Behavioral researchers have demonstrated that consumers frequently depart from conventional economic assumptions when they evaluate the benefits and payments related to a certain alternative – the term “mental accounting” has been used to describe the cognitive operations that consumers apply to organize and evaluate such benefits and payments. However, there has been limited research on how the supply side of the market (i.e., managers and firms) must react to such departures from conventional assumptions. In addressing this gap, we first demonstrate that a monopolist always benefits from knowledge about mental accounting. In contrast, even when top level managers in a duopoly know that consumers engage in mental accounting, profits may be higher if they do not share this knowledge with their subordinates in charge of pricing and instead let them compete under the belief that consumers follow conventional assumptions. Correspondingly, while knowledge about consumers that contradicts conventional assumptions may represent their behavior more accurately, such knowledge must be extrapolated and applied in competitive markets with care. Sometimes, the truth hurts.

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1. INTRODUCTION

The frequent failure of neoclassical economic theory to explain the real-life behavior of consumers has been voluminously documented. Correspondingly, suggestions have been advanced that positive models that describe how consumers do behave must replace normative models that describe how rational consumers should behave. For example, it has been held that “an exclusive reliance on normative theory leads economists to make systematic, predictable errors in describing or forecasting consumer choices” (Thaler 1980, p.39). Economic theory in the neoclassical tradition has persisted with the notion of rational consumers who maximize utility as measured by a straightforward discounting of costs and benefits. In parallel, however, psychologists and behavioral economists have advanced alternative perspectives of consumer behavior.

At the risk of some oversimplification, a bird’s eye view of the contrasting approaches may be described as follows. In focusing on the supply side of the market, neoclassical economists, along with researchers in other fields such as business and strategy who adopt a similar perspective, have developed a sophisticated body of knowledge about the working of firms and markets, but typically under simple assumptions about consumer behavior. On the other hand, in focusing on the demand side of the market, psychologists, along with researchers in other fields such as business and economics who adopt a similar behavioral perspective, have developed a sophisticated body of knowledge about how consumer behavior departs from conventional economic assumptions, but have not sufficiently explored the implications of such behavior for the workings of product and service markets.

Only recently have researchers begun to consider how departures from neoclassical assumptions regarding consumer behavior can affect firm-level decisions and industry-level outcomes. For example, Gabaix and Laibson (2003) consider how imperfect consumer knowledge and noisy evaluations of product attributes affect firms’ product design and pricing decisions. Esteban, Miyagawa and Shum (2003) study how sellers optimally respond when consumers’ preferences exhibit reversals on account of temptation and self-control. DellaVigna and Malmendier (2004) analyze the optimal design of pricing contracts by firms for investment goods (these have immediate costs and delayed benefits, e.g., a health club membership) and leisure goods (these have immediate benefits but delayed costs, e.g., credit card-
financed consumption) when consumers have time-inconsistent preferences. Speigler (2004) examines how bounded rationality on the part of consumers influences the intensity and kind of competition in the marketplace. Despite these advances, on balance, relatively little is known about how knowledge regarding consumer departures from neo-classical assumptions regarding their behavior and knowledge regarding optimal strategies of profit-maximizing firms must be integrated in the middle-ground where supply meets demand. Against that backdrop, this paper adds to the literature that has begun to examine how the supply side of the market must optimally respond to consumer behavior that departs from conventional economic assumptions.

In particular, we examine the implications of mental accounting by consumers for the supply side of the market. Mental accounting may be defined as the “set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities” (Thaler 1999, p. 183). Formalized by Thaler (1980, 1985), the notion of mental accounting competes with the conventional assumption that, when evaluating an option, consumers engage in a straightforward discounting of relevant costs and benefits over time. As a body of literature, mental accounting now constitutes a sophisticated and influential derivative branch of the well known prospect theory of Kahneman and Tversky (1979).1

The three central components of mental accounting are: (i) an accounting system that captures how outcomes are perceived and experienced, and how decisions are made; (ii) an assignment system that assigns activities into various accounts (e.g., housing, food, etc.) and (iii) a retrieval system that decides how frequently the accounts are assessed and evaluated. Thaler (1999) argues that mental accounting matters because it influences choice.

Briefly, the setting for our analysis is as follows. In a linear spatial market (following Hotelling 1929), consumers purchase a single product at the outset of the first period and consume it over two periods.2 Consumers may either: (a) behave according to conventional assumptions regarding utility and discounting, or (b) engage in mental accounting.

To capture mental accounting, we employ the double entry mental accounting system proposed by Prelec and Loewenstein (1998). This system, which we describe later, constitutes a robust and generalized representation of mental accounting. Prelec and Loewenstein (1998) test the proposed
mental accounting model using multiple surveys and conjoint-type analyses. They demonstrate that it provides a significantly better explanation of consumer preferences and behavior in a variety of situations than conventional models of discounted costs and benefits that do not incorporate mental accounting. For example, many consumers are actually pleased to make the last loan payment on an automobile. Conventional models struggle to explain why this might be so, but the proposed model offers the intuitive explanation that the (positive) benefits imputed to that payment on account of all future usage of the vehicle can swamp the disutility due to the payment itself.

We first address the case of a monopoly, with a single seller located at the center of a spatial market (a Hotelling line). We solve three cases: (a) The Conventional case (C): Here, consumers behave according to conventional economic assumptions and the seller knows about such behavior (this is the standard result from the literature); (b) The Unrevealed case (U): Here, consumers engage in mental accounting, but the seller prices as if they were acting according to conventional economic assumptions (i.e., the seller is unaware of the fact that consumers engage in mental accounting); (c) The Revealed case (R): Here, consumers engage in mental accounting, and the seller is aware of such behavior. Our central finding in the monopoly case is that when consumers engage in mental accounting, it always pays for the monopolist to incorporate such knowledge into the pricing decision.

We then invoke the tools of game theory to analyze a competitive setting, with a duopolist located at each end of the Hotelling line. To formalize the strategic application of knowledge about mental accounting, we assume that each competing firm comprises two levels—the top level marketing manager who may (or may not) be aware of mental accounting, and a lower level marketing manager in charge of pricing, with whom the former may decide to share knowledge about mental accounting (if it exists, and if the former is aware of it).

