Dynamic anticipated regret aversion and sunk-cost fallacy

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Abstract

People are often affected by their past choices while economic theory assumes that they ignore their sunk costs. Psychological and economic literature calls it sunck-cost effect, sunk cost fallacy, or escalation of commitments. But some experimental studies provide evidences against hypotheses of sunk-cost effects, and troublingly, others support the hypotheses.

This paper proposes a model of dynamic anticipated aversion (DARA) to give a microfoundation of sunk-cost effects. We give an axiomatic foundation of it. In a simple investment model, we show the condition for sunk-cost effect under DARA. Further, we demonstrate applications of DARA to Bertrand competiton in which firms provide experience goods such as rental properties and can set initial fee and running fee both. We show that if consumer has sufficiently large parameter of DARA, there is a subgame perfect Nash equilibrium in which all firms earn positive profits.

Keyword: Anticipated regret, Bertrand competiton, Confirmation bias

JEL classifications: D11, D81, D91

1 Introduction

People are often affected by their past choices while economic theory assumes that they ignore their sunk costs. Psychological and economic literature calls it sunck-cost effect, sunk cost fallacy, or escalation of commitments. We say sunk-cost effect occurs if a decision maker who paid more sunk costs for an opportunity tends to commit more to the opportunity. To introduce sunk cost effect, Thaler (1980, p.47) describes a following anecdote:

> *A family pays \$40 for tickets to a basketball game to be played 60 miles from their home. On the day of the game there is a snowstorm. They decide to go anyway, but note in passing that had the tickets been given to them, they would have stayed home.*

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In this anecdote, the family has paid \$40 and it is suggested that the sunk cost made them go the stadium. This behavioral bias is, if any, significant for several social situations such as investments, political decision making, development cooperation, and so on.

An aim of this paper is to give a microfoundation of sunk cost effects. There are many empirical papers that validate the sunk cost effects, but some of them support the effects (e.g., Augenblick 2016; Ronayne et al., 2021) whereas the others do not (e.g., Friedman et al., 2007; Ashraf et al., 2010). In addition, there is no research showing when and why sunk cost effect works. To predict consequences and evaluate welfare of public policies, economists need some microfoundation of the sunk cost effects. In this paper, we propose a utility representation to explain sunk cost effects. We refer to it as dynamic anticipated regret aversion (DARA) model because our model is a dynamic extension of anticipated regret (Zeelenberg, 1999; Sarver, 2008).

Eyster (2002) and Eyster et al. (2022) formulate a utility model to explain sunk-cost effects. In their model, a decision maker's utility function itself changes according to her paid sunk cost. In this point, their model differs from DARA, in which a decision maker cannot change her taste and avoids information that leads her regret. Hence, our model contributes to literature of information avoidance (see Golman et al. 2017 for a survey). We note here that Suzuki's (2019) model of post-decision dissonance is a wider class including Eyster (2002), Eyster et al. (2022) and DARA.

The rest part of this draft is organized as follows: Section 2 introduces definitions. Section 3 explains sunk-cost effect in Thaler's situation. Section 4 applies the model to Bertrand market. Section 5 concludes.

2 Definition

Fix sets A_1 and A_2 and let X denote a set of *menus* of $A_1 \times A_2$. As usual, we will write (a_1, a_2) in $A_1 \times A_2$ by $\boldsymbol{a}$. We assume that A_1 and A_2 are the sets of lotteries over a finite sets Z_1 and Z_2 of prizes, and assume the usual mixture operation over the sets. For given $a_1 \in A_1$, define a set $D(a_1)$ as

$$D(a_1) \equiv \{(a_2, x) \in A_2 \times X \mid a_2 \in x\}, \tag{1}$$

and we will consider a preference $\succsim_{a_1}$ over $D(a_1)$. An alternative $(a_2, x) \in D(a_1)$ says that a decision maker chooses a_2 at period 2 and, after the decision, she will observe consequences that would occur if she chose each $a_2' \in x$. Now we asuume our utility model as follows:

Definition 1. A pair (μ, θ) is a *dynamic ranticipated regret aversion (DARA) representation* of $\langle \succsim_{a_1} \rangle_{a_1 \in A_1}$ if μ is a measure over $\mathcal{U}$ and θ is a positive number such that

$$U_{a_1}(a_2, x) = \sum_{u \in \mathcal{U}} \left[u(\boldsymbol{a}) - \theta \left(\sum_{v} \max_{\boldsymbol{a}^* \in x} v(\boldsymbol{a}^*) \mu(v) - u(\boldsymbol{a}) \right) \right] \mu(u) \tag{2}$$

represents $\succsim_{a_1}$ for each $a_1 \in A_1$.

