Pitchers' Decision-Making and Context Effects

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Abstract

This paper studies pitchers' decision-making in baseball, particularly the strategic actions after two strikes, called waste pitches. Given pitch distribution after two strikes, we find that pitchers' strategies are similar to the context effects such as the *Attraction* and *Similarity* effects. It is well-known that these behavioral regularities are not consistent with *Regularity* and *Independence of Irrelevant Alternatives* (IIA) in stochastic choices, respectively. We study a model of costly information acquisition, which allows for these behavioral regularities. We focus on the information structure behind pitchers' decision-making. We show that the optimal information structure can lead to such a waste pitch under costly information acquisition.

Keywords: Attraction effect, Similarity effect, Information Acquisition, Rational Inattention, Waste Pitches.

JEL classification: D00, D81, D83, D91, Z20.

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1. Introduction

We study pitchers' decision-making in baseball, and contribute to the following; First, we find that the *Attraction* and *Similarity* effects, well-known context effects in various fields, have been observed in baseball. We provide evidence from MLB. Next, we show that these behavioral regularities are consistent with the Caplin and Dean (2015)'s information acquisition model, which captures *information structures* behind their actions. Finally, to affect these behavioral regularities, we consider wasted balls, which are purpose pitches to strikeouts, and have the role of *decoy* options. We show that waste pitches are optimal under costly information acquisition.

The Attraction & Similarity effects. The *Attraction* effect has been introduced in Huber et al. (1982) and observed in various contexts of decision-making among gambles (Wedell, 1991), consumer products and services (Wedell and Pettibone, 1996), job applicants (Highhouse, 1996), and political candidates in U.S. elections (Pan et al., 1995). The *Similarity* effect is a well-known violation of the consistency condition, *Independence of Irrelevant Alternatives* (IIA) (Luce, 1959). These behavioral regularities are highly robust in both within-subject designs and between-subject designs (Rieskamp et al., 2006).

We provide evidence of these behavioral effects in the context of baseball. We pay much attention to the case of two strikes. In particular, when pitchers have advantageous counts such as 0-2 (zero ball and two strikes) and 1-2 (one ball and two strikes), the behavioral patterns can occur in the presence of waste balls. The *Attraction* effect is related to the following pitching pattern; After wasting a pitch, the probability of a pitch of the “dominance” ball to the waste ball increases (Figure 2). On the other hand, in the *Similarity* effect, after the waste pitch, the probability of the opposite or different ball to the waste ball increases (Figure 1).

Pitchers' Decision-Making. We model a costly information acquisition of pitchers' decision-making. To strike batters out, pitchers need to read batters' strategies. The model captures such a procedural aspect of decision-making. We study pitchers' information structures behind their actions. We also consider how information structures are related to context effects.

The Rationality of Waste Pitches. The model states that the costly information acquisition is optimal; that is, the procedure of wasted pitches is optimal. In baseball, different pitchers have different ideas on wasted pitches. In this paper, we theoretically show that wasted pitches can be optimal under costly information acquisition.

Outline. The rest of the paper is organized as follows. In Section 2, we briefly explain both the *Attraction* and the *Similarity* effects. In Section 3, we provide evidence from MLB. In Section 4, we introduce the model of costly information acquisition. The formal analysis is in the full paper.

2. The Attraction and Similarity effects

In this section, we explain both the *Attraction* and *Similarity* effects. We also consider a relationship between these behavioral regularities and well-known axioms in stochastic choices.

2.1 The Attraction Effect

We define the Attraction effect. Let ρ be a stochastic choice. Take alternatives a, b, and c. Consider the menu $\{a,b,c\}$. Suppose that the alternative a *dominates* the alternative c; that is, in all attributes of alternatives, a is superior to c. Then, the behavioral pattern says that $\rho(a,\{a,b,c\}) > \rho(a,\{a,b\})$.

We mention that this behavioral regularity is not consistent with the axiom of *Regularity*, one of the most well-known properties in stochastic choices.