We solve four cases related to the duopoly: (a) The Conventional case [C,C]: Here, consumers behave according to conventional economic assumptions and both sellers correctly assume such behavior (this is the standard result from the literature); (b) The Symmetric Unrevealed case [U,U]: Here, consumers engage in mental accounting, but both sellers price as if consumers were acting according to conventional economic assumptions (i.e., both sellers are unaware of the fact that consumers engage in mental accounting); (c) The Symmetric Revealed case [R,R]: Here, consumers
engage in mental accounting, both top level managers know about this, and both inform their lower level managers accordingly; and (d) The Asymmetric case \([U,R]\): Here, consumers engage in mental accounting, and both top level managers know about this—however, one top level manager informs the lower level manager in charge of pricing accordingly, whereas the other withholds this information from the lower level manager. Note that the profit outcomes corresponding to the last three cases (b, c, and d above) together constitute the payoff matrix of a game where consumers engage in mental accounting, but the top level managers can strategically choose to reveal knowledge about such accounting to their managers in charge of pricing. This simple formulation allows us to address the provocative issue of whether more detailed knowledge about the departure of consumers from conventional economic assumptions must be employed at the level of the firm, even when such knowledge more accurately depicts consumer behavior.

Our central finding here is that, under certain conditions, even when consumers engage in mental accounting and the top level marketing managers in each firm are aware of this, those managers in both firms will decide not to reveal that information to their subordinate managers in charge of pricing. Rather, the top level managers will prefer that the latter continue to operate under the belief that conventional economic assumptions about consumer discounting and decision making are applicable.

The analysis and findings offer two key contributions. First, they demonstrate that knowledge about consumer behavior must be incorporated into firm-level strategy with care. Richer, more accurate knowledge about consumer decision making is much like a double-edged sword. While such knowledge does help managers and researchers better understand and predict the decisions of individual consumers, reliance on this knowledge in the strategic context may erode rather than enhance profits. Second, from a theoretical perspective, the analysis demonstrates how rich models of consumer decision making that depart significantly from conventional assumptions about consumer behavior in the neoclassical tradition can be accommodated within rigorous game theoretic formulations of the competitive marketplace. As will be seen, our approach involves simple, workhorse-like models that can be applied to other settings.

In the next section, two sub-models — one that describes the marketplace, and the other that describes consumer decision making (including mental accounting) — are introduced. Following that, the monopoly and duopoly scenarios are analyzed and discussed.
2. THE MODELS

Two sub-models are required to capture (a) the structure of the market and (b) the nature of decision making by consumers in that market.

2.1 Model of the market

Following the classic formulation of Hotelling (1929), consumers are uniformly distributed along a linear city of unit length. Each consumer has linear travel costs (t per unit distance) and purchases (at most) a single unit of the product. In the monopoly case a single seller is located at the center of the linear city. In the duopoly case, competing sellers are located at either end of the city. Reservation utility (r) is sufficiently high so that the market is completely covered in the competitive case. Sellers converge to equilibrium prices at the beginning of period 1, following which the market clears. The product is consumed over two periods (n = 1, 2). There is no second hand market. In discounting utility (or payments) across time, consumers apply a discount factor δ per period.

2.2 Model of the consumer utility and decision making

Consumers may (a) behave according to conventional economic assumptions, or (b) may engage in mental accounting.

Case (a): Consumers behave according to conventional economic assumptions

Here, consumers act much like the rational utility maximizers frequently invoked in the economics literature. Consumers compute the net present value of each available option by discounting the utility of consumption and the disutility of payments associated with the option. Consumers then choose that option that offers the greater net present value. Payment for a good is treated as sunk cost and does not decrease the quality of future consumption experiences. This is straightforward, and requires no further elaboration.

Case (b): Consumers engage in mental accounting

To capture mental accounting by consumers, we adopt the descriptive, “double entry” model of mental accounting proposed by Prelec and Loewenstein (1998). That model, in turn, synthesizes and
builds forward from earlier work on prospect theory and mental accounting, including Kahneman and Tversky (1978) and Thaler (1980, 1985).

The core intuition underlying the model is that thoughts of payments can undermine the pleasures of consumption, and conversely, that the pain of making payments can be buffered by the thoughts of consumption that these payments finance. The first set of entries records the net utility derived from consumption after subtracting the disutility of associated payments, and the second set records the net disutility of payments after adjusting for the (positive) utility of associated consumption.

The model is based on three assumptions about mental accounting: (a) prospective accounting—this describes how imputed costs and benefits depend on the timing of consumption and payments; (b) prorating—this is an amortization rule for allocating a single payment over multiple consumption events, or a single consumption event over multiple payment events; and (c) coupling—this allows for the imperfect (i.e., less than complete) imputation of payments (benefits) to benefits (payments).

The operational version of the model we employ here is briefly described as follows. Consider a consumer experience related to a product or service that takes place over a time horizon \( n = 1, \ldots, N \). At any time \( n \), the consumer may engage in consumption (e.g., enjoy a vacation), make a payment (e.g., pay for the vacation), or engage in both consumption and payment. The utility from the “consumption experience” during a time period \( n \) is:

\[
U_n = U_n - \alpha \left( \sum_{i \in n} U_n \right) \sum_{i \in n} P_i
\]

(1)

Here, \( U_n \) is the (conventional) utility gained from consumption. However, this (positive) utility is reduced by the second term in eq. (1), which represents the imputed cost of consumption. That cost can be explained as follows. At the time of consumption, the consumer is reminded of the “shadow of the future” cast by all the remaining (future) payments. Of that total remaining payment, the fraction that is imputed to the current consumption is a function of how much consumption remains for the future. Intuitively, if the remaining payments will support significant consumption in the future, then the imputed cost of the current consumption is low. \(^4\)
Effectively, the imputed cost of consumption at time $t$ is based on the sum of payments remaining at time $n$ (i.e., $\sum_{i \geq n} p_i$), prorated over consumption remaining at time $n$ (i.e., $u_n / \sum_{i \geq n} u_i$). However, not all of this cost is imputed to consumption—this cost is adjusted downward by $\alpha \in (0,1]$ , which represents the “degree of attenuation,” i.e., the degree to which payments attenuate the pleasure of consumption. Such imperfect “coupling” between consumption and payment allows for the reality that the benefits of consumption are seldom washed out completely by thoughts of payment.

Likewise, the disutility from the “payment experience” during a time period $t$ is:

$$
\beta \left( \frac{p_n}{\sum_{i \geq n} p_i} \right) \sum_{i \geq n} u_i - p_n
$$

(2)

Here, $p_n$ is the (conventional) disutility due to payment. However, this (negative) disutility is reduced by the first term in eq. (2), which represents the imputed benefit of payment. That benefit can be explained as follows. At the time of payment, the consumer is reminded of the “silver lining” represented by the benefits of future consumption that the payment facilitates. Of that total remaining consumption, the fraction that is imputed to the current payment is a function of how much payment is postponed into the future. Intuitively, if the remaining consumption needs to be supported by significant payments in the future, then the imputed benefit of the current payments is low.