We can define her regret by a difference between the best utility that she would obtain if she took the ex-ante optimal choice and the realized utility. So the first term of (2) represents a material utility and the later part represents anticipated regret.

We can characterize DARA by applying Kreps's (1979) result. Roughly, by his Proposition 3 with negative sign and separability axiom, we can obtain the second term of (2).

3 Model of investment

We can describe the Thaler's anecdote by a two-period decision model as follows: At period 1, DM chooses whether to buy the ticket (denoted by $a_1 = 1$) or not ($a_1 = 0$). At period 2, she chooses whether to go ($a_2 = 1$) or not ($a_2 = 0$). Then, her utility function is written by

$$u(a_1, a_2, s) = a_1 a_2 s - a_1 c_1 - a_2 c_2, \tag{3}$$

where $c_1 > 0$ denotes the ticket fee, $c_2 > 0$ denotes the cost of going to the stadium, and $s > 0$ denotes the gross utility from the basketball game.

Also, we can interpret the above model as following several situations:

- A manager decides whether or not to invest a project at period 1, and whether or not to continue it at period 2.
- An investor decides which asset to buy at period 1, and whether or not to buy out it at period 2.
- A consumer decides which firm to contract with at period 1, and whether or not to cancel it and move to another firm at period 2.
- A consumer decides whether or not to buy a good at period 1, and how much to use it at period 2.

We can define $D(\cdot)$ by $D(0) = \{(0, \{(0, 0)\})\}$ and

$$D(1) = \{(0, \{(0, 0), (1, 0)\}), (1, \{(0, 0), (1, 0), (1, 1)\})\}. \tag{4}$$

The second element of (4) say that, if a decision maker chooses $(a_1, a_2) = (1, 1)$, then she will observe not only what occurs actually but also what occured if she chose $(0, 0)$ and $(1, 0)$. Note that there is asymmetry of feedback: if she chose $a_2 = 1$, she can observe what realizes if she would choose if she had chosen $a_2 = 0$, but otherwise she cannot.

According to (2) and (3), the decision maker continues to invest at period 2 if $-c_1 + \theta(0 - c_1) \leq pv - c_1 - c_2 + (1 - p)\theta(0 - (c_1 + c_2))$, that is,

$$c_2 \leq \frac{p(v + \theta c_1)}{1 + (1 - p)\theta}. \tag{5}$$

This result implies that sunk-cost effect occurs only if (i) the choice is risky and (ii) the feedback of information depends on her choice. In these points, our model's prediction differs from Eyster's model.

4 Application: Bertrand competition

In this section, we apply our model to a Bertrand market of experience goods (e.g., rental properties, subscription streaming services, or telecommunications services). Let there be two homogenous firms supplying ex-ante homogenous experience goods at identical fixed cost $c_p > 0$ for initial setting and margin cost $c_q > 0$. Also, we suppose that there are one unit of consumers and each of them demmands at most one unit of the goods. All consumers have representation (2) with an identical parameter $\theta \in \mathbb{R}_+$. Assume that each consumer does not know what gross utility she can have from the experience good provided by each firm: her gross utility derived from firm i's good is $u_i = v \in \mathbb{R}_{++}$ with probability α, while $u_i = 0$ with probability $1-\alpha$, and this binary distrinbution is independent among all firms. The timing of the game is as follows:

- 0° Each firm $i \in \{1, \ldots, N\}$ simultenously chooses a contract fee $p_i \in \mathbb{R}$ and a price $q_i \in \mathbb{R}_+$ of its providing goods such as monthly rent fee.
- 1° Each consumer chooses which firm to buy an experience good from.
- 2° After each consumer realizes the level of gross utility derived from the good provided by her chosen firm, she decides whether or not to switch to another firm.
- t° At period $t \leq T$, each consumer can decide whether or not to cancel and take a contract with another firm. That is, she can repeatedly take and cancel contracts with at most $T \geq N$ firms.

We assume a homogenous hidden cost $h > c_q$ on a consumer, that is, each firm can exploit h from a consumer who contracts with it at the end of period 2. All consumers cannot realize this hidden cost when they decide which firm to take contracts. Each firm i's payoff is given by

$$\beta_i(1)(p_i - c_p) + \beta_i(2)(p_i + q_i + h - c_p - c_q), \tag{6}$$

where $\beta_i(t)$ denotes the fraction of consumers that contracts with firm i at the end of stage t.