Axiom. (Regularity): For any $A, B \in \mathscr{A}$ with $A \subseteq B$ and $a \in A \cap B$,

$$\rho(a,A) \geq \rho(a,B).$$

This axiom states that choice probabilities of alternatives from smaller menus are larger than that from larger menus.

This axiom does not allow for the *Attraction* effect. Consider the above example of three alternatives. Assume that $\rho(a,\{a,b\}) = \rho(b,\{a,b\}) = 0.5$. The behavioral pattern requires that $\rho(a,\{a,b,c\}) > \rho(a,\{a,b\}) = 0.5$, and $\{a,b\} \subset \{a,b,c\}$ holds, which is a violation of *Regularity*.

2.2 The Similarity Effect

The *Similarity* effect is a behavioral pattern known as the violations of the Luce (1959)'s IIA. We explain the *Similarity* effect. Take alternatives a, b, and a'. First, consider the menu $\{a,b\}$. Suppose that we observe that $\rho(a,\{a,b\}) \geq \rho(b,\{a,b\})$. Next, consider the menu $\{a,b,a'\}$. Suppose that the alternative a' is "similar" to the alternative a. Then, the *Similarity* effect states that $\rho(a,\{a,b,a'\}) < \rho(b,\{a,b,a'\})$. Intuitively, the attractiveness of the similar alternatives in the same menu decreases, and then the choice probability of a decreases as the alternative a' is added.

We mention that this behavioral regularity is not consistent with IIA.

Axiom. (Luce's IIA): For any $A, B \in \mathscr{A}$ with $a, b \in A \cap B$,

$$\frac{\rho(b,A)}{\rho(a,A)} = \frac{\rho(b,B)}{\rho(a,B)}.$$

This axiom states that the ratio of choice probabilities does not change through menus; that is, irrelevant alternatives do not affect them.

3. Evidence from MLB

We study pitchers’ decision-making in baseball. In particular, we focus on the case after two strikes, and study the role of waste balls. When pitchers are ahead in the count such as 0-2 or 1-2, they will deliberately waste a pitch here, to strike out effectively. We collect the data from the official MLB website (MLB.com).

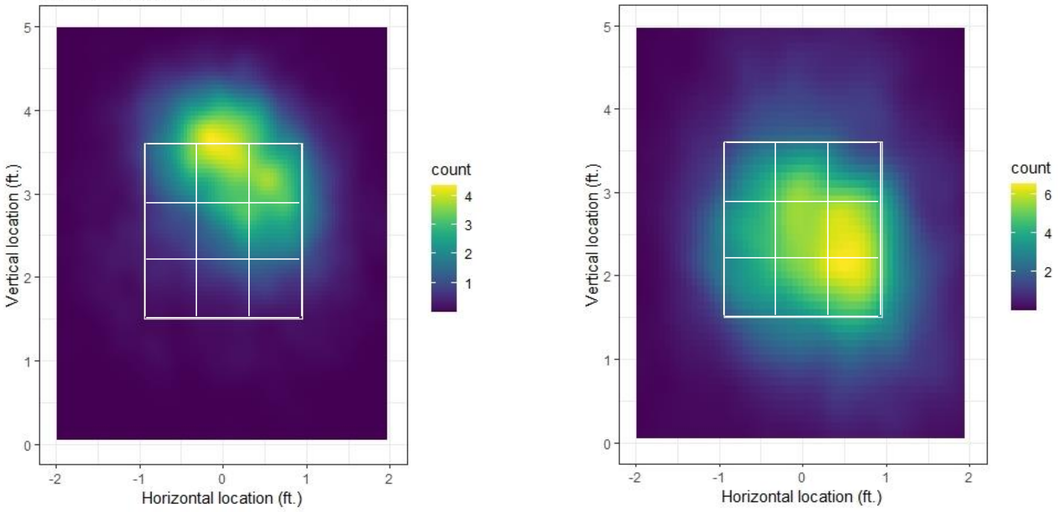

Figure 1. **The Swinging Strike Out by Fastballs**. The LHS depicts the pitch distribution when the hitters struck out swinging by fastballs. The RHS depicts the pitch distribution just before the swinging strike out by fastballs.