Effectively, the imputed benefit of payment at time $t$ is based on the sum of consumption (utility) remaining at time $n$ (i.e., $\sum_{i \geq n} u_i$), prorated over payment remaining at time $n$ (i.e., $p_n / \sum_{i \geq n} p_i$). However, not all of this benefit is imputed to the payment—the benefit is adjusted downward by coupling coefficient $\beta \in (0,1]$ , which represents the “degree of buffering,” i.e., the degree to which consumption buffers the pain of payment. Integrating these “double entries,” the total consumer experience at time $n$ is captured by adding (eq. 1) and (eq. 2):

$$
U_n = u_n - \alpha \left( \frac{u_n}{\sum_{i \geq n} u_i} \sum_{i \geq n} p_i + \frac{p_n}{\sum_{i \geq n} p_i} \sum_{i \geq n} u_i - p_n \right)
$$

(3)
Accordingly, when consumers look forward into the future, the overall expected pattern of the consumer experience over multiple periods that involve consumption and/or payments \((n = 1, \ldots, N)\) can be derived and discounted to the beginning of period 1 by applying the discount factor \(\delta\).

Two comments are in order. First, the mental accounting model described above provides a general and flexible representation of consumer utility formation. For example, setting \(\alpha = \beta = 0\) removes the effects of mental accounting and yields the conventional (neoclassical) notion of utility. Second, the model can easily accommodate heterogeneous consumers who differ in their values of \(\alpha\) and/or \(\beta\). The consumers at any location in the linear market could be drawn from a distribution of \(\alpha\) and/or \(\beta\), in which case the specific values of these parameters would correspond to a representative consumer at that location. Our results are robust to such a specification of heterogeneity. The only caveat is that the distribution of these parameters at any market location must be independent of distance from either seller (or, in characteristics space, of the location of either product)—a priori, there is no strong reason to expect such a correlation. We now apply the models of the consumer and the market in monopoly and duopoly settings.

### 3. THE MONOPOLY

Consider a single seller located at the center of the linear city described in § 2.1. As described earlier, three cases may exist. Outcomes pertaining to each of these cases, including the resulting consumer and social surplus, are detailed in Table 1.

--------- Insert Table 1 here ---------

**The Conventional case (C).** This is the standard case studied in the literature. Consumers do not engage in mental accounting, and the monopolist correctly proceeds to price according to conventional economic assumptions about consumer behavior.

**Proposition 1:** In case (C), the monopolist prices at \(p^* = \frac{r}{2} (1 + \delta)\).

**Proof of Proposition 1:** See Appendix 1.
The Unrevealed case (U). Here, consumers engage in mental accounting, but the monopolist is unaware of such accounting. Instead, the monopolist, who possesses knowledge about reservation utility \( r \), transportation cost \( t \) and per-period discount factor \( d \), assumes that consumers are acting according to conventional economic assumptions. Therefore, the price charged by the monopolist is identical to that in case (C). However, because consumers compute utility differently, the market outcomes differ from those under (C). Formally:

**Proposition 2**: In case (U), the monopolist prices at \( p_u^* = \frac{r}{2} (1 + \delta) \), which is identical to the price in case (C). However, the other market outcomes differ across the two cases.

Proof of Proposition 2  See Appendix 1.

The Revealed case (R). Here, consumers engage in mental accounting, and the monopolist is aware of this. In setting prices, the monopolist accommodates such accounting. Formally:

**Proposition 3**: In case (R), the monopolist prices at \( p_R^* = r \left( \frac{1 + 2\beta + \delta}{2 + \alpha} \right) \).

Proof of Proposition 3  See Appendix 1.5

3.1 Discussion

Comparison of cases (C) and (U). First, profits under (C) are lower than under (U) when:

\[
\alpha < \frac{4\beta}{1 + \delta} \tag{4}
\]

That is, even when mental accounting occurs and the monopolist is unaware of it, the existence of such accounting can favor the monopolist provided the condition in eq. (4) holds. Intuitively, when \( \alpha \) is relatively low and \( \beta \) is relatively high, the pleasure of consumption is less attenuated by thoughts of payment, and the pain of making payments is more buffered by thoughts of consumption. In this situation, for the same price charged by the monopolist, more consumers purchase the product than expected, and correspondingly, the derived profits are higher. The opposite outcome results when eq. (4) does not hold, i.e., fewer consumers purchase the product at the margin, and profits contract when the monopolist is unaware of mental accounting.

Consumer surplus in case (C) is lower than in case (U) when:
On inspection, the RHS of inequality (5) is always greater than the RHS of inequality (4). Combining the conditions in eqs. (4) and (5), consumer surplus would be higher but firm profits would be lower under (U) compared to (C) when the following condition holds:

\[
\frac{4 \beta}{1 + \delta} < \alpha < \frac{2(1 + \delta + 4 \beta - \sqrt{(1 + \delta)(1 + \delta + 2 \beta)})}{1 + \delta}
\]

(6)

Intuitively, since prices are common across cases (C) and (U), profits are higher under (U) only when a larger fraction of consumers purchase the product. However, increased surplus accrues not just to these “new” customers, but also to those already purchase in the (C) case.

**Comparison of cases (U) and (R).** In both these cases, consumers engage in mental accounting, but the monopolist is aware of and accounts for such accounting only under (R). First, the difference in profits across the cases can be expressed as:

\[
\pi^R - \pi^U = \frac{(\alpha - 4 \beta + \alpha \delta)^2}{4 \tau (2 + \alpha)(1 + 2 \beta + \delta)} \tau^2
\]

(7)

Since this expression is always positive, monopoly profits are always (weakly) higher in the revealed case compared to the unrevealed case. The monopolist underprices (overprices) under (U) compared to (R) when \(\alpha\) is less than (greater than) \(4 \beta / (1 + \delta)\). Intuitively, under (R), the monopolist accommodates the differences in the values of \(\alpha\) and \(\beta\) by optimally lowering or raising market prices. Except in the (statistically unlikely) case where market prices under (U) and (R) are identical (this happens when \(\alpha = 4 \beta / (1 + \delta)\)), such accommodation yields higher profits. That is, the monopolist always benefits from knowing when consumers engage in mental accounting.

Since the construction of consumer utility is identical across the (U) and (R) cases, consumer surplus is solely dependent on price. Correspondingly, consumer surplus is higher (lower) under (U) compared to (R) when \(\alpha\) is less than (greater than) \(4 \beta / (1 + \delta)\).

It can be verified that total social surplus is also higher under (U) compared to (R) when \(\alpha < 4 \beta / (1 + \delta)\). While monopoly profits are always lower under (U), consumer surplus is sufficiently higher under these conditions on account of underpricing by the uninformed monopolist so that society
benefits on the whole. However, when $\alpha > 4\beta / (1 + \delta)$, social surplus is higher under (R), even though the monopolist’s profits are higher under (R) than under (U). Intuitively, when $\alpha > 4\beta / (1 + \delta)$, the informed monopolist reduces prices to optimally accommodate the fact that $\alpha$ is relatively high compared to $\beta$ — this increases both monopoly profits and consumer surplus. From a social planner’s viewpoint, the interesting insight here is that a perfectly informed monopolist may sometimes be less harmful to society than an imperfectly informed one.

