Do round numbers always become reference points?: An examination by Japanese and Major League Baseball data

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Abstract

The round number effect refers to discontinuity around round numbers ("0.300", "4 hours") in frequency distribution, indicating that people consider the round numbers as goals or reference points for their performances. This study aimed to examine the round number effect by exploring the following two issues: (1) examination of Japanese baseball data, and (2) comparison between batters who exceeded the regulation number of at-bat of season and those who did not. Results indicate the following three points; (1) the round number effect was found in Japanese baseball data, (2) but it was found only for the batters who exceeded provision bat number of season, and (3) magnitude of the effect was stronger in Japanese than Major League Baseball data. General discussion argued these results in terms of players' motivation and disposition.

Keywords: reference dependence, round number effect, discontinuity

Introduction

How people perceive values of objects depends not only on nature of the objects themselves but also the degree the objects are judged compared using a criterion. This tendency is known as reference dependency (Kahneman & Tversky, 1979; Rosch, 1978), and has been demonstrated through exploration for anomalies in human decision-making including studies on framing effect (Tversky & Kahneman, 1981) or anchoring effect (Tversky & Kahneman, 1974). According to these studies, people's judgments are affected by arbitrarily presented numbers (Tversky & Kahneman, 1973) or wordings of decision problems (Tversky & Kahneman, 1981) that are not themselves irrelevant to answers for the decision tasks, indicating that people make judgments according to the reference points that are considered as goals for their behavior rather than relying on their own beliefs or preferences.

The round number effect (Allen et al, 2016; Pope & Simonsohn, 2009) is a new example of reference dependency that refers to a discontinuity of distribution for continuous variables around the round numbers that can be considered goals for performance. When students take the SAT, they may say that they want to acquire 1100 points, but never 1098 or 1103 points. Marathon runners may try to finish the race within 4 hours, but never within 3 hours and 56 minutes. As these examples indicate, round numbers are often employed as goals for performances. As a result, people's behavior would change depending on whether they can perform just short of the round number or not, and density of the distribution for the performance would fluctuate around the round number (also see Heath et al., 1999; Kahneman & Miller, 1986; Medvec & Savitsky, 1997).

Pope and Simonsohn (2011) reported the round number effect in Major League Baseball (MLB) data. In their study, they analyzed data about batting averages of MLB players who had scored at least 200 at bats during the season from 1975 to 2007, and found that the relative frequency of baseball players whose batting averages at the end of the seasons were 0.300 was higher than those whose batting averages were 0.299. In addition to the discontinuity of frequency around 0.300, Pope and Simonsohn (2011) also found that performance or strategy of the batters who could achieve "0.300" by hit on their final bat differed from those of the batters who could not or already achieved "0.300": their probabilities for hitting at the final bat were higher than, and probabilities to choose the walks at the final bat were lower –in fact, 0- than the other batters. These results indicate that the batters used "0.300" as their goal for their batting performance, and tried to achieve this goal by any means, resulting in discontinuity around the round number. Beside the example of batting average data, the round number effect was reported in various domains including SAT score (Pope & Simonsohn, 2011) or marathon running time (Allen et al, 2011; also see Pope & Simonsohn, 2011 for an example of fictitious scenario).

Studies on round number effect suggest that people in some sense can do nothing without a concrete goal In other words, rather than trying as much as they can, people aim to exceed their criteria that are arbitrarily determined, and round numbers are often chosen as simple and definite goals. This study aimed to deepen the understanding of how round numbers become reference points by analyzing records of batting average data in the same way as Pope and Simonsohn (2011). However, this study explored the following two points that have not been examined in the previous studies.

One purpose of this study was to test the round number effect in Japanese baseball data. Although Pope and Simonson (2009) demonstrated the round number effect in MLB data, its replicability in other leagues is still unexplored. In Japan, baseball is the one of the most popular and major professional sports, and abundant data for batting records are available for this examination. Additionally, the round number "0.300" is often referred to the cutoff for top-ranking batters in Japanese baseball. Thus, Japanese professional baseball (Nippon Professional Baseball: NPB) data is adequate to test whether the round number effect can be replicated in the same way as in MLB.

