitchers—the batter goes to first base and the inning is extended, the cost of hitting a batter is smaller for a poor pitcher. Thus, the number of hit batsmen should decrease as pitcher quality increases.

To test whether the DH rule prompted such a change in strategy, we use team panel data and estimate the relationship between a team's pitcher performance (PP_{it}) and the number of opposing batters hit by a team's pitchers (HBP_{it}). Pitcher performance serves as a proxy for the harder-to-measure pitcher quality. We measure pitcher performance (PP_{it}) as the number of strikeouts recorded by $team_i$ pitchers in season t over the number of walks they allowed in the same season. This measure of pitching performance is used as it isolates the productivity of the pitcher rather than the joint productivity of the pitcher and his fielders. We use fixed effects generalized least squares (FEGLS) to estimate the following specification:

(8) $$HBPi_t = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \beta_3 PAi_t + \beta_4 PP_{it} + \varepsilon_{it.}$$

As in our earlier panel regressions, we run all regression specifications using two different methods for adjusting for autocorrelation within panels.[10] The regression results are, however, robust to both methods of adjusting for autocorrelation. We report our results in Table III (columns 3 and 4). The estimated coefficients on plate appearances by opposing players (PA_{it}) are positive, as expected, and statistically significant at the 1 percent level; the estimated coefficient on $DH1_t$ is positive and statistically significant at the 5 percent level; and the estimated coefficient on $DH2_t$ is positive but not statistically significant at the 10 percent level. These results are broadly similar to those obtained in the panel regressions using offensive performance [Table 3, columns 1 and 2]. However, the estimated coefficients on pitcher performance are negative, as expected, but also statistically insignificant at the 10 percent level.

Ideally, the regression specifications should take into account both pitching performance and hitting performance. However, incorporation of pitching performance into our first set of panel regressions and offensive performance into our second set of panel regressions is problematic, as both measures are five-team averages and vary little across teams. To incorporate team pitching performance and team offensive performance into the same regression, we offer a normalized ratio specification with the dependent variable being the normalized ratio of opposing batters hit by team i's pitchers and team i batters hit by opposing pitchers ($NRHB_{it}$); and explanatory variables being relative pitcher performance (RPP_{it}) defined as the ratio of team pitcher performance to opposing team pitcher performance $((K_{it}/W_{it})/(K_{ot}/W_{ot}))$; relative slugging performance (RSA_{it}) defined as the ratio of team slugging performance to opposing team slugging performance (SA_{it}/SA_{ot}); and the two DH variables, $DH1_t$ and $DH2_t$.[11] We use a fixed

[10] We emphasize to the reader that the dependent variable in specification (8) is not the same dependent variable as in specifications (1)-(7).

[11] $NRHB_{it}$ is the ratio whose numerator is the number of opposing team batters hit by

effects generalized least squares (FEGLS) estimator to obtain consistent coefficient estimates from the following specification.

$$(9) \qquad NRHBi_t = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \beta_3 RPP_{it} + \beta_4 RSA_{it} + \varepsilon_{it}$$

Results are reported in Table IV, columns 1 and 3. Using a common coefficient for adjusting for AR(1) autocorrelation [column 1], we find that neither of the estimated coefficients for $DH1_t$ and $DH2_t$ are statistically significant at the 10 percent level. However, estimated coefficients on RPP_{it} and RSA_{it} have the expected signs and are statistically significant at the five percent level. When a team-specific coefficient for adjusting for AR(1) autocorrelation is used, estimated coefficients on RPP_{it} and RSA_{it} still have the expected signs, but RSA_{it} is not statistically significant at the 10 percent level. From these results, we conclude that team pitching performance should be included in regressions attempting to explain relative or absolute number of hit batsmen. These results are also highly supportive of the TWK and Levitt view that the DH rule has no independent effect on the number of hit batsmen once other co-variates that influence the number of hit batsmen are introduced to the regression.

Finally, we consider whether the pitching strategy of a baseball team is affected by the DH rule. Compare the strategies of managers from teams with high-quality and low-quality pitching staff: It is the manager of less talented pitchers who is more tempted to use hit batsmen as a means of minimizing the damage incurred by opposing teams' sluggers. A team with more talented pitchers does not choose this strategy as often, since its pitchers can retire opposing teams' batters more easily. For a team with low-quality pitchers, one obstacle to using this strategy is that its pitchers may fear personal retaliation at the plate from the other team's pitchers. Managers pay attention to these concerns, as they could affect their pitchers' mental or physical capabilities to carry out their assigned duties. Once the DH rule is adopted and pitchers can completely escape this particular form of retaliation, a manager finds it easier to instruct his pitchers to engage in aggressive pitching which includes brush-back and beanball pitches.[12] To

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$team_i$'s pitchers normalized by the opposing batters' plate appearances, and denominator is the hit batsmen received by $team_i$'s batters normalized by their plate appearances.