Comparison of cases (C) and (R). When consumers do engage in mental accounting, case (C) is best interpreted as a purely theoretical benchmark against which case (R) can be compared. Prices and profits are higher (lower) under (R) compared to (C) when $\alpha$ is less than (greater than) $4\beta / (1 + \delta)$. Intuitively, when $\alpha < 4\beta / (1 + \delta)$, the perfectly informed monopolist increases price under mental accounting to take advantage of the fact that consumption is relatively pleasurable and payment is relatively less painful. This higher price, in tandem with increased consumer willingness to pay, yields higher profits. Alternatively, when $\alpha > 4\beta / (1 + \delta)$, the monopolist lowers prices and obtains lower profits than under (C). However, note that while profits under (R) may be higher or lower than under the theoretical benchmark (C), they are always higher than those under (U). The outcomes corresponding to (U) are what would be realized if the monopolist charged a price according to (C), not knowing that the consumers employed mental accounting. In that sense, the comparison between cases (U) and (R) that was undertaken earlier is more interesting and relevant.

3.2 Summary

For a monopolist pricing according to conventional assumptions, the existence of mental accounting may lead to higher or lower profits than expected under the conventional case depending on the relative magnitudes of the attenuation and buffering effects. However, when consumers engage in mental accounting, the realized monopoly profits are always greater when the monopolist is aware of and accommodates such accounting while setting prices. Under certain circumstances, consumer surplus may also increase when the monopolist knows about and accommodates mental accounting compared to the case where the monopolist prices according to conventional assumptions that do not accommodate
mental accounting. Typically, this happens when the monopolist reduces prices to accommodate strong attenuation effects and weak buffering effects that diminish consumer utility.

4. THE DUOPOLY

We adopt the same assumptions as in § 2.1., but replace the monopolist with a pair of competing sellers, each located at one end of the linear city. We assume that reservation utility is sufficiently high that the market is completely covered across all considered cases. Each competitor comprises two levels—the top level marketing manager, who may (or may not) be aware of mental accounting, and a lower level marketing manager in charge of the pricing decision, with whom the former may decide to share knowledge about mental accounting (if it exists, and if the former is aware of it). We solve for four possible outcomes below. Equilibrium outcomes are described in Table 2.\(^6\)

-------- Insert Table 2 here --------

**The Conventional [C,C] case.** This is the standard case from the literature. Mental accounting does not take place, and each duopolist acts according to conventional economic assumptions.

**Proposition 4:** In the conventional case \([C,C]\), a single (pure strategy) Nash equilibrium exists in prices.

In equilibrium, each duopolist prices at \(p^* = t(1 + \delta)\).

**Proof of Proposition 4.** See Appendix 1.

**The Symmetric Unrevealed case [U,U] case.** Here, mental accounting does take place, but all managers are unaware of it, and each manager in charge of pricing acts according to conventional economic assumptions.

**Proposition 5:** In the symmetric unrevealed case \([U,U]\), a single (pure strategy) Nash equilibrium exists in prices. In equilibrium, each duopolist prices at \(p^* = t(1 + \delta)\).

**Proof of Proposition 5.** See Appendix 1.

The \([C,C]\) and \([U,U]\) cases yield identical outcomes in terms of prices and seller profits because each duopolist charges the same price across these cases, and share the market equally. However, because the construction of consumer utility is different under mental accounting, consumer surplus may vary across these cases.
The Symmetric Revealed case [R,R] case. Here, consumers engage in mental accounting and the top level manager in each firm is aware of such accounting. Further, each top level manager informs the lower level manager in charge of pricing about such accounting.

**Proposition 6:** In the symmetric revealed case [R,R], a single (pure strategy) Nash equilibrium exists in prices. In equilibrium, each duopolist prices at 
\[ p^* = \frac{2}{2 + \alpha} (1 + 2 \beta + \delta) t. \]

**Proof of Proposition 6:** See Appendix 1.

The Asymmetric case [U,R]. Here, consumers engage in mental accounting and the top level manager in each firm is aware of such accounting. However, the top level manager in firm 1 (corresponding to U) does not disclose such accounting to the manager in charge of pricing — this manager sets prices assuming that consumers were following conventional assumptions regarding the computation of utility. In contrast, the top level manager in firm 2 (corresponding to R) reveals the existence of mental accounting to the manager in charge of pricing.

**Proposition 7:** In the asymmetric unrevealed-revealed case [U,R], a single (pure strategy) Nash equilibrium exists in prices. In equilibrium, firm 1 prices at 
\[ p_u^* = \frac{2((3 + \alpha)(1 + \delta) + 2 \beta)}{3(2 + \alpha)} t \]

and firm 2 prices at 
\[ p_r^* = \frac{(6 + \alpha)(1 + \delta) + 8 \beta}{3(2 + \alpha)} t. \]

**Proof of Proposition 7:** See Appendix 1.

4.1 Equilibrium revelation strategies

Consider the case where consumers do engage in mental accounting and this is known to the top level managers in both firms. In the first stage, the top level managers decide whether or not to reveal this information to their pricing managers. In the second stage, the managers compete in a price setting game, and the market clears once the managers arrive at equilibrium prices. The payoff patterns to the firms are captured by a standard payoff matrix, as shown below. All relevant profits are in Table 2.
We now examine the strategy pairings associated with each cell of the matrix. Figure 1 contains a plot of profits under various strategy pairings and provides an intuitive feel for the arguments.

--------- Insert Figure 1 here ---------

**The symmetric revealed case [R,R]:** For [R,R] to constitute an equilibrium, a firm (i.e., the top-level manager) must not unilaterally shift from (R) to (U). On comparing profits from Table 2, it is easy to demonstrate that:

\[
\Pi_{RR} > \Pi_{UR} \quad \forall \alpha < \frac{4\beta}{1+\delta} 
\]  

(8)

Therefore, when \(\alpha < \frac{4\beta}{1+\delta}\), the revelation of information regarding mental accounting by both top-level managers constitutes a Nash equilibrium (also see Figure 1).

**The symmetric unrevealed case [U,U]:** For [U,U] to constitute an equilibrium, a firm (i.e., the top-level manager) must not unilaterally shift from (U) to (R). On comparing profits from Table 2, it is easy to demonstrate that:

\[
\Pi_{UU} > \Pi_{RU} \quad \forall \alpha > \frac{4\beta}{1+\delta} 
\]  

(9)

Therefore, when \(\alpha > \frac{4\beta}{1+\delta}\), the non-revelation of information regarding mental accounting by both top-level managers constitutes a Nash equilibrium (also see Figure 1).