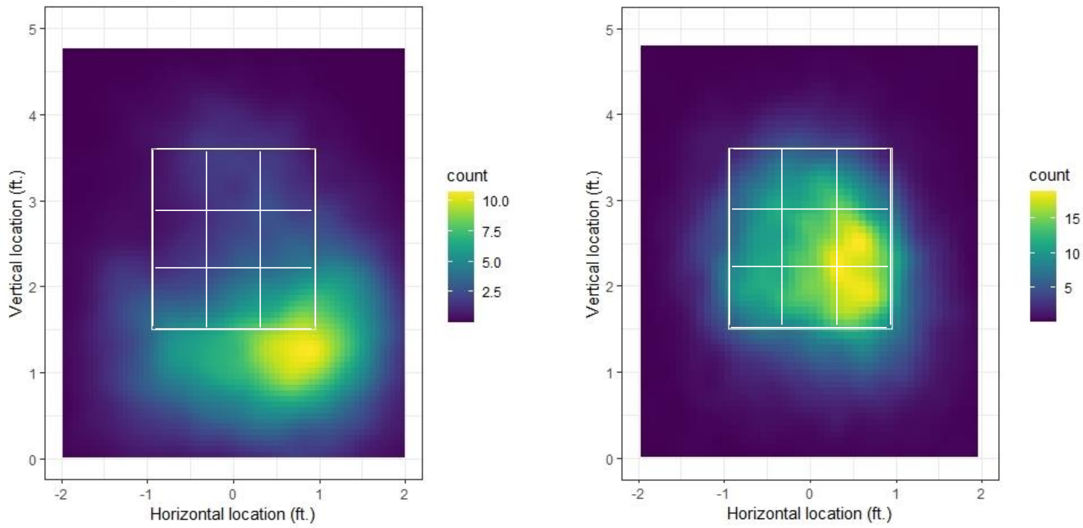

Figure 2. **The Swinging Strike Out by Breaking balls**. The LHS depicts the pitch distribution when the hitters struck out swinging by breaking balls. The RHS depicts the pitch distribution just before the swinging strike out by breaking balls.

4. The Model

In this section, we introduce the model of costly information acquisition. First, after stating notation, we define the model. Next, we use the model to describe pitchers' decision-making in baseball. Finally, we provide a remark on costly information acquisitions.

4.1 Costly Information Acquisition

Notation. Let Ω: a finite state space. The element is denoted by $\omega \in \Omega$. Let $\mathscr{A}$ be the set of actions denoted by a $\in \mathscr{A}$, defined by $a : \Omega \to X$ where X is a set of all outcomes. The element in X is denoted by $x \in X$. Let $u : X \to \mathbb{R}$ bet the utility function for each outcome $x \in X$. Let $\Gamma := \Delta(\Omega)$ be the set of all probability distributions over Ω, and the element is denoted by $\mu \in \Gamma$. We call it a prior belief. Let $\pi : \Omega \to \Delta(\Gamma)$ be the conditional probability of signal given a state $\omega \in \Omega$. This is denoted by $\pi(\gamma \mid \omega)$. Let $\gamma \in \Gamma(\pi)$ be a posterior belief. Let $K : \Pi \to \overline{\mathbb{R}}$:be an *information* cost function, a mapping from information structures from an extended real space. Let $\rho_A : \Omega \to \Delta(A)$ be a *state-dependent* stochastic choice function, for each choice set $A \in \mathscr{D}$, where $\mathscr{D}$ is the set of non-empty subsets of $\mathscr{A}$.

The Model. We introduce the model.