[12] It should be noted that the hypothesis of aggressive pitching by poorly pitching teams

test this hypothesis, we use a fixed effects generalized least squares (FEGLS) estimator to obtain consistent coefficient estimates from the following specification which includes interaction terms between RPP_{it}, and RSA_{it} with $DH1_t$ and $DH2_t$:

(10) $NRHBi_t = \beta_0 + \beta_1 DH1_t + \beta_2 DH2_t + \beta_3 RPP_{it} + \beta_4 RSA_{it} + \beta_5 DH1_t *RPP_{it} + \beta_6 DH2_t *RPP_{it} + \beta_7 DH1_t *RSA_{it} + \beta_8 DH2_t *RSA_{it} + \varepsilon_{it}.$

Our initial regressions provided estimated coefficients on $DH1_t*RSA_{it}$ and $DH2_t*RSA_{it}$ that were not statistically significant from zero at the 10 percent level, and we dropped these two variables from subsequent regressions. We report results using common and team-specific AR(1) autocorrelation coefficients in Table IV, columns 2 and 4. In both specifications, the estimated coefficients on $DH1_t$ become positive and statistically significant at the 5 percent level, while the estimated coefficients on $DH1_t *RPP_{it}$ are negative and statistically significant at the 5 percent level.

What is the net effect of the DH rule in these two specifications? For both specifications, the DH rule has a small net positive effect (.01 with common AR(1);.02 with team-specific AR(1)) at the mean RPP_{it}, a net positive effect (.24;.22) at the minimum RPP_{it}, and a net negative effect (-.28;-.24) at the maximum RPP_{it}.[13] Both specifications support the hypothesis that some Pacific League teams responded to the DH rule by altering their pitching strategies as pitcher quality varied. As we discuss below, this finding poses difficulties for econometricians trying to detect moral hazard by pitchers.

IV. CONCLUSION

The results from our regression analyses of Japanese professional

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under the DH rule rests on the potential for personal retaliation and does not require that retaliation actually take place. The correlation coefficient between team pitcher-HBs and team batter-HBs (in terms of their divergence from league averages) for Japanese teams in 1958-2004 is –0.145, which does not provide evidence of retaliation. This parallels Trandel's (2004) findings for MLB.

[13] These calculations are based on RPP summary statistics for the Pacific League teams (mean 1.0198; minimum 0.5867; maximum 1.5946).

baseball league data generally support the hypothesis that the DH rule led to more hit batsmen until rule changes in 1989 prohibited pitchers from intentionally throwing dangerous pitches at a batter. It is notable that the impact of the DH rule can be isolated in Table III even after we control for the improved team batting line-ups in the Pacific League after the introduction of the DH rule and for team pitcher quality. These new findings using Japanese data stand in contrast to TWK's (1998) and Levitt's (1998) findings using North American MLB data—that the increase in hit-batsmen in the American League during the DH era was well within the range that would be observed due to improvements in the batting line-ups of AL teams.

Our unified regression framework in Table IV produces more varied results across different regression specification. Those specifications using just DH dummies produce estimated coefficients on DH1 and DH2 that are statistically insignificant at the 10 percent level. However, regression specifications using DH dummies and interaction terms between player productivity and DH1 produce estimated coefficients for $DH1_t$ and for the $DH1t*RPP_{it}$ interaction terms that are statistically significant at the 5 percent level.

The estimates from the interaction specifications lead us to infer that teams changed pitching strategies in response to the DH rule. Of course, the estimated coefficient on DH1 could also be picking up the effects of pitcher moral hazard. And that result poses a new problem for researchers: Once the introduction of the DH rule induces changes in pitching strategies towards batsmen of a given quality, it becomes more difficult to distinguish econometrically whether increases in hit batsmen were due to pitcher moral hazard or to changes in pitching strategies ordered by the team manager. Perhaps our results should serve to remind us that pitching a baseball to a batter is far from a bright line enterprise; that a pitcher's control over his toolkit of pitches varies across games, start times, seasons, and stadiums; that team managers often struggle to "figure out" and properly manage the modern player; and that there may typically be some, very limited space for team pitchers to indulge their preferences while facing batters from the mound.