**The asymmetric case [U,R]:** For [U,R] to constitute an equilibrium, two conditions are necessary. The first condition is that the top-level manager of the first firm must not unilaterally shift from (U) to

<table>
<thead>
<tr>
<th>Firm 1: Reveal (R)</th>
<th>Firm 1: Not reveal (U)</th>
<th>Firm 2: Reveal (R)</th>
<th>Firm 2: Not reveal (U)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Pi_{RR}, \Pi_{RR})</td>
<td>(\Pi_{UR}, \Pi_{RU})</td>
<td>(\Pi_{UR}, \Pi_{RU})</td>
<td>(\Pi_{UU}, \Pi_{UU})</td>
</tr>
</tbody>
</table>
(R). On comparing profits from Table 2 and Figure 1, it is easy to demonstrate that the required condition for first firm to not shift (i.e., for $\Pi_{UR} > \Pi_{RR}$) is:

$$\alpha > \frac{4 \beta}{1 + \delta}$$

(10)

Intuitively, when $\alpha$ is relatively low compared to $\beta$, the nature of mental accounting enhances consumer utility and works in favor of the sellers compared to the benchmark conventional case. The top-level manager of the first firm can increase profits by letting the manager know about mental accounting—this increases equilibrium prices and profits as the firms move to [R,R].

Second, the top-level manager of the second firm must not shift from (R) to (U). On comparing profits from Table 2, it is easy to demonstrate that the required condition for second firm to not shift (i.e., for $\Pi_{UR} > \Pi_{RR}$) holds when:

$$\alpha < \frac{4 \beta}{1 + \delta}$$

(11)

Intuitively, when $\alpha$ is relatively high compared to $\beta$, the nature of mental accounting reduces consumer utility and works against the sellers compared to the benchmark conventional case. The top-level manager of the second firm can increase profits by not sharing information about mental accounting with his manager—this increases equilibrium prices and profits as the firms move from [U,R] to [U,U].

Given that conditions (10) and (11) are mutually exclusive, one firm or the other will always shift from the [U,R] strategy pairing across the entire range of $\alpha$ (also see Figure 1). Consequently, [U,R] never constitutes an equilibrium. Only two pure strategy Nash equilibria emerge, yielding a key finding of this paper:

- When $\alpha < \frac{4 \beta}{1 + \delta}$, top-level managers in both firms will choose to reveal the existence of mental accounting to their managers in charge of pricing.

- When $\alpha > \frac{4 \beta}{1 + \delta}$, top-level managers in both firms will choose not to reveal the existence of mental accounting to their managers in charge of pricing.
4.2 Discussion

Knowledge about mental accounting is always useful to a monopolist and invariably increases monopoly profits. However, knowledge about mental accounting is not always beneficial to sellers in a competitive context, even when it provides a more accurate description of the marketplace to managers in charge of pricing decisions. When mental accounting only weakly attenuates the pleasure of consumption with thoughts of payment, but strongly buffers the pain of payment with thoughts of consumption, consumer utility is enhanced compared to the conventional setting where consumers engage in a straightforward discounting of benefits and payments. Under these circumstances, top-level managers who are aware of mental accounting would optimally inform their managers in charge of pricing about such accounting. In contrast, when mental accounting strongly attenuates the pleasure of consumption with thoughts of payment, but only weakly buffers the pain of payment with thoughts of consumption, consumer utility is reduced compared to the conventional setting. Exposing the managers in charge of pricing to knowledge about mental accounting under these circumstances intensifies competition, leading to lower prices and profits. Under these circumstances, it is optimal for both top level managers not to expose their lower level managers to knowledge about mental accounting, and instead, to let them continue to compete under the (incorrect) conventional assumption that consumers are engaging in a straightforward discounting of benefits and payments.

4.3 An Extension

In the basic model, the duopolists each announce a single price at the outset of period 1 though consumption occurs over two periods. To some extent, this assumption can be viewed as favoring the consumption side of the mental account because all payments are made upfront and there is no shadow of current or future payments hanging over the customer during the second period. To address this issue consider the case where the firms announce prices for two periods at the outset of the game. For each firm, prices are assumed to be equal across periods, as is the case, for example, with subscription payments for cable television. Consequently, consumption and payments occur in a balanced pattern across periods. In this scenario, the utility of a consumer located at a distance $x$ from a seller who prices at $p$ for each of the periods is denoted by equation (a25) in Appendix 2. Only two pure strategy Nash equilibria emerge in this case as well:
When $\alpha < \beta$, top-level managers in both firms will choose to reveal the existence of mental accounting to their managers in charge of pricing, i.e., $[R,R]$ is an equilibrium.

When $\alpha > \beta$, top-level managers in both firms will choose not to reveal the existence of mental accounting to their managers in charge of pricing, i.e., $[U,U]$ is an equilibrium.

Comparing this with the conditions for the equilibria described in § 4.1, we find that the magnitudes of the coupling coefficients play a more balanced role here in deciding whether or not top-level managers reveal the existence of mental accounting to the managers in charge of pricing. This is a consequence of the finer balance between consumption and payments patterns in this case.

5. CONCLUSION

Our results suggest that there are two distinct dimensions to the study of consumer behavior that departs from conventional economic assumptions. The first dimension, which has been much researched and discussed, relates to the existence and nature of such departures at the level of an individual consumer or sets of consumers (for reviews and applications of mental accounting, see Dhar 1996, Hogarth and Reder 1987, Kahneman, Slovic, and Tversky 1982, Kivetz 1999, Loewenstein and Prelec 1992, Soman 2001). The second dimension, which has not been sufficiently addressed in the literature, relates to the optimal application of the knowledge of such departures in the context of the marketplace. This paper takes some early steps towards clarifying when and how knowledge of such departures must be applied by managers.

Our single most important finding is that, even when it is indisputably established that consumers depart from conventional economic assumptions, it is not always optimal to let managers who decide on price and potentially other elements of the marketing mix in competitive markets know about these departures. Such knowledge may represent the marketplace more accurately, but may erode profits. Knowledge from laboratory and field settings about how consumers depart from conventional economic assumptions must be extrapolated and applied within competitive markets in a careful and selective manner after considering the content of the knowledge and its potential impact on the...
competitive equilibrium. This is in contrast to the monopoly setting, where the monopolist always gains from applying such knowledge.