Definition 1. Given $\mu \in \Gamma$ and $u : X \to \mathbb{R}$, a state-dependent stochastic choice data set $(\mathscr{D}, \mathscr{P})$ has a costly information representation if there exists (a) information cost function $K : \Pi \to \overline{\mathbb{R}}$, (b) attention function $\{\pi_A\}_{A\in\mathscr{D}}$, and (c) choice function $\{C_A\}_{A\in\mathscr{D}}$ such that, for all $A \in \mathscr{D}$:

(i) Information is optimal: $\pi_A \in \Pi(K, A) := \arg\max_{\pi\in\Pi}\{G(A,\pi) - K(\pi)\}$ where

$G : \mathscr{D} \times \Pi \to \mathbb{R}$: the gross payoff of using a particular information structure in a particular choice set, defined by

$$G(A,\pi) := \sum_{\gamma\in\Gamma(\pi)}\left[\sum_{\omega\in\Omega}\mu(\omega)\pi(\gamma|\omega)\right]\left[\max_{a\in A}\sum_{\omega\in\Omega}\gamma(\omega)u\big(a(\omega)\big)\right] \quad (1)$$

(ii) Choices are optimal: the choice function $C_A : \Gamma(\pi_A) \to \Delta(A)$ is such that, given $a \in A$ and $\gamma \in \Gamma(\pi_A)$ with $C_A(a \mid \gamma) := \mathbb{P}(a \mid \gamma)$, for all $b \in A$,

$$\sum_{\omega\in\Omega}\gamma(\omega)u\big(a(\omega)\big) \geq \sum_{\omega\in\Omega}\gamma(\omega)u\big(b(\omega)\big) \quad (2)$$

for all $b \in A$.

(iii) The data is matched: Given $\omega \in \Omega$ and $a \in A$,

$$\rho_A(a|\omega) = \sum_{\gamma\in\Gamma(\pi_A)}\pi_A(\gamma|\omega)C_A(a|\gamma) \quad (3)$$

4.2 Pitchers' Decision-Making and Context Effects

We study a relationship between pitchers' decision-making and context effects.

The Attraction Effect. Let $w \notin A$ be a waste ball. Let $a \in A$ denote the action that the pitcher throws the "dominance" ball to the waste ball. The pitcher throws the waste ball to trigger the *Attraction* effect. As a result, $\rho_A(a) \leq \rho_{A\cup\{w\}}(a)$. This is a violation of *Regularity*.

The Similarity Effect. Let $w \notin A$ be a waste ball. Let $a \in A$ denote the action that the pitcher throws the opposite ball to the waste ball. The pitcher throws the waste ball to trigger the *Similarity* effect. Let $b \in A$ denote the action that the pitcher throws the ball in the strike zone. Then, as a result, $\frac{\rho(b, A)}{\rho(a, A)} \neq \frac{\rho(b, A \cup \{w\})}{\rho(a, A \cup \{w\})}$. This is a violation of *IIA*, which can occur because the probability of taking action a can increase in the presence of the waste ball.

4.3 The Rationality of Pitchers' Decision-Making

Using the model of costly information acquisition (Definition 1), we show that the strategic use of context effects is optimal; that is, under costly information acquisition, the waste pitch is optimal. In particular, we study how information structures are related to context effects (see the full paper).

Reference

Caplin, A. and Dean, M., 2015. Revealed preference, rational inattention, and costly information acquisition. American Economic Review, 105(7), pp.2183-2203.

Highhouse, S. 1996. Context-dependent selection: The effects of decoy and phantom job candidates. Organizational Behavior and Human Decision Processes, 65(1), 68-76.

Luce, R. D. 1959. *Individual Choice Behavior: A Theoretical Analysis*. John Wiley and Sons, New York.

Pan, Y., O'Curry, S., and Pitts, R. 1995. The attraction effect and political choice in two elections. Journal of Consumer Psychology.

Rieskamp, J., Busemeyer, J.R. and Mellers, B.A., 2006. Extending the bounds of rationality: Evidence and theories of preferential choice. Journal of Economic Literature, 44(3), 631-661.

Wedell, D. H. 1991. Distinguishing among models of contextually induced preference reversals. Journal of Experimental Psychology: Learning, Memory, and Cognition, 17(4), 767.

Wedell, D. H., and Pettibone, J. C. 1996. Using judgments to understand decoy effects in choice. Organizational Behavior and Human Decision Processes, 67(3), 326-344.