The other purpose of this study as to explore individual differences in the round number effect of “0.300.” Although this study referred to the number “0.300” as cutoff for the top-ranking batters in professional baseball, it also recognizes that this number does not always become goals for all the players. In professional baseball, batting average itself cannot be proof of the top-ranking batters because values of the batting averages depend on number of plate appearance. For example, although batting averages of the batters who got three hits at ten bats or one hundred and fifty hits at five hundred bats are both the same at “0.300,” meanings of “0.300” might be different between the batters. Though the former average might be considered as a result of chance, the latter average would be thought as reflecting real ability. In fact, both MLB and NPB determined the regulation number of at-bat, and averages cannot be recognized as formal records without achieving the regulation number. Thus, it is probable that whether batters consider “0.300” as reference points depend on their numbers of battings: while the batters who cannot achieve number of regulations at battings do not consider “0.300” as their goal, for ones who can achieve the number, it might be valuable goal. The second purpose of this study was to test this possibility.

To accomplish the above purposes, this study gathered data for batting averages both in MLB and NPB, and tested the round number effect by examining whether relative frequencies of the batters whose batting averages were “0.300” stick out in the frequency distribution. In doing so, this study employed statistical test used in Chetty, Friedman, Olsen, and Pistaferri (2011) that utilize a broader range of data than Pope and Simonsohn (2011). With this method, this study also analyzed data that were divided by the number of plate appearance and examined whether the round number effect depends on whether the batter achieved the number of regulations at bats or not. The theoretical meanings and scope of the round number effect were discussed as well..

Method

This study obtained batting average data of Japanese baseball from Nippon Professional Baseball Organization (http://npb.jp/). This website contains results for all players of Japanese professional baseball from 2005 to 2018. Similar to Pope and Simonsohn (2011), this paper restricted its sample to players who had at least 200 at bats during the season. As a result, data of 1436 players were analyzed.

This paper also obtained MLB data in the same time as NPB data from Retrosheet.com. This website has data that was used by Pope and Simonsohn (2011), and contains data of all players in MLB for the same periods as Japanese data. This paper collected data of MLB using the same criteria as Japanese data, resulting in analysis of data of 4630 players.

This study aimed to investigate whether the round number effect would vary according to the number of appearances at bats. To accomplish this, the study divided the data into two groups by whether the number of appearances at bats exceeded the regulation numbers at bats or not both in NPB and MLB data. In NPB data, the regulation numbers at bats differed depending on year and league. In 2005 and 2006 the regulation numbers were 452 at Central League and 426 at Pacific League, and during 2007 and 2014, the number in both leagues was 446, and after 2015, it was 443. As a result, this study considered 743 batters as exceeding the regulation number at bats and 818 batters as not exceeding the regulation number.

In MLB, the regulation number at bats was settled as 400 since 1957. Thus, this study considered 2561 batters as exceeding the regulation number at bats and 2081 batters as not exceeding the regulation number in MLB data.

Results and discussion

Analyses of fundamental statistics of the round number effect

Figure 1 shows distribution of relative frequencies of batting averages at the ends of season both for players who had at least 200 at bats in both NPB and MLB. Visual inspections to these distributions suggest the following three points. First, with regard to the players who had at least 200 at bats, relative frequency of the average “0.300” is higher than any other values of batting averages of NPB and MLB players. In fact, similar to Pope and Simonsohn (2011), the proportion of players ending the season with a 0.298 or 0.299 was lower than that with a 0.300 or 0.301 (z=4.84 and 3.99 for MLB and NPB, respectively) in both the leagues, indicating that this study replicated the round number effect with a dataset different from that of Pope and Simonsohn (2011).

However, trends of the frequency around 0.300 appear to be different between the batters who exceeded the regulation number of at-bat of season and those who did not: the density of frequency around 0.300 that occurred for the batters who exceeded the number disappeared for the batters who did not. The Z tests demonstrated a significant difference in the proportion between 0.298 or 0.299 and 0.300 or 0.301 (z=4.87 and 4.05 for MLB and NPB, respectively) for the batters who exceeded numbers of regulation at bat in season, but did not demonstrate significant differences for the batters who did not exceed the number (z=1.48 and 1.50 for MLB and NPB, respectively). These results indicate that the round number effect would vary according to the number of at bat.

Third, increases in the frequency around 0.300 were higher for the NPB than MLB players. With regard to the total data, though the ratio of the frequency between 0.300 and 0.299 was more than 9 (3 for 0.299, and 28 for 0.300) in NPB data, that in MLB data was less than 3 (22 for 0.299,