This paper represents but an early step towards the integration of psychological and economic perspectives within a game theoretic approach. The analysis presented here can serve as a “proof-of-concept” in that context. As a next step, we intend to explore the implications of mental accounting for the endogenous choice of alternative pricing mechanisms such as selling and renting in competitive markets. The approach in this paper can be extended to examine a range of other issues. First, competing sellers’ reactions to mental accounting by consumers can be studied in an experimental setting. Second, the competitive implications of marketing mix variables such as coupons and discounts can be revisited in a setting where consumers employ mental accounting to evaluate such initiatives. Third, using the approach developed in this paper as a platform, the strategic implications of other kinds of departures of consumer behavior from conventional economic assumptions can be studied. We hope this paper catalyzes further research in these directions.
REFERENCES


APPENDIX 1

MONOPOLY CASES

All monopoly models are set in a linear city (Hotelling, 1929). Consumers are uniformly distributed along a linear city of unit length. Each consumer has linear travel costs (t per unit distance) and purchases (at most) a single unit of the product. In the monopoly case a single seller is located at the center of the linear city.

**Proposition 1**: In case (C), the monopolist prices at \( p^*_c = \frac{r}{2}(1 + \delta) \).

**Proof of Proposition 1**: Here consumers do not engage in mental accounting, and the seller acts according to conventional assumptions regarding the construction of consumer utility. Given a price \( p \), the utility of a consumer at a distance \( x \) from the monopoly location is the sum of utility in period 1 and (discounted) utility in period 2, less the price paid at the beginning of period 1:

\[
u(x) = r - tx + \delta (r - tx) - p = (1 + \delta)(r - tx) - p \quad (a1)
\]

Equating (a1) to zero, the location of the consumer who is indifferent between purchasing the product and not purchasing it is denoted by:

\[
x^+ = \left( r - \frac{p}{1 + \delta} \right) \frac{1}{t} \quad (a2)
\]

The profits of the monopolist are:

\[
\pi = 2p \left( r - \frac{p}{1 + \delta} \right) \frac{1}{t} \quad (a3)
\]

Differentiating these profits wrt \( p \) and equating the resulting differentials to zero yields the relevant FOC. Solving the FOC yields the optimal price:

\[
p^* = \frac{r(1 + \delta)}{2} \quad (a4)
\]

Substituting this price into the market size and profit expressions, outcomes corresponding to row (C) in Table 1 are obtained. Consumer surplus is obtained by integrating the utility of a consumer located at distance \( x \) from the seller over the range of the market:
\[
CS = 2 \int_{x=0}^{\frac{r}{2t}} [(1+\delta)(r-tx) - p^*] \, dx = \frac{1+\delta}{4t} r^2
\]  

(a5)

See the row corresponding to case (C) in Table 1 for a tabulation of the results.

Proposition 2: In case (U), the monopolist prices at \( p_v^* = \frac{r}{2} (1+\delta) \), which is identical to the price in case (C). However, the other market outcomes differ across the two cases.

\underline{Proof of Proposition 2} Here consumers engage in mental accounting, but the seller acts according to conventional assumptions regarding the construction of consumer utility. Therefore, the seller charges the same price as in Case (C):

\[
p^* = \frac{r(1+\delta)}{2}
\]  

(a6)

Following the double entry mental accounting system described in Prelec and Loewenstein (1998), the utility of a forward-looking consumer at a distance \( x \) who engages in mental accounting is constructed as follows:

**Period 1**

(a) Conventional utility from obtaining/ using the product (or utility when “free“): \( r-tx \)

(b) Imputed cost of consumption: \(-\frac{\alpha(r-tx)}{2(r-tx)} p = -\frac{\alpha}{2} p\)

(c) Conventional (dis)utility from payment: \(-p\)

(d) Imputed benefit from payment: \(\beta(2(r-tx))\)

**Period 2**

(e) Conventional utility from obtaining/ using the product (or utility when “free“): \( r-tx \)

(f) Imputed cost of consumption: 0

(g) Conventional (dis)utility from payment: 0

(h) Imputed benefit from payment: 0
Adding together the components of utility after appropriately discounting the components from period 2, the total utility experienced by a forward looking consumer who engages in mental accounting is denoted by:

\[(1 + 2\beta + \delta)(r - tx) - \left(1 + \frac{\alpha}{2}\right)p\]  \hspace{1cm} (a7)

Next, the indifferent consumer can be located by substituting the price charged from (a6) into (a7), equating the resulting expression to zero, and solving for \(x^*\):

\[x^* = \frac{2(1 + 4\beta + \delta) - \alpha(1 + \delta)}{2(1 + 2\beta + \delta)t} r\]  \hspace{1cm} (a8)

The market size equals twice the expression in (a8). Profits are computed by multiplying the price in (a6) by market size. Consumer surplus is denoted by:

\[CS = 2 \int_{x^*}^{x^*} \left[(1 + 2\beta + \delta)(r - tx) - \left(1 + \frac{\alpha}{2}\right)p^*\right] dx = \frac{(2(1 + 4\beta + \delta) - \alpha(1 + \delta))^2}{16(1 + 2\beta + \delta)t} r^2\]  \hspace{1cm} (a9)

Here, \(p^*\) and \(x^*\) are substituted from eqs. (a6) and (a8), respectively. See the row corresponding to case (U) in Table 1 for a tabulation of the results.

\textbf{Proposition 3:} In case (R), the monopolist prices at \(p_r^* = r \left(\frac{1 + 2\beta + \delta}{2 + \alpha}\right)\).

\textbf{Proof of Proposition 3}  Here consumers engage in mental accounting, and the seller is aware of, and incorporates such accounting into the pricing decision. With mental accounting, the total utility experienced by a forward looking consumer is denoted by (a7). The indifferent consumer can be located by equating (a7) to zero and solving for \(x^*\):

\[x^* = \frac{2 r(1 + 2\beta + \delta) - (2 + \alpha)p}{2(1 + 2\beta + \delta)t}\]  \hspace{1cm} (a10)

The market size is double the expression in (a10). The profits of the monopolist are:

\[\pi = 2px^* = p \frac{2 r(1 + 2\beta + \delta) - (2 + \alpha)p}{(1 + 2\beta + \delta)t}\]  \hspace{1cm} (a11)
Differentiating these profits wrt $p$ and equating the resulting differentials to zero yields the relevant FOC. Solving the FOC yields the optimal price:

$$p^* = \frac{(1 + 2 \beta + \delta)}{2 + \alpha} r$$  \hspace{1cm} (a12)

Substituting this price into the market size and profit expressions, outcomes corresponding to the market size and profit corresponding to row (R) in Table 1 are obtained. Consumer surplus is denoted by:

$$CS = 2 \int_{x=0}^{x^*} [(1 + 2 \beta + \delta)(r - t x) - \left(1 + \frac{\alpha}{2}\right)p^*] \, dx = \frac{1 + 2 \beta + \delta}{4t} r^2$$  \hspace{1cm} (a13)

Here, $x^*$ and $p^*$ are substituted from eqs. (a10) and (a12), respectively, prior to integration. See the row corresponding to case (R) in Table 1 for a tabulation of the results.