Assume that a consumer has a quasi-linear preference in a sense that, if she takes a contract with firm i at the both stages, her material utility is given by

$$u_i - p_i - q_i - h, \tag{7}$$

where u_i denote a gross utility of firm i's good for this consumer. Similarly, if contracts with i at period 1 and swithes to j at period 2, her material utility is

$$-p_i + (u_j - p_j - q_j - h). \tag{8}$$

I she contracts with no firm after period 2, her gross payoff (i.e., reservation value) is assumed to be $\underline{u} < 0$.

As tie-breaking rules, we assume that (i) each of the n firms attracts $\frac{1}{n}$ consumers if there are n firms that set the lowest price, (ii) a consumer takes a contract if she is indifferent between taking and not, and (iii) a consumer continues to contract with firm chosen at stage 1° if she is indifferent between switching or not switching.

Similarly to a usual Bertrand model, when $\theta = 0$ and $T < N$, There is a unique equilibrium contract in which firms earn zero profit. However, when $\theta > 0$, there may be a SPE in which firms earn positive profits.

First consider $N = 2$. Because the consumer is assumed to be naive, we have the following condition for that a consumer takes a constract with some firm $i \in \{1, 2\}$:

$$\alpha(v - q_i) + (1 - \alpha)(\alpha v - p_j - q_j) - p_i \geq \underline{u}. \tag{IR}$$

Under condition (IR), at period 2, a consumer who contracted with firm i and found $u_i = 0$ remains to contract with i if and only if $0 - p_i \geq \alpha(v - \theta p_i) + (1 - \alpha)(0 - \theta(p_j + q_j - q_i)) - p_i - p_j - q_j$, that is,

$$\alpha\theta p_i \geq \alpha v - (1 - \alpha)\theta(p_j + q_j - q_i) - p_j - q_j. \tag{9}$$

Let $((p_1^*, q_1^*), (p_2^*, q_2^*))$ satisy that $p_1^* = p_2^*$, $q_1^* = q_2^* = 0$ and (9) binds. Then, on the one hand, a firm i has no incentive to lower its p_i if and only if $p_i^* - c_p + \alpha(q_i^* + h - c_q) \leq \frac{1}{2}(p_i^* + q_i^* - c_p - c_q + h)$, that is,

$$\frac{1}{2}(p_i^* - c_p) \leq \left(\frac{1}{2} - \alpha\right)(q_i^* + h - c_q). \tag{10}$$

On the other hand, each firm has no incentive to set a higher price than p_i^* because then it cannot attract any consumer at period 1 and no consumer switch to it as long as the opponent sets (p_j^*, q_j^*). The above result is summarized by the following proposition:

Proposition. *Let $N = T = 2$. There is a symmetric equilibrium contract in which $p_1^* = p_2^* > 0$ if and only if*

$$\frac{\alpha v}{1 + \theta} \leq (1 - 2\alpha)(h - c_q) + c_p \tag{11}$$

and (IR) hold. Furthermore, the equilibrium prices are given by

$$\begin{cases} p_1^* = p_2^* = \dfrac{\alpha v}{1 + \theta} > 0 \\ q_1^* = q_2^* = 0 \end{cases}. \tag{12}$$

It is intuitive implications of the proposition that positive initial fee is likely set with higher θ, higher h, higher c_p, and lower α. Especially, firms never set any positive contract fee when $\alpha \geq \frac{1}{2}$. That is, such a contract more likely to occur in markets if a good to sell is inferior to some extent. It is suprising that the contract fee p_i^* is decreasing in θ if it satisfies (11). This is because if the parameter θ of regret is lower, firms require higher sunk costs to stick consumers. This result holds for larger N as follows:

Collorary. *Let $N \geq 3$ and $T < N$. There is a symmetric equilibrium contract in which $p_i^* > 0$ and $q_i^* = 0$ for each firm i if and only if*

$$\frac{\alpha v}{1 + \theta} \leq \frac{1 - \alpha N}{N - 1}(q_i^* + h - c_q) - c_p.$$

Furthermore, the equilibrium prices are given by

$$\begin{cases} p_i^* = \dfrac{1-\alpha N}{N-1}(h-c_q) - c_p > 0 \\ q_i^* = 0 \end{cases} \tag{13}$$

for each firm i.

5 Conclusion

We propose a new model called dynamic anticipated regret aversion (DARA) and have a new prediction of sunk cost effect. In section 4, we apply the model to Bertrnd market and obtain a policy implication.

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