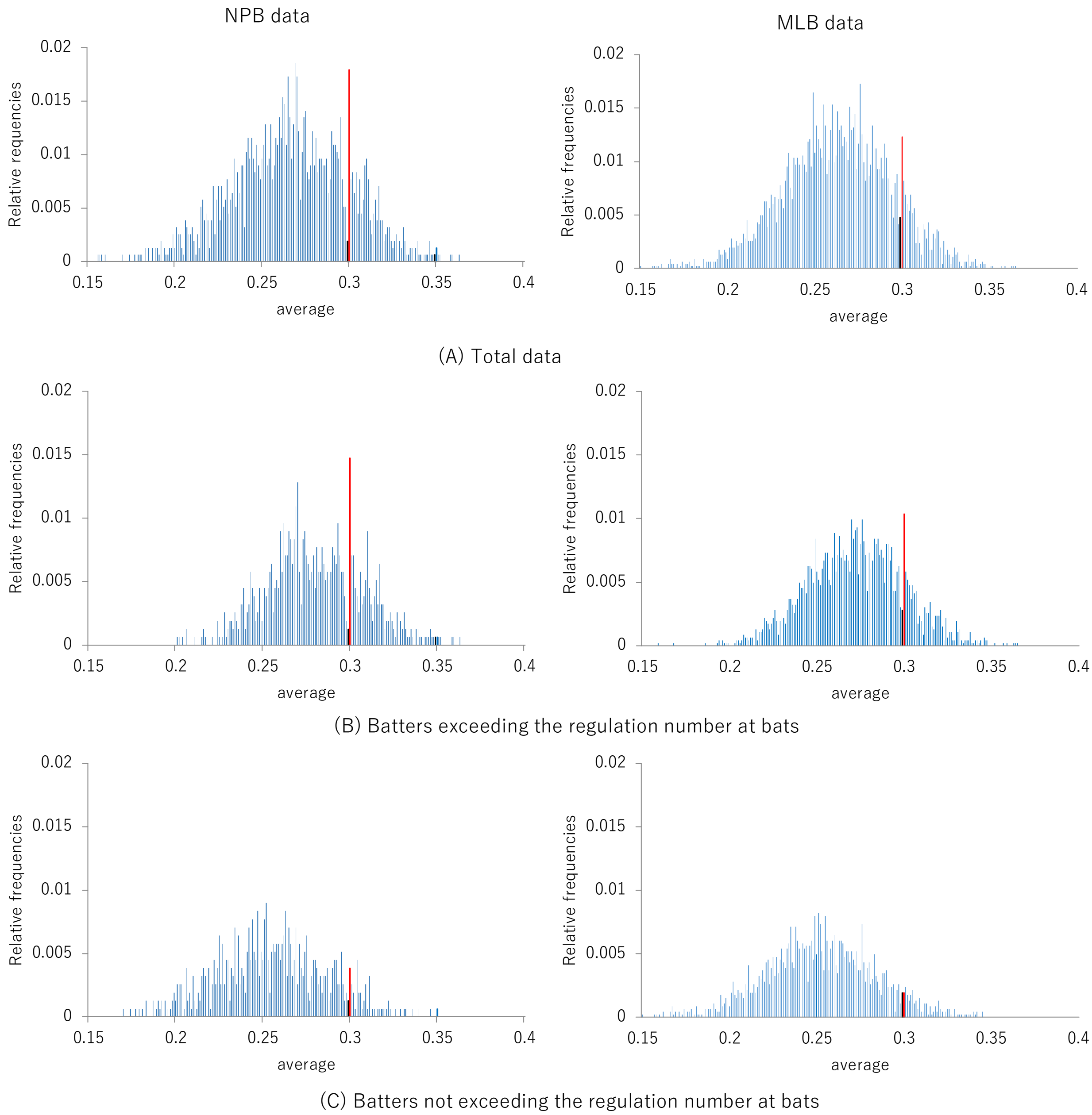

Figure 1 Distributions for batting averages of batters in NPB and MLB: Left and right column demonstrate distributions for NPB batters and MLB batters, respectively. Figures in the top, middle, and bottom row demonstrate distributions of the all batters, the batters who exceeded the number of regulation at bats, and batters who did not exceed the number of regulation at bat, respectively.

and 57 for 0.300). When data were limited only to the batters who achieved the provision bat number in the season, differences in the ratio became more salient (2 for 0.299 and 23 for 0.300 in NPB data, and 13 for 0.299 and 48 for 0.300 in MLB data). These results suggest that the round number effect would occur more strongly in NPB than MLB.