---

**DUOPOLY CASES**

The duopolists are located at the ends of the linear city. We assume that reservation utility $r$ is sufficiently high that the market is completely covered in all cases, i.e., all consumers purchase from one seller or the other in equilibrium.

**Proposition 4:** In the conventional case [C,C], a single (pure strategy) Nash equilibrium exists in prices.

In equilibrium, each duopolist prices at $p^* = t(1 + \delta)$.

**Proof of Proposition 4** Here consumers do not engage in mental accounting, and managers in charge of pricing act according to conventional assumptions regarding the construction of consumer utility. Consider a consumer at distance $x$ from firm 1, which is located on the left edge of the market. Given prices $p_1$ and $p_2$, this consumer gains the following utility when purchasing from firm 1 and firm 2, respectively:

$$u_1(x) = (1 + \delta)(r - tx) - p_1; \quad u_2(x) = (1 + \delta)(r - t(1 - x)) - p_2$$  \hspace{1cm} (a14)

Equating these utilities and solving for $x$, the consumer who is indifferent between purchasing from one firm or the other is located at:
Multiplying \( x^+ \) from (a15) by \( p_1 \) yields the profits of firm 1. Multiplying \((1-x^+)\) by \( p_2 \) yields the profits of firm 2. Differentiating the resulting profits of firm 1 and firm 2 wrt \( p_1 \) and \( p_2 \) respectively and setting these differentials to zero yields the relevant FOCs. Solving the FOCs, the following equilibrium prices are obtained:

\[
p_1^* = p_2^* = t(1 + \delta)
\]

Substituting these prices into the market size and profit expressions, outcomes corresponding to the market size and profit corresponding to row \([C,C]\) in Table 2 are obtained.

---

**Proposition 5**: In the symmetric unrevealed case \([U,U]\), a single (pure strategy) Nash equilibrium exists in prices. In equilibrium, each duopolist prices at \( p^* = t(1 + \delta) \).

**Proof of Proposition 5**. Here consumers engage in mental accounting, but the managers in charge of pricing act according to conventional assumptions regarding the construction of consumer utility. Therefore, on observing a price from the competitor, each manager will react with precisely the same price as in the \([C,C]\) case. The firms will arrive the same equilibrium prices, market shares, and profits as in the \([C,C]\) case. See row \([U,U]\) in Table 2 for corresponding outcomes. Note that consumer surplus may differ across the \([C,C]\) and \([U,U]\) cases because, given a pair of equilibrium prices, consumers compute utility differently across these cases.

---

**Proposition 6**: In the symmetric revealed case \([R,R]\), a single (pure strategy) Nash equilibrium exists in prices. In equilibrium, each duopolist prices at \( p^* = \frac{2 (1 + 2 \beta + \delta)}{2 + \alpha} t \).

**Proof of Proposition 6**. Here consumers engage in mental accounting, and the managers in charge of pricing are all aware of, and incorporate such accounting into their pricing decisions. Consider a consumer at distance \( x \) from firm 1, which is located on the left edge of the market. Following (a7),
given prices \( p_1 \) and \( p_2 \), this consumer gains the following utility when purchasing from firm 1 and firm 2, respectively:

\[
\begin{align*}
    u_1(x) &= (1 + 2\beta + \delta)(r - tx) - \left(1 + \frac{\alpha}{2}\right)p_1; \\
    u_2(x) &= (1 + 2\beta + \delta)(r - t(1 - x)) - \left(1 + \frac{\alpha}{2}\right)p_2
\end{align*}
\]  

(a17)

Equating these utilities and solving for \( x \), the consumer who is indifferent between purchasing from one firm or the other is located at:

\[
x^+ = \frac{1}{2} - \frac{(p_1 - p_2)(2 + \alpha)}{4t(1 + 2\beta + \delta)}
\]  

(a18)

Multiplying \( x^+ \) from (a18) by \( p_1 \) yields the profits of firm 1. Multiplying \((1-x^+)\) by \( p_2 \) yields the profits of firm 2. Differentiating the resulting profits of firm 1 and firm 2 wrt \( p_1 \) and \( p_2 \) respectively and setting these differentials to zero yields the relevant FOCs. Solving the FOCs, the following equilibrium prices are obtained:

\[
    p_1^* = p_2^* = \frac{2(1 + 2\beta + \delta)t}{2 + \alpha}
\]  

(a19)

Substituting these prices into the market size and profit expressions, outcomes corresponding to the market size and profit corresponding to row \([R,R]\) in Table 2 are obtained.

---

**Proposition 7**: In the asymmetric unrevealed-revealed case \([U,R]\), a single (pure strategy) Nash equilibrium exists in prices. In equilibrium, firm 1 prices at

\[
p_{U,*} = \frac{2((3 + \alpha)(1 + \delta) + 2\beta)}{3(2 + \alpha)}t
\]

and firm 2 prices at

\[
p_{R,*} = \frac{(6 + \alpha)(1 + \delta) + 8\beta}{3(2 + \alpha)}t.
\]

Proof of Proposition 7. Here consumers engage in mental accounting, but only the manager in charge of pricing for firm 2 is of, and incorporates such accounting into the pricing decision. The manager in charge of pricing for firm 1 acts according to conventional economic assumptions.

Following (a15), given any price \( p_2 \), the manager in firm 1 expects that for any price \( p_1 \) the consumer who is indifferent between purchasing from seller 1 and seller 2 is located at:
\[ x^+ = \frac{p_2 - p_1 + t(1 + \delta)}{2t(1 + \delta)} \]  
(a20)

The expected profits to seller 1 on charging price \( p_1 \) is denoted by:

\[ p_1 \left( \frac{p_2 - p_1 + t(1 + \delta)}{2t(1 + \delta)} \right) \]  
(a21)

Following (a18), given any price \( p_1 \), the manager in firm 2 expects that for any price \( p_2 \) the consumer who is indifferent between purchasing either seller is located at the following distance (from the location of seller 2):

\[ x^{++} = \frac{1}{2} - \frac{(p_2 - p_1)(2 + \alpha)}{4t(1 + 2\beta + \delta)} \]  
(a22)

The expected profits to seller 2 on charging price \( p_2 \) are denoted by:

\[ p_2 \left( \frac{1}{2} - \frac{(p_2 - p_1)(2 + \alpha)}{4t(1 + 2\beta + \delta)} \right) \]  
(a23)

Differentiating expression (a21) wrt \( p_1 \) and expression (a23) wrt \( p_2 \) and equating these differentials yields the reaction curves of the sellers. Solving the corresponding FOCs yields the following equilibrium prices:

\[ p_1^* = \frac{2((3 + \alpha)(1 + \delta) + 2\beta)t}{3(2 + \alpha)}; \quad p_2^* = \frac{((6 + \alpha)(1 + \delta) + 8\beta)t}{3(2 + \alpha)} \]  
(a24)