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TABLE I. Hit Batsmen Rates (Hit Batsmen/10,000 Plate Appearances)

	Pre-DH Rule 1958-1974	Post-DH Rule 1975-2004	Pre-Dangerous Balls Rule 1975-1988	Post-Dangerous Balls Rule 1989-2004
Pacific League	73.3 (14.7)	81.7 (15.5)	87.1 (11.5)	76.9 (17.3)
Central League	68.4 (16.4)	75.0 (13.3)	70.9 (12.3)	78.6 (13.4)
League Difference	4.9 (10.0)	6.6 (13.8)	16.2 (11.3)	-1.7 (10.0)

TABLE II. OLS Estimates of Hit Batsmen Differences between Pacific and Central Leagues: 1958-2004

Dependent Variable	HB Difference (1)	(2)	(3)	Normalized HB Difference (4)	(5)	(6)
DH	7.16			3.45		
	(0.37)			(0.56)		
DH1		34.48**	36.29***		11.50**	12.63***
		(2.48)	(2.73)		(2.69)	(3.05)
DH2		-16.22	-17.68		-5.78	-5.70
		(1.21)	(1.37)		(1.39)	(1.46)
Plate App. Differences	0.002	0.01	0.005			
	(0.31)	(1.09)	(0.67)			
Slug Ave Difference			258.34			72.99
			(1.08)			(1.00)
Intercept	14.39	12.22	10.99	3.74	4.44	3.50
	(0.87)	(1.17)	(1.09)	(0.73)	(1.50)	(1.20)
Adjusted R^2	-0.042	0.239	0.274	-0.015	0.249	0.283
F-statistic	0.09	5.71	5.25	0.32	8.45	6.91
rho	0.466	0.102	0.046	0.461	0.121	0.057
DW(corrected)	2.080	1.842	1.848	2.046	1.852	1.851

Note: t-statistics are in parentheses.

Asterisks indicate statistical significance at the 10% (***) and 5% (**) level.

TABLE III: Fixed-Effects GLS Estimates of Hit Batsmen by Team: 1958-2004

Dependent Variable	Hit Batsmen (team batters)		Hit Batsmen (by team pitchers)	
	(1)	(2)	(3)	(4)
	(ar1)	(psar1)	(ar1)	(psar1)
DH1	4.498**	3.655**	5.839**	7.534***
	(2.47)	(2.28)	(2.50)	(3.39)
DH2	0.838	-0.441	0.901	2.902
	(0.46)	(0.28)	(0.39)	(1.32)
Plate Appearances	0.012***	0.013***	0.017***	0.017***
	(4.42)	(4.91)	(6.22)	(6.39)
Slugging Average	32.893**	37.437***		
	(2.57)	(3.01)		
Pitcher Performance			-1.041	-1.111
			(1.07)	(1.20)
Intercept	-37.33***	-44.194***	-46.681***	-46.685***
	(3.07)	(3.69)	(3.21)	(3.33)
Log-L	-1954.70	-1951.56	-1932.38	-1925.81
Wald chi	53.40***	63.28***	60.06***	70.15***

Note: Autocorrelation within panels are assumed to be common across all panels (ar1) or to be unique to each panel (psar1). z-statistics are in parentheses.
Asterisks indicate statistical significance at the 1% (***) and 5% (**) levels.

TABLE IV: Fixed-Effects GLS Estimates of Normalized Hit-Batsmen Ratio

Dependent Variable	Normalized HB-Ratio (ar1)		Normalized HB-Ratio (psar1)	
	(1)	(2)	(3)	(4)
DH1	0.012	0.542***	0.017	0.490**
	(1.13)	(2.64)	(1.39)	(2.38)
DH2	-0.007	0.166	-0.003	0.113
	(0.68)	(0.74)	(0.25)	(0.51)
RPP	-0.258***	-0.163*	-0.266***	-0.198***
	(3.49)	(1.91)	(3.85)	(2.55)
RSA	-0.376**	-0.383**	-0.257	-0.250
	(1.99)	(2.06)	(1.45)	(1.42)
DH1*RPP		-0.518**		-0.458**
		(2.58)		(2.28)
DH2*RPP		-0.170		-0.111
		(0.78)		(0.51)
Constant	1.683***	1.595***	1.565***	1.489***
	(8.81)	(8.29)	(8.64)	(8.12)
Log-L	-46.70	-43.88	-44.60	-42.84
Wald chi	21.32***	29.51***	21.18***	27.70***

Note: Autocorrelation within panels is assumed to be common across all panels (ar1) or to be unique to each panel (psar1). z-statistics are in parentheses. Asterisks indicate statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

Figure I. Hit Batsmen per 10,000 Plate Appearances, 1958-2004