Quantitative estimation of the round number effect

One concern of the above discussion is that they solely consider data around the round number. However, as shapes of the distributions indicate, rise and drop around the round number in frequencies might be within probabilistic fluctuation. Thus, to explore this possibility, this study adapted a methodology proposed in Chetty et al. (2011) to quantify the extent of excess mass in an interval around a round number. This methodology enables examining

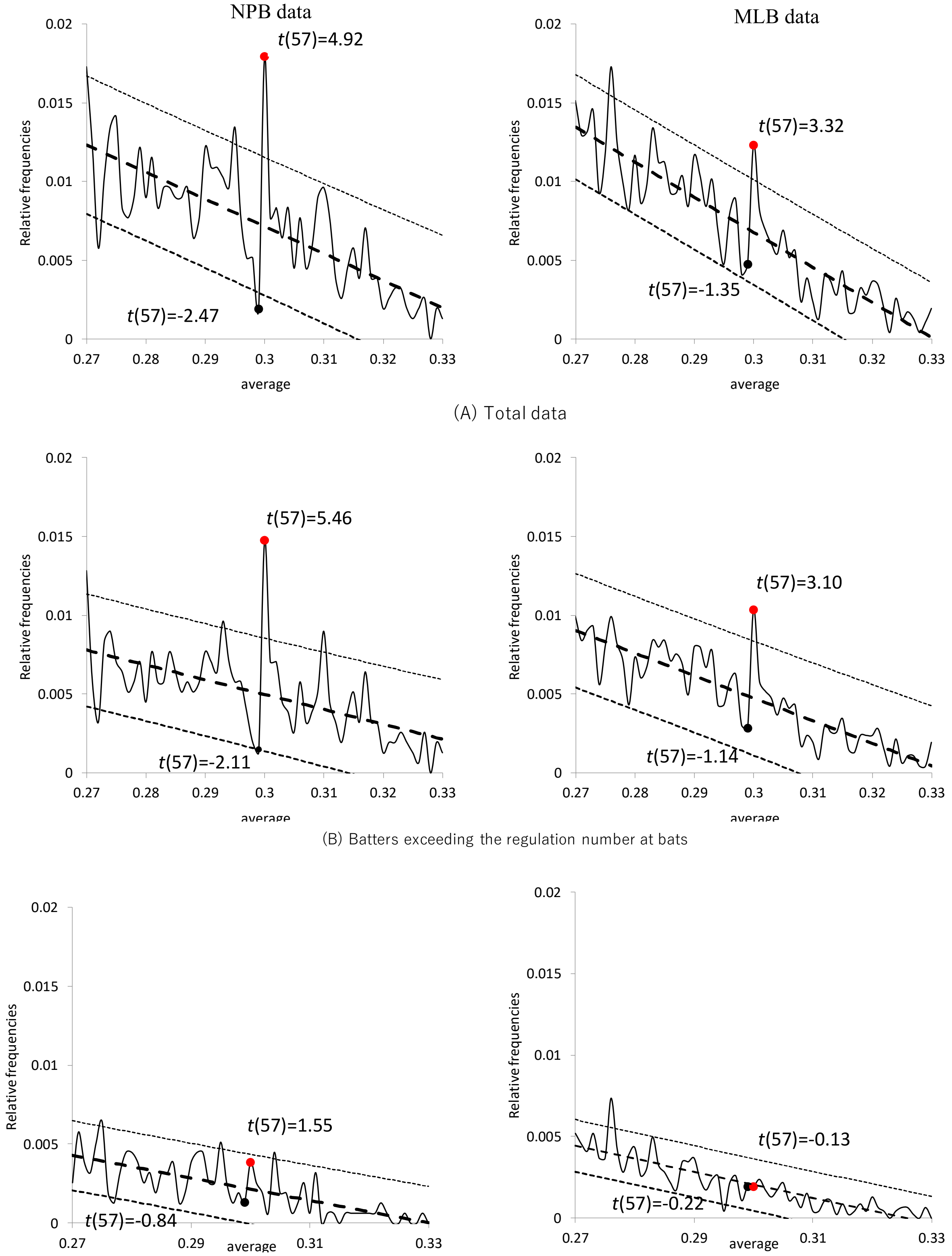

Figure 2 Result of Chetty's test: Left and right columns demonstrate distributions for NPB batters and MLB batters, respectively. Figures in the top, middle, and bottom row demonstrate distributions of the all batters, the batters who exceeded the number of regulation at bats, and batters who did not exceed the number of regulation at bat, respectively. Dotted lines in the graphs indicate regression line (bold) and 95% predictive intervals (thin). Red points indicate data of 0.300, and black points indicate data of 0.299.

whether discontinuity in distribution would occur around the reference point. The following section explains this methodology referring to the case of the round number effect in the batting average data.