In reality, the assumptions of the manager in charge of pricing for firm 2 are correct—consumers engage in mental accounting. Substituting equilibrium prices from (a24) into (a22) yields the market share of seller 2 when the market clears. The residual market is captured by seller 1. Multiplying prices in (a24) by the respective market shares yields equilibrium profits. See the row corresponding to case [U,R] in Table 2 for the equilibrium outcomes.

\[ \text{APPENDIX 2} \]

\textbf{Consumer utility under mental accounting when both consumption and payment occur in each period}

27
Following Prelec and Loewenstein (1998), the utility of a forward-looking consumer who engages in mental accounting and located at a distance $x$ from a seller is constructed as follows:

**Period 1**

(a) Conventional utility from obtaining/ using the product (or utility when “free”): $r - tx$

(b) Imputed cost of consumption: $-\alpha \frac{(r - tx)}{2(r - tx)} 2p = -\alpha p$

(c) Conventional (dis)utility from payment: $-p$

(d) Imputed benefit from payment: $\beta \frac{p}{2p} (2(r - tx)) = \beta(r - tx)$

**Period 2**

(e) Conventional utility from obtaining/ using the product (or utility when “free”): $r - tx$

(f) Imputed cost of consumption: $-\alpha \frac{(r - tx)}{(r - tx)} p = -\alpha p$

(g) Conventional (dis)utility from payment: $-p$

(h) Imputed benefit from payment: $\beta \frac{p}{p} (r - tx) = \beta(r - tx)$

Adding together the components of utility after appropriately discounting the components from period 2, the total utility experienced by a consumer who engages in mental accounting is denoted by:

\[ (1 + \delta)[(1 + \beta)(r - tx) - (1 + \alpha)p] \]  

The pattern of the proofs follows that for the case where all payments to the sellers are made upfront (see Appendix 1), and are available from the authors on request.
ENDNOTES

1 In their theory, Kahneman and Tversky advanced the notion of a value function that differed from the conventional utility function in three important ways: (a) the carrier of value were changes in wealth or welfare, rather than their final states—hence the value function was defined in terms of changes (positive or negative) from a reference point; (b) the value function was generally concave for gains and convex for losses; (c) the value function was steeper for losses than for gains. Prospect theory has been successful in explaining a range of behaviors that were difficult to explain using neoclassical notions of utility.

2 We assume that no second hand market exists. This circumvents the well-known problems related to durable goods markets, which are not of central interest in this paper.

3 Alternatively, the market can be described in terms of characteristics space as well. There, $t$ represents the disutility of the consumer for each (arbitrarily defined) unit that the product differs from his or her ideal product.

4 For convenience, we assume that utility is measured in terms of its monetary equivalent and drop the payment/ utility conversion parameter in Prelec and Loewenstein (1988).

5 We assume in the monopoly case that $r < \frac{t(1 + 2\beta + \delta)}{(2 - \alpha)(1 + \delta) + 8\beta}$. This ensures that the market is not fully covered at the profit maximizing price across the conventional (C), revealed (R) and unrevealed (U) cases.

6 The analytical expressions for consumer and social surplus are complicated and are not discussed here.

7 Proofs follow those in the basic model and are available from the authors on request.
### TABLE 1

**MONOPOLY RESULTS**

<table>
<thead>
<tr>
<th>Case</th>
<th>Price</th>
<th>Market size</th>
<th>Profits</th>
<th>Consumer surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional case (C)</td>
<td>$(1 + \delta) \frac{r}{2}$</td>
<td>$\frac{r}{t}$</td>
<td>$\frac{1 + \delta}{2} r^2$</td>
<td>$\frac{1 + \delta}{4} r^2$</td>
</tr>
<tr>
<td>Unrevealed case (U)</td>
<td>$(1 + \delta) \frac{r}{2}$</td>
<td>$\frac{2(1 + 4 \beta + \delta) - (1 + \delta) \alpha}{2(1 + 2 \beta + \delta)t}$</td>
<td>$\frac{(2(1 + 4 \beta + \delta) - (1 + \delta) \alpha)(1 + \delta)}{4(1 + 2 \beta + \delta)t} r^2$</td>
<td>$\frac{(2(1 + 4 \beta + \delta) - \alpha(1 + \delta))^2}{16(1 + 2 \beta + \delta)t} r^2$</td>
</tr>
<tr>
<td>Revealed case (R)</td>
<td>$\frac{1 + 2 \beta + \delta}{2 + \alpha} r$</td>
<td>$\frac{r}{t}$</td>
<td>$\frac{1 + 2 \beta + \delta}{(2 + \alpha)t} r^2$</td>
<td>$\frac{1 + 2 \beta + \delta}{4t} r^2$</td>
</tr>
<tr>
<td>Case</td>
<td>Price</td>
<td>Market share</td>
<td>Profits</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------</td>
<td>--------------</td>
<td>------------------------------</td>
<td></td>
</tr>
<tr>
<td>C,C</td>
<td>((1 + \delta)t)</td>
<td>(\frac{1}{2})</td>
<td>(\frac{(1 + \delta)t}{2})</td>
<td></td>
</tr>
<tr>
<td>U,U</td>
<td>((1 + \delta)t)</td>
<td>(\frac{1}{2})</td>
<td>(\frac{(1 + \delta)t}{2})</td>
<td></td>
</tr>
<tr>
<td>R,R</td>
<td>(\frac{2(1 + 2\beta + \delta)t}{2 + \alpha})</td>
<td>(\frac{1}{2})</td>
<td>(\frac{(1 + 2\beta + \delta)t}{2 + \alpha})</td>
<td></td>
</tr>
</tbody>
</table>

**Firm U**

\[
\text{C, C: } \frac{2((3 + \alpha)(1 + \delta) + 2\beta)t}{3(2 + \alpha)} \quad \frac{(6 - \alpha)(1 + \delta) + 16\beta}{12(1 + 2\beta + \delta)} \quad \frac{(3 + \alpha)(1 + \delta) + 2\beta)(6 - \alpha)(1 + \delta) + 16\beta)t}{18(2 + \alpha)(1 + 2\beta + \delta)}
\]

**Firm R**

\[
\text{C, C: } \frac{2((3 + \alpha)(1 + \delta) + 8\beta)t}{3(2 + \alpha)} \quad \frac{(6 + \alpha)(1 + \delta) + 8\beta}{12(1 + 2\beta + \delta)} \quad \frac{(6 + \alpha)(1 + \delta) + 8\beta)^2t}{36(2 + \alpha)(1 + 2\beta + \delta)}
\]
FIGURE 1

Profits Under Various Strategy Pairings (Plotted For $\beta = 0.25$, $\delta = 0.95$, $t = 1$)