This study aimed to examine whether discontinuity occurs between 0.299 and 0.300 because for the batters, "0.300" serves as reference point to be achieved. To address this issue, this study considered what would happen if "0.300" was not the reference point and the bunch around this number occurred in fact by chance. If so, frequencies of the batters around these values would follow trends that can be predicted through data from other domains. To test this consideration, this study first analyzed batting average data excluding frequencies of the batters whose averages were 0.299 and 0.300 with polynomial regression analysis where the batting average was the independent variable and the frequency of the batters was the dependent variable. Then, based on the results of this analysis, this study predicted frequencies of the batters whose averages were 0.299 and 0.300, and compared these predictions with the data. In sum, Chetty et al.'s (2011) method constructed "counterfactual" prediction from the data excluding values around the round numbers and examined the degree of deviation of the data from the counterfactual prediction by estimating prediction intervals of the polynomial regression models.

Using this methodology requires several inspections. First, the range of data used for this methodology must be selected in terms of research. For example, Allen et al. (2013) decided the range of data to be analyzed using Chetty et al.'s (2011) methodology through "visual inspection" of the data. Following Allen et al. (2013), this study also decided the range of data through visual inspection of the distribution. Thus, frequencies of the batters between 0.270 and 0.330 were used for the analysis. Second, the number of independent variables must be selected from results of polynomial regression analyses. This study adopted single regression model to approximate the data because only the effect of first order term in this model was significant throughout the six distributions.

Results of the analyses are shown in Figure 2. As the graphs shown in Figure 2 demonstrate, the frequencies of the batters whose averages were 0.300 were beyond 95% predictive intervals of the regression model both for NPB and MLB data. However, the frequencies of the batters who did not achieve the number of regulations at bat were within the 95% predictive interval from the regression models. Additionally, values of t-statistics for frequencies of the batters at 0.300 were larger in NPB than MLB, indicating that deviation from the predictions from the regression are more extreme in NPB than in MLB. In sum, these results support the findings in the previous section: the round number effect was replicated in NPB data, and depends on the number of plate appearance. Moreover, magnitude of the round number effect is more prominent in NPB than MLB.

Conclusion

Findings from the above analyses can be summarized as follows. First, this study demonstrated the round number effect using dataset other than that of Pope and Simonsohn (2011). The results indicate that the round number effect occurred in NPB data, and in doing so, this study analyzed MLB data collected using criteria different from those of Pope and Simonsohn (2011). This finding is also important in showing replicability of the round number effect in real situations with more strict methodology (Chetty et al., 2011) that was not adopted in the previous study (Pope & Simonsohn, 2011).

Second, this study found that the round number effect depends on people's incentives or motivation. Analyses of the data of the batters who did not exceed the number of regulations at bat indicated that increase in the frequencies of batters whose averages were 0.300 did not occur, indicating that 0.300 was not the reference point for performance for these batters. This finding indicates scpoe of the round number effect, which had not been explored in the existing studies (Allen et al., 2016; Pope & Simonsohn, 2011). Specifically, this finding is important in that the round number effect does not solely depend on people's preference for the round number.

In this vein, it is interesting that this study found difference in the round number effect between NPB and MLB data. Although NPB and MLB data are different in their sample size, discontinuities in the distributions around 0.300 in NPB data are more prominent than those in the MLB data, indicating that Japanese batters attach more weight to average 0.300 than Major League batters. This difference might be based on some cultural difference in professional baseball, suggesting that situational factor also affect the round number effect. In other words, Japanese baseball culture might attach greater importance on batting average to evaluate abilities of batters than in MLB. More precise analyses should be conducted to understand this difference in future research more profoundly.

According to Pope and Simonsohn (2011), the round number can serve as cognitive reference point in numerical scale in the same way as goals (Heath, Larrick, & Wu, 1999; Larrick, Heath, & Wu, 2009), expectations (Feather, 1969; Mellers, Schwartz, Ho, & Ritov, 1997), and counterfactual (Kahneman & Miller, 1986; Medvec, Gilovich, & Madey, 1995; Medvec & Savitsky, 1997). In contrast to this interpretation, this study revealed motivational and situational aspect of the round number effect. In other words, this study suggests that the round number cannot become reference point for performance solely by itself. Although for batters who exceed the number of regulations at bat the average of 0.300 can serve as proof for the top rank batter, for the batters who do not exceed the number, 0.300 itself might not be an important number. That is, for these batters, before achieving the average 0.300, it is important to exceed the number of regulation at bat. In addition, situational or cultural factor may also enhance the round number effect. This implication of the round number suggests that meaning of the number depends on individual disposition. Thus, exploring conditions that enhance or inhibit the round number effect is an important future research question.

One methodological concern for this study was the arbitrariness of assumptions in analysis. This study performed the Chetty test (Chetty et al., 2011) using data from 0.270 to 0.330 through visual inspection of the distributions. However, it is possible to consider other criteria for data selection from the distribution to analyze the round number effect. Sophistication of methodology to test the round number effect is also necessary for future